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ISSUES IN MANAGING WATER CHALLENGES AND POLICY INSTRUMENTS: REGIONAL PERSPECTIVES AND CASE STUDIES

Prepared by an IMF Staff Team

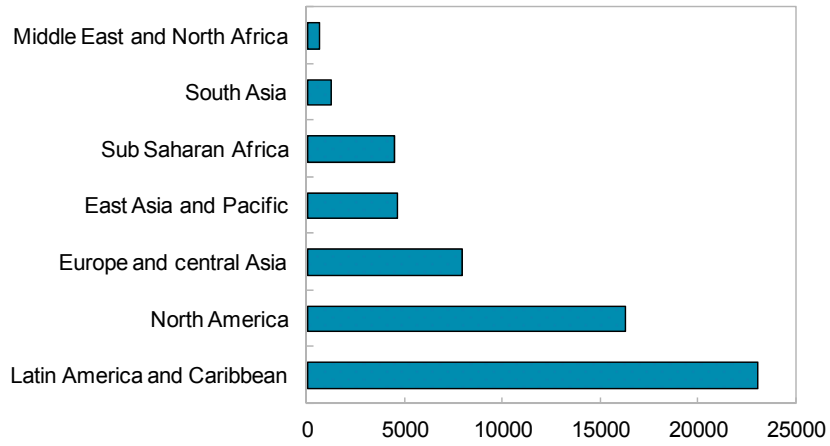
CONTENTS

REGIONAL PERSPECTIVES

A. Key Water Issues in Sub-Saharan Africa[1]

1. *Sub-Saharan African (SSA) countries are characterized by highly variable water resources, with* relatively low per capita supply on average. Countries in the western Sahel, eastern horn, and southern tip have scarce access to watersheds and highly variable rainfall (e.g., Burkina Faso, Kenya, Niger, Zimbabwe), with relatively abundant resources in the middle of the continent (Angola, Cameroon, Democratic Republic of the Congo (DRC), Republic of Congo). On average, SSA countries have relatively limited water resources compared to other regions of the world (Figure 1).

Figure 1. Annual Renewable Freshwater Resources per Capita *(m^3/person/year)*



Source: FAO, *Aquastat*.[2]

2. Despite low per capita supply of resources, "water stress" (as defined elsewhere in this exercise) is tempered by low annual withdrawals, reflecting both low access rates and low depth of access to water. On average, SSA countries withdraw the lowest annual volume per capita of all regions (Figure 2) and display the lowest rate of access to drinking water (64.5 percent), except for Oceania (55.2 percent).[3] Chief among the reasons for this low access is a deficit of infrastructure (including energy), reflecting insufficient, outdated, or poorly maintained water storage, distribution, and treatment facilities. The annual infrastructure investment gap in Africa's water sector is estimated to be $22 billion (Foster and Briceño-Garmendia 2010). The infrastructure deficit is magnified by poor management, including through poor maintenance, waste, below-cost-recovery tariffs, and low collection rates. Ironically, such problems seem more pronounced in some countries with relative water abundance. Particularly acute examples are DRC and Angola, gifted with some of the most ample supplies of water resources in the world, yet with some of the lowest rates of access

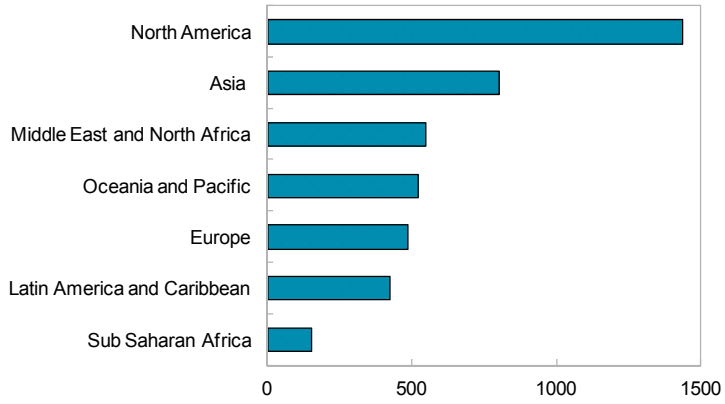
[1] Contributors: Laure Redifer and Samba Mbaye.

[2] Aquastat is a global water information system, developed by the Land and Water Division of the Food and Agriculture Organization (FAO) of the United Nations, http://www.fao.org/nr/water/aquastat/main/index.stm. The main mandate of the program is to collect, analyze, and disseminate information on water resources, water uses, and agricultural water management, with an emphasis on countries in Africa, Asia, Latin America, and the Caribbean.

[3] The concept of "access" masks large discrepancies across regions in the amount of access per person.

to drinking water in SSA (46 and 54 percent, respectively). On the other hand, other SSA countries have been successful in expanding access through large-scale investment and sound management strategies. These countries have often been able to achieve full recovery of costs for drinking water, partly through the application of a progressive tariff grid (Burkina Faso, Lesotho, Mozambique, and Seychelles).

Figure 2. Annual Freshwater Withdrawals per Capita
(m^3/person/year)



Source: FAO, *Aquastat*.

3. There is a pronounced lag in the rate of access of rural vs. urban areas. On average in SSA countries, there is a 28 percentage point gap between urban and rural rates of access to drinking water.[4] In several countries, the responsibility for operating rural water systems has been decentralized and transferred to local communities, as opposed to urban areas, where the responsibility generally falls to a publicly owned water utility. Increasing access to drinking water in rural areas and the efficiency of their operations is one of the main challenges in most African countries and the object of numerous ongoing initiatives by development partners. To improve rural access and irrigation, the authorities have often invested in smaller-scale mechanisms, such as wells, small reservoirs, and rainwater collection schemes.

4. In general, access to improved sanitation in SSA lags far behind drinking water access. As of 2012, average access to improved sanitation was 35 percent, with a 20 percentage point gap between urban and rural access rates.[5] There are numerous factors responsible for this: cultural, difficulties in charging for access, lack of maintenance, and hoarding.

5. Water challenges in SSA put significant constraints on growth, but these are difficult to quantify. Water in most SSA countries is concentrated on agricultural and household use, followed by energy generation and industrial uses. Because agriculture is a key component of growth, employment, and subsistence in most SSA countries, water supply and variability are key

[4] WHO/UNICEF Joint Monitoring Program for Water Supply and Sanitation, http://www.wssinfo.org/data-estimates/.

[5] WHO/UNICEF Joint Monitoring Program for Water Supply and Sanitation.

determinants of growth, agricultural productivity, and food security. Variations in GDP growth are highly correlated with rainfall, with growth affected strongly by drought and flood events. A World Bank study (for period 1981–2004) suggested that GDP growth in Mozambique is reduced by about 1.1 percentage points annually due to the impact of shocks typically occurring every five years (World Bank 2007a). The vulnerability of agriculture to consistent water supplies also leads to risk-minimizing strategies that favor low-return, low-risk crops over those with high returns and high risk. Finally, in many countries, low or difficult-to-access water supplies negatively impact women's participation in income-generating activities and education, as women and girls are usually in charge of fetching water. The costs of gaps in improved sanitation are numerous, including disease, water contamination, violence, lost time, etc. Sharing access of water across country borders does not seem to be a large source of stress in SSA, with a few exceptions.

6. Water stress will become more acute going forward, due to high population growth, urbanization, structural transformation, climate change, and contamination. Currently, most SSA countries are not classified as "water stressed," since per capita withdrawals remain lower than per capita supplies. However, with an average population growth rate of around 2.5 percent, per capita supplies will quickly diminish. Many countries report that increased urbanization and the development of more water-intensive activities have put stress on existing infrastructure. Several countries report that the quality of water resources is deteriorating due to contaminants, ranging from fertilizers to mining activities. Almost all SSA countries have extensive infrastructure development strategies for the water sector, many with support from development partners.

B. Key Water Issues in Middle-Eastern and Central Asian Countries[6]

7. Middle-Eastern and Central Asian countries face important water challenges. Many countries are faced with high water stress, given limited renewable water resources. Much of the Middle-Eastern and North African (MENA) region already faces difficulty meeting current water demand, and per capita water availability in the MENA region is projected to fall by half by 2050 (World Bank, 2007b). Some economies, particularly countries in Caucasus and Central Asia (CCA), as well as Afghanistan, are highly water intensive while facing significant water stress. Countries in both the MENA and CCA regions share significant water resources across international borders, adding an additional layer of complexity to their water management challenges.

8. While past water policy has led to some successes, important challenges remain. Countries have a long history in implementing water policy, including, over the last few decades, large public investment programs. As a consequence, the MENA region's proportion of surface freshwater resources stored in reservoirs is by far the highest in the world. Overall access to improved water and sanitation is relatively widespread. However, it has been uneven, with rural populations in oil-importing countries at particular disadvantage. In addition, individual well drilling has led the MENA region to use more of its renewable and non-renewable water resources than

[6] Contributor: Harald Finger with inputs from the country teams.

other regions, with regulators having insufficient capacity to control the extraction. There remains ample scope for improving resource management, in light of continued allocation of water to low-value uses, significant service outages, vulnerability to droughts and floods, overextraction of groundwater, and water-related environmental problems.

9. In addition to natural water scarcity in often arid climates, three sets of issues are important in Middle-Eastern and Central Asian countries:

- **Subsidies or lack of metering.** The prevalence of water subsidies and/or the failure to properly meter and bill for water use—both for domestic use and in agriculture—encourages overconsumption and can imply sizable costs for the public sector (often outside of budgets). For example, costs are estimated at around 2 percent of GDP in the Gulf Cooperation Council (GCC) countries, in part reflecting the high costs of desalinating water, which are not passed on to consumers; and 1 percent of GDP in Algeria and Jordan. Issues of subsidies or lack of metering are prevalent in Algeria, Armenia, Djibouti, Egypt, the GCC countries, Iraq, Jordan, Kyrgyz Republic, Lebanon, Mauritania, Pakistan, Sudan, Tunisia, and Turkmenistan. Tajikistan faces water-related financial sector issues linked to ailing utilities' defaulted bank loans. In Yemen, subsidized diesel encourages overconsumption because it makes pumping of groundwater relatively cheap.
- **Infrastructure issues and water management.** Aging infrastructure or general lack of adequate infrastructure lead to low water quality and large network losses in many countries, reinforcing water shortages. Examples include Afghanistan, Armenia, Azerbaijan, Iraq, Kyrgyz Republic, Pakistan, Sudan, Turkmenistan, West Bank/Gaza, and Yemen. In a number of cases, water supply is rationed (e.g., Jordan, Lebanon), leading the private sector to step in with more reliable but also more expensive ways to supply water (such as with water trucks). The estimated cost of infrastructure needs to address these issues can be sizable (for example, in Djibouti, Kyrgyz Republic, and Lebanon).
- **Potential for cross-border coordination issues**. Actual or potential cross-border issues can come into play where water sources are shared among countries. These are often linked to existing or planned dams for flood control, electricity generation, and irrigation. Examples of cross-border sharing of significant water resources include Egypt/Sudan/Ethiopia, Jordan/Israel/West Bank, Iraq/Turkey/Syria, Afghanistan/Iran/Uzbekistan/Turkmenistan/Pakistan, India/Pakistan, Uzbekistan/Tajikistan/Kyrgyz Republic.

10. Water challenges in Middle-Eastern and Central Asian countries can have important macroeconomic implications. Reliance on, and high variability of rainfall can have a sizable impact on economic growth, as agricultural output directly depends on it (for example, Morocco). More broadly, water scarcity constrains productivity of agriculture and, to some extent, industries, thereby depressing economic growth potential. In some countries, underpricing of water and/or lack of collection lead to costly resource misallocation (land used for water-intensive crops and housing construction in dry areas). Sizable water subsidies (and energy subsidies that help users extract ground water) exacerbate fiscal imbalances and/or crowd out more efficient uses of scarce resources. Some countries face large water infrastructure investment needs that have significant

macroeconomic impacts and cannot be met from their own resources or by commercial borrowing (for example, Djibouti).

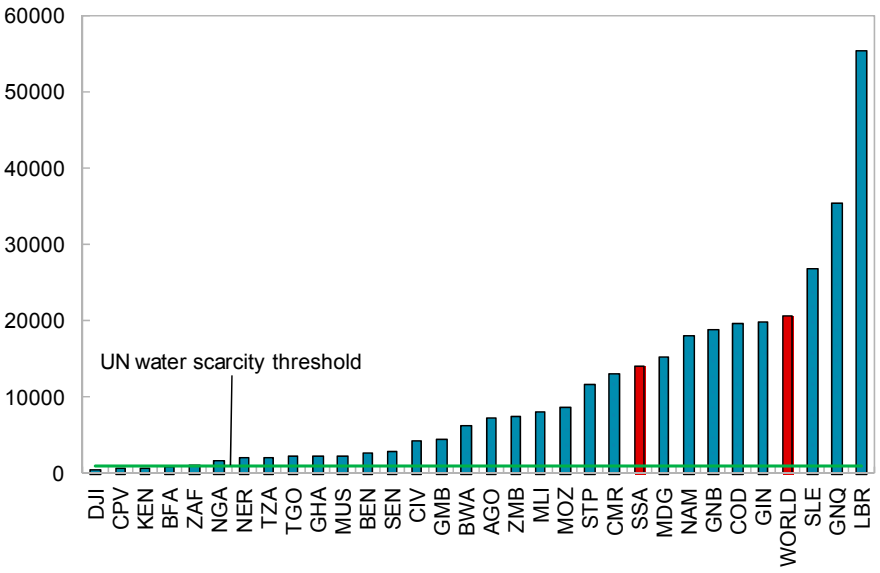
11. The region also features some relative success stories. These include Algeria, which has achieved continuous water supply in Algiers after a decade of massively investing in the water sector, and Tunisia, which has been implementing active water management policies since the 1970s and as result has achieved the highest access rates to water supply and sanitation services in the MENA region. That said, both countries still face important issues such as costly water subsidies.

CASE STUDIES

C. BURKINA FASO[7]

12. Burkina Faso has one of the lowest per capita supplies of water in SSA and in the world (Figure 3). A land-locked West African country, Burkina Faso's climate is tropical, with Sahelian (desert) dominance. Burkina Faso is well below the United Nations water scarcity threshold, largely resting on a crystalline surface that does not support productive aquifers. The country relies exclusively on surface water, and up to 49 percent of its renewable annual freshwater resources are consumed by evaporation and, to a lesser extent, water sharing agreements. Thus, water collection, treatment, and distribution are critical. Water variability is also a major challenge. Rainfall from year to year varies as much as 50 percent, causing ongoing droughts that affect food security. Seasonal rainfall fills reservoirs and rivers, but they systematically run dry in the dry season. The timing of rain is a determining factor: if too much time elapses between rainfalls, crops fail, even in abundant rain years.

Figure 3. Burkina Faso: Total Renewable Water Resources *(m^3/person/year)*



Source: FAO, *Aquastat*.

[7] Contributors: Laure Redifer and Samba Mbaye.

13. However, Burkina Faso's low level of water use has kept supply constraints from being binding. Annual water withdrawals per capita are half the SSA average and about one-eighth the world average. Low use compared to SSA is related to depth of access, as an adaptation to scarcity, and low access to improved sanitation (Table 1). Agriculture accounts for the lion's share of usage. Water scarcity and variability have brought about innovation through increasingly efficient home-grown means for meeting agricultural demands for water. For example, in sugarcane fields, large cisterns collect water and distribute it via highly water-efficient drip irrigation methods. The introduction of genetically modified cotton allowed more drought- and pest-resistant plants that required one-third the fertilizer applications and doubled yields.

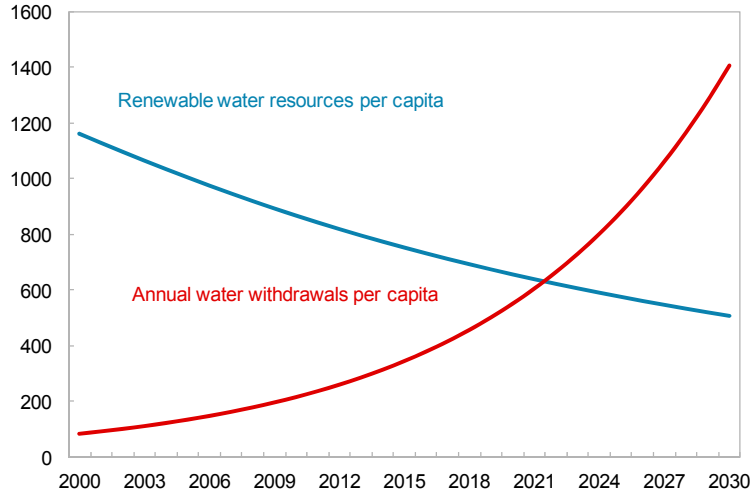
Table 1. Burkina Faso: Selected Indicators

	Annual water withdrawals per person (m3)	Percent of pop. With access to improved water	Percent of pop. with access to improved sanitation	Dam capacity per capita (m3)
Burkina Faso	62	82	19	321
SSA average	152	73	35	1146
World Average	473	89	72	1785

Sources: WHO/UNICEF, *Joint Monitoring Program* and FAO, *Aquastat*.

14. Despite major strides on drinking water in urban areas, a significant rural-urban gap remains, and progress on improved sanitation has lagged considerably. Over the last two decades, access to drinking water has doubled, with nearly universal access in urban areas and access in rural areas only catching up to earlier urban levels. While the Millennium Development Goals (MDG) target for drinking water has already been met, with the 5th highest progress in the world, the target for improved sanitation will not be met (WHO and UNICEF, 2014). Access to improved sanitation is constrained by an acute deficit of infrastructure.

Figure 4. Burkina Faso: Actual and Projected per Capita Supply and Use, 2000–30
(m^3)



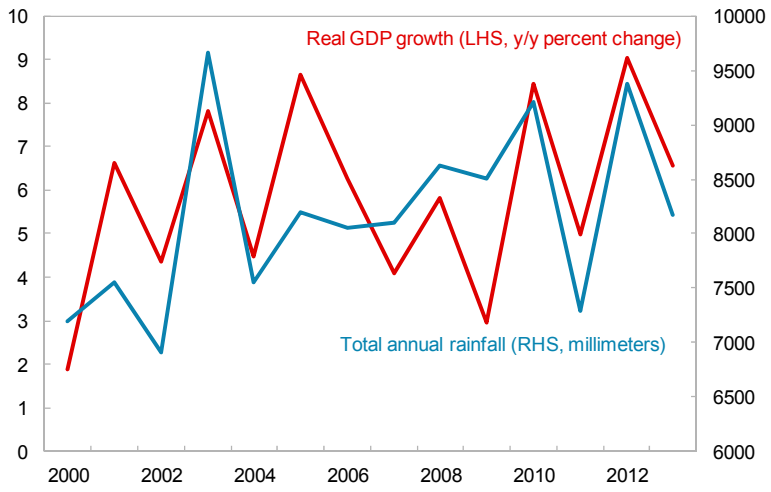
Sources: FAO, *Aquastat*; World Bank, *World Development Indicators*; and IMF staff calculations.

15. Going forward, water demand is likely to outpace the country's low supply, reflecting mainly population growth, urbanization, and climate change. As a function of population

growth alone, per capita water use could outstrip supply in roughly 10 years. In addition, water pollution (including fertilizers and cyanides in informal mining), encroaching desertification, and land degradation will put pressure on supplies (Figure 4).

16. Burkina Faso's water challenges impose significant constraints on growth and social outcomes, with significant fiscal costs (Figure 5). The main channel of impact on growth is the agricultural sector, which employs a large majority of the population (70 percent of the labor force), provides a significant contribution to growth (25 percent), and is highly dependent on annual rainfall. Growth is indirectly impacted by the health consequences of low access to drinking water and improved sanitation and the costs associated with water fetching, especially for women. The World Bank's Water and Sanitation Program recently estimated that the cost of insufficient access to improved sanitation in Burkina Faso was as much as 2 percent of 2010 GDP, but addressing the sanitation deficit will require substantial infrastructure investment. Beyond infrastructure costs, fiscal costs include contingency food stocks, subsidized prices, and distribution mechanisms to ensure food security in light of ongoing droughts and floods. The 2011–12 drought, for example, created fiscal costs of around 2–5 percent of GDP.

Figure 5. Burkina Faso: Real Growth and Rainfall



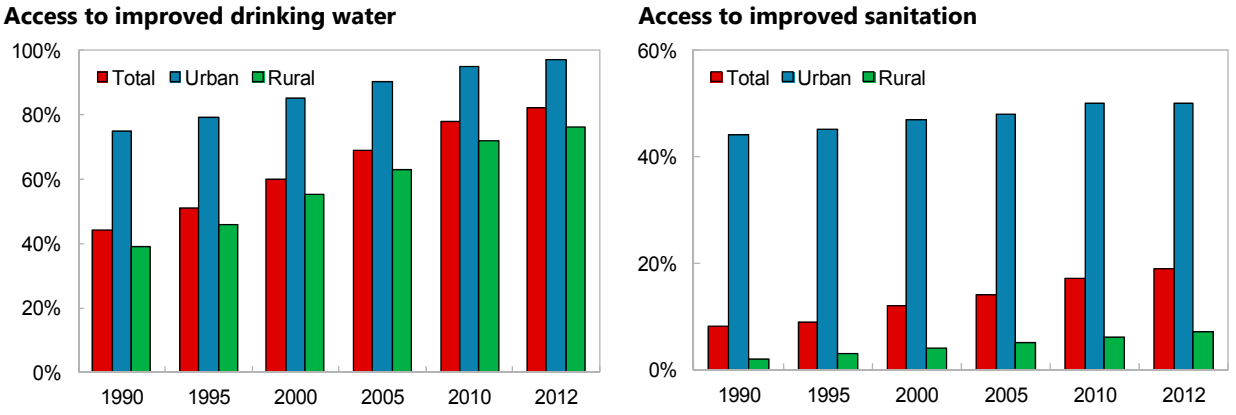
Sources: Burkinabe authorities and IMF staff estimates.

17. In the face of its considerable water challenges, Burkina Faso has developed a widely praised approach to water management. Two aspects of its strategy are particularly notable: (i) water access in urban areas; and (ii) investments in agricultural productivity and water storage and irrigation. These investments have coincided with a sustained increase in growth and a concurrent drop in its variability. Five-year average real growth doubled between 1990 and 2012, with a decline in the standard deviation from 3.8 to 2.5 percentage points over the same period, despite numerous shocks.

18. Burkina Faso's public water utility (ONEA) has been responsible for a remarkable improvement in the population's access to drinking water (Figure 6). The company is charged with water management in urban areas. In the early 2000s, three-year performance-based service contracts between ONEA and the government were introduced, bringing in experienced private management from abroad, combined with large infrastructure investments by donors. Elements of the public-private partnership that were essential to its success include: arm's length management contracts; performance benchmarking with independent monitoring; new infrastructure investments

based on strict financial sustainability; performance-based compensation for the private manager; and cost recovery tariffs. As for the latter, a progressive tariff grid was introduced for drinking water, based on the volume of use, with the higher tiers subsidizing the lowest tier, as well as part of sanitation activities. The company has recovery bill rates of 97 percent and low debt ratios and realizes annual profits.

Figure 6. Burkina Faso: Access to Water and Sanitation
(Percent of population)



Source: WHO/UNICEF, *Joint Monitoring Program*.

19. A second notable aspect of Burkina Faso's water management strategy has been its aggressive investment strategy to improve resilience to water scarcity and variability. In the context of its development strategy, since the mid-2000s the country has invested extensively in water collection and storage and productivity-enhancing initiatives in agriculture, including reservoirs, irrigation, crop rotation, genetically modified cotton, and diverse crops. Agricultural productivity has increased notably and cash crops are no longer lost to droughts. One unique innovation is the Bagré "growth pole." Thirty years ago, the river basin was plagued by river blindness. The government bought the land, relocated residents, and flooded the valley to create a huge man-made reservoir. In the past 10 years, the government has invested in industries and supportive services to attract private investors and create jobs around the water source. The reservoir now supports fishing, irrigation for diverse crops, livestock and dairy, eco-tourism, and a hydro-electric power plant.

20. Despite having one of the most challenging water situations in SSA, Burkina Faso has been one of the continent's best performers in providing access to water for its population and reducing its vulnerability to water variability. Some lessons include:

- Restricted access/high costs for water can bring about home-grown solutions to improve efficiency and reduce per capita use.
- Public water utilities can achieve cost recovery for drinking water access. ONEA's focus on independent management, cost recovery, financially sustainable investment, quality of service, and social objectives serve as a model.

- Resilience to variability of water supply can be improved through aggressive government investment strategies, including in introducing diversified crops, land rotation, and use of new technologies (GMO cotton seeds). The decline in the volatility of growth in Burkina Faso suggests that the government's aggressive investment strategy has yielded benefits fairly quickly.
- Avoiding water stress will require more aggressive policies in the future, particularly for countries with high population growth. Even after significant investment, Burkina Faso still faces major water challenges, including a large infrastructure gap, low access to sanitation, and still high vulnerability to water shocks. Going forward, the country will face more pressure on its already-scarce resources, as a result of high population growth, contamination, urbanization, climate change, and structural transformation.

D. DEMOCRATIC REPUBLIC OF THE CONGO[8]

21. The Democratic Republic of the Congo (DRC) has more than half of the water resources of sub-Saharan Africa (SSA). The country's territory is covered by a large system of rivers and lakes, providing 19,967 cubic meters of freshwater per person per year for an estimated population of 77 million, well above the SSA average (14,048.97 cubic meters). In addition, the DRC's large rivers offer a vast potential for electric power generation because of the strength and low variability of the water flow. Rainfall is reliable and abundant across most of the country, averaging 1,545 millimeters (mm) per year, more than twice the continental average of 680mm per year.

22. Despite water abundance, current water usage is far below SSA averages, implying significant untapped economic potential. The population's consumption of drinking water is far below the regional average, and only a fraction (6,800 hectares in 2000) of the potential 4 to 7 million hectares of agricultural land are irrigated. Currently, 356 million cubic meters of water are withdrawn every year, less than 1 percent of the available renewable water resources. That is around 7 cubic meters per person per year against an SSA average of 152 cubic meters, reflecting the poor state of water infrastructure in DRC. Only 46 percent of the population has access to improved drinking water against an SSA average of 73 percent (Table 2).

Table 2. Democratic Republic of the Congo: Selected Indicators

	Annual water withdrawals per person (m3)	Percent of pop. With access to improved water (2012)	Percent of pop. with access to improved sanitation (2012)
DRC	7	46	31
SSA average	152	73	35
World Average	473	89	72

Sources: WHO/UNICEF, *Joint Monitoring Program*; and FAO, *Aquastat*.

[8] Contributors: Rodolfo Maino and Klaus Peter Hellwig.

23. The unavailability of safe drinking water and poor sanitary conditions pose a major threat to public health. The difficult sanitary conditions are a root cause of poor health outcomes in DRC. The mortality of children under the age of five in DRC (11.9 percent) remains higher than in SSA (9.2 percent), with a high prevalence of diarrhea and recurring outbreaks of cholera and other diseases linked to unsafe water. Moreover, malnutrition associated with a lack of safe water continues to affect large parts of the population.

24. The DRC stands as a prime example for the urban/rural gap in access to water that characterizes the water sector throughout SSA. There is considerable heterogeneity in access to improved water with 79 percent of the urban population having access against 29 percent in rural areas. The level of access to improved sanitation facilities is comparable, though low at 29 percent in urban areas and 33 percent in rural areas.

25. Poor management of the water resources has contributed to the weak water outcomes. Since 1990, the national public water utility for urban areas (REGIDESO) has experienced a steep decline in its operational performance. As a consequence, the country's urban water supply coverage rate fell from 88 percent in 1990 to under 79 percent in 2012. Most of REGIDESO systems serving secondary towns are presently out of service due to the combined effect of a lack of electricity and the absence of new investment and maintenance. Moreover, operating costs are significantly higher in DRC than in other SSA countries, weighing heavily on the water administration authorities' finances. Staff expenses amount to 35 percent of REGIDESO's turnover, against 20 percent in Burkina Faso. In addition to its inadequate size, the composition of REGIDESO's staff is skewed toward executives and clerical workers instead of field agents. REGIDESO's dire financial situation is compounded by the lowest bill collection rate in SSA as well as an inadequate tariff structure. The current water tariff structure results in a billing price that is, on average, 80 percent of production cost.

26. Many years of civil war have also been a contributing factor. The armed conflict that has ravaged the DRC since 1997 has led to the destruction and pillaging of crucial water infrastructure. Likewise, critical maintenance work has been neglected over these years, resulting in a sharp drop in access to improved water and sanitation in urban areas from their pre-conflict levels of 88 percent and 32 percent in 1990. Similarly, the use of irrigation in agriculture was more widespread before the civil war with 13,500 hectares of land under irrigation in 1995.

27. Lack of reforms and a poor regulatory environment hamper progress. While improving the water infrastructure would require large investments, the slow pace of institutional reforms remains the main impediment for immediate progress. The water sector is governed by a multitude of conflicting laws and regulations with policies falling into the domains of several ministries and agencies at the national, provincial, and local levels. While a coordinating body has been put in place, a clear distribution of responsibilities is still missing. A proposed law to address these deficiencies and reform the water sector has yet to be passed. As a consequence of the low implementation capacity, only 50 percent of the resources originated from donors and devoted to water projects can be absorbed. Achieving the MDG targets (providing access to safe water to 71 percent of the population by 2015) remains out of reach. To meet its own less ambitious goal of

providing safe water access to 50 percent of the population, the government estimates a required investment of US$171 million per year. In 2007–08, public expenditure on water and sanitation was around US$65 million, or less than US$1 per person.

28. The main takeaways of the DRC water situation are the following:

- Strengthening the institutional environment is crucial for adequate management and expansion of the water infrastructure. The water situation in DRC mirrors the weaknesses of other sectors (mining, oil extraction), where delays in the passage of crucial legislation and limited capacities of state institutions such as ministries and administrative bodies are impeding a full exploitation of an otherwise abundantly available and diversified natural resource.
- The current cross-subsidized system among user categories is not working properly given the very low collection rate.
- Investment in the water and sanitation infrastructure is a potential channel for enhancing the inclusiveness of growth in DRC. Currently, there are large regional differences in the allocation of investment, with a large share of public expenditure directed toward Kinshasa. A more equitable distribution of funds could reduce the urban/rural gap in access to water and sanitation and let the most disadvantaged benefit from DRC's recent growth of mining export revenues.
- Despite the abundance of water resources, international coordination is important for medium-term sustainability. The DRC's surface waters draw from a wider basin covering 10 countries, and major developments in upstream countries would directly affect the quality and quantity of water available in DRC.

E. PAKISTAN[9]

29. Despite having the world's largest glaciers, Pakistan is facing the prospect of water scarcity. Pakistan is among the world's 36 most water-stressed countries, with its agricultural, domestic, and industry sectors scoring high on the World Resource Institute's water stress index. Per capita annual water availability has dropped, fundamentally due to population growth, from 5,600 cubic meters at independence to the current level of 1,017 cubic meters, and is projected to decline further under the current infrastructure and institutional conditions (Figure 7). Demand for water is on the rise, projected to reach 274 million acre-feet (MAF) by 2025, while supply is expected to remain stagnant at 191 MAF, resulting in a demand-supply gap of approximately 83 MAF. Concerns over this widening gap between water supply and demand are compounded by certain characteristics of Pakistan's geography, climate, and hydrological cycle:

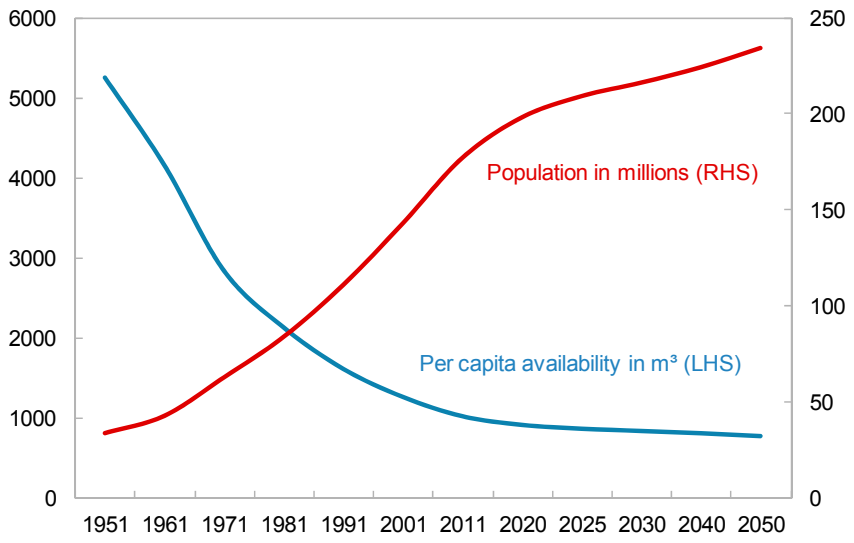
- Pakistan depends on a single source, the Indus system and its tributaries, for most of its water supply needs. Fed mostly by snow and glacier melt in the greater Himalayas, water availability in the Indus system is highly seasonal, with 85 percent of annual river flows occurring during the June-

[9] Contributors: Mansoor Dailami, Tasneem Alam, and Hiba Zaidi.

September period, which coincides with the concentration of rainfall in the monsoon. Rainfall varies from 1,500 mm per year in northern Punjab to 150 mm per year in upper Sindh province.

- Pakistan is exposed to extreme weather conditions, including severe episodes of floods and droughts that wreak significant damage on the country's agricultural, livestock, and water infrastructure. Much of these costs have been attributed to lack of adequate storage capacity and control structures. Total dam storage in Pakistan represents only 30 days of average demand, compared to 1,000 days for Egypt and 220 days for India.

Figure 7. Pakistan: Water Availability
(m^3/person)



Source: Pakistan's Water and Power Development Authority.

30. Pakistan needs to develop an integrated approach to water resource management that prioritizes conservation and sustainable water use through improved cost recovery, upgrading infrastructure, and bringing agriculture under the tax regime. Pakistan has a long history of water resource development, in close engagement with the international donor community. The key challenges facing the country have been well articulated, with a fair degree of consensus emerging on the main policy and institutional reform imperatives. These include:

- **Reform water tariffs and cost recovery.** Tariff reform is critical to ensure sustainable water use in both the agricultural and urban sectors. Canal water is heavily underpriced and cost recovery is poor, resulting in high inefficiency in the use of water and a financially unsustainable irrigation system. The prevalent irrigation water charges (*abiana*) only recover 24 percent of the annual operating and maintenance costs, and collection is only 60 percent of total receivables, imposing a drain on the government budget. The pricing structure for major crops is uniformly based and, thus, does not reflect differential water consumption, even though, for instance, rice consumes 60 percent more water than cotton does. This has impeded adoption of more efficient technology and high-value crops. Furthermore, excessive irrigation water use has resulted in poor water quality (36 percent of groundwater is highly saline). Similar problems of inadequate tariff and low cost recovery have afflicted urban drinking water. Tariffs for water utilities for consumption in households are quite low and have not been revised for several years. Tariff collection varies from 20–80 percent across cities. Access to piped water supply in rural and small towns remains inadequate.

- **Increase investment in water infrastructure.** Pakistan's water infrastructure was historically built to cater to the needs of agriculture, but as urbanization accelerates and industry grows, there will be significant investment needs to build the necessary infrastructure to supply safe drinking water and sanitation. Currently more than 35 percent of the population lacks access to safe drinking water. Harnessing Pakistan's huge hydro potential through construction of new dams and hydropower projects, as highlighted in National Power Policy 2013, also deserves serious attention. With hydro potential of 50,000 megawatts of electricity generation, Pakistan could overcome its energy shortage several times over, notwithstanding the seasonality involved in hydropower generation. Of this potential, only 13 percent has been developed so far at a relatively low cost of 2 cents/kilowatt hour. The country's two existing mega hydropower dams—Mangla and Tarbela, commissioned in 1967 and 1976 respectively—are losing their storage capacity because of rapid silting. In both urban and hydro sectors, reliance on private investment and capital needs to be an integral part of the solution.

31. There are both equity and efficiency rationales for bringing agriculture within the tax net. Because of the country's arid and semi-arid climate, agriculture in Pakistan is predominantly irrigated (90 percent) and consumes about 95 percent of annual available surface water. Though the bulk of farmland is irrigated through the canal system, farmers utilize water from other sources, including groundwater exploitation, and this has increased significantly in recent decades: subsidized water and electricity tariffs have induced adoption and expansion of electric pumps to tap groundwater at an alarming rate. Approximately 60 percent of farm-gate-delivered water in Punjab comes from tube wells. Yet agriculture is largely untaxed (contributing less than 0.1 percent of total tax revenues), even though it accounts for 21 percent of GDP and employs 43 percent of the population.

32. Given water's multifaceted development role and its global dimension, there is room for closer engagement of the IMF through awareness raising and leveraging the ongoing lending arrangement. The IMF's support for water reform in Pakistan should focus on agriculture taxation in the context of the upcoming National Finance Commission's (NFC's) award; phasing out electricity subsidies; and policy design for water pricing as part of the broader energy sector reform.

33. What are the lessons? Water can serve as an engine of economic growth and regional trade expansion in Pakistan. The country has the necessary natural endowment and is blessed with the world's most extensive irrigation system. Harnessing such potential needs virtually a paradigm shift in reframing water policy and management in a national context that emphasizes demand-side measures that would promote conservation and control of excessive groundwater exploitation. Pakistan has a long history of experience with supply-side measures, including construction of mega hydro power projects and dams. Moving forward, the thrust of policy reform needs to be on improving water-use efficiency in agriculture, which continues to dominate water consumption while escaping taxation at the federal level and lightly taxed at the provincial level. This would require greater engagement of stakeholders at the local level in water management and capacity building of water management institutions. Furthermore, encouraging the provinces to reform their agriculture taxation systems in the context of the forthcoming NFC award could be a major step in overcoming

the entrenched political interests of powerful landowners and bringing agriculture into the tax net. The nexus between water and electricity is the other area calling for reform of water and electricity subsidies. Reforming NFC revenue-sharing mechanisms and phasing out electricity subsidies are two major reform areas supported by the current IMF Extended Fund Facility for Pakistan.

F. SINGAPORE[10]

34. Singapore is a densely populated city-state with no natural fresh water resources, apart from rainfall. It is located on an island (and some 60 small islets) with a total area of some 714 square kilometers (roughly the area of five boroughs of New York City). With a population of almost 5½ million, the country is third in the world in terms of population density. Ever since achieving independence, the authorities have been looking into ways to secure its water supply. The "*Four Taps*" strategy, which looks into alternative sources of water, was put in place in the late 1990s and aims at achieving self-sufficiency by 2062. The Singaporean approach is not limited to diversification of the supply sources. It also relies on demand management tools, research and development (R&D), and broad public support.

35. The *Four Taps*, the four sources of water, are:

- *Imports (up to 1,100 thousand cubic meters a day)* have been the main source of water since 1932, when a pipeline from the Malaysian state of Johor was inaugurated. Under the current agreements, expiring in 2061, the country is entitled to receive up to 60 percent of its current needs.

- *Local catchment water (900–1,400 thousand cubic meters a day)* is collected from about two-thirds of the country's territory through a system of 17 reservoirs (started in 1868) and a comprehensive network of drains, canals, rivers, and storm-water collection ponds. The catchment territory is classified as partly protected with certain restrictions on land use in place, with land and water management processes closely integrated. Reservoir water is treated through chemical coagulation, rapid gravity filtration, and disinfection.

- *Reclaimed water (up to 520 thousand cubic meters a day)* refers to used water turned into potable using advanced membrane technologies. The NEWater project originated in 1974 but had to be shelved until 1998 given unreliability of the process and high costs. Today four plants meet up to 30 percent of the nation's water needs, and the capacity is to be expanded to 55 percent by 2060. Although quality of treated water exceeds the WHO standards for drinking water, it is mostly used by industries for non-potable uses.

- *Desalinated seawater (up to 230 thousand cubic meters a day)* is produced by two plants that were launched in 2005 and 2013, are among Asia's largest seawater reverse-osmosis plants, and allow meeting up to 25 percent of the current water needs. The plan is for this source to continue supplying a quarter of the country's water needs in the 2060s.

[10] Contributor: Robert Tchaidze.

36. Singapore employs a pricing policy that aims at discouraging excessive use of water and recovering costs to the fullest extent possible. Unlike in many other countries, both domestic and non-domestic users face the same base tariff, with no cross-subsidization of households by industrial and commercial users. Moreover, beyond a certain level of consumption, households face an additional surcharge that brings the total tariff to the rate higher than that for commercial and industrial users. There is no subsidized "basic" consumption; instead the government provides targeted help for low-income families. Consumers are also charged a flat water-borne fee (to offset costs of treating used water and maintaining public sewage system; for non-domestic users this fee doubles); a flat sanitary appliance fee (charged per sanitary fitting); and a progressive water conservation tax (supposed to reflect the marginal cost of the "next," alternative water sources, including the R&D costs).

37. Rigorous management practices, continued investment in new technologies, and involvement of the broad society are other building blocks in the Singaporean approach. Singapore has a single agency—the Public Utilities Board (PUB)—that is responsible for all aspects of the water cycle, such as collection, production, distribution, and reclamation. The PUB is autonomous and enjoys support both from politicians and the general population. It undertakes significant investments in its own assets as well as assets that are in the government's ownership, but under its management (such as sanitation and drainage infrastructure). Since 2005 it has regularly issued bonds to finance some of these investments.

38. Opening the *third and fourth taps* would have been impossible, had it not been for decades of investment into research and development of new, revolutionary technologies. The PUB cooperates with local and international researchers by making its research facilities available as test-beds and by sharing the costs and risks associated with these tests. This allows it to attract both private and public sector innovators and to remain ahead of the curve in implementation of new technologies. In addition, the National Research Foundation promotes R&D in the water sector through an inter-agency outfit, Environment and Water Programme Office, led by the PUB. Finally, an Institute of Water Policy has been established at the National University in 2008.

39. Given the emphasis put on water-related R&D by the government, Singapore has emerged as an international hub for water-related research. Today, the country is home to over 70 local and international water companies and more than 20 research and development centers. It also hosts an annual event, the Singapore International Water Week, where key global industry players share and co-create innovative water solutions.

40. The PUB encourages every segment of the society to engage in efforts to make use of water resources more efficient. This is done through various public programs that aim at the so-called *3P* of population and public and private sectors and call for cleanup, beautification, and conservation of water resources. The PUB also gathers feedback on its work and suggestions for alternatives from the water industry and the broad community.

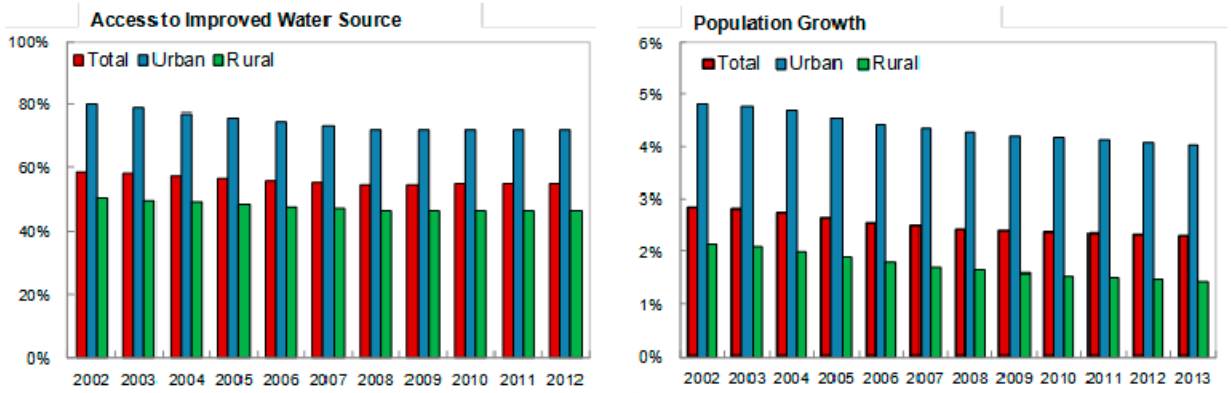
41. What are the lessons? High-level political support for long-range policy objectives and strong institutions, including an autonomous technocratic institution such as the PUB, seem to be among the key factors that enabled Singapore to put in place such a comprehensive strategy. The rapid improvement in living standards and industrialization of the economy, with a significantly reduced role of the agricultural sector, may have helped secure broad support for the government's water management policies.

G. YEMEN[11]

42. Yemen is one of the world's most water-deficient countries. The extremely low level of water has led to increasing local conflict over water rights since the year 2000. Groundwater and rainfall are the sole sources of freshwater. Water availability per capita is around 2 percent of the world average, and has been trending downward in recent years, from 113 cubic meters in 2002 to 86 m^3 in 2013. Over the same period, access to "improved water sources" declined from 60 percent to 55 percent of the population in aggregate. Both urban and rural population access to safe water also declined, with the latter now standing at 46 percent (Figure 8).

43. Demand for water is rising, while renewable supply has remained stable and groundwater is being depleted. Several factors contributed to the surge in demand for water in recent years, including rapid population growth, urbanization, and economic growth. Annual freshwater use has increased from 3.4 billion m^3 in 2002 to 3.9 billion m^3 in 2010. Meanwhile, annual renewable supply remains relatively constant at 2.5 billion m^3 during the same period, and the inefficient and unregulated use of groundwater is depleting Yemen's deep aquifers.

Figure 8. Yemen: Water Access and Population Growth
(Percent of population, percent)



Source: World Bank, *World Development Indicators*.

[11] Contributors: Mohd Zaher and Fouad Al-Kohlany.

44. Disparity in access to safe water follows the poverty map. The majority of urban consumers have access to a public water network, even though around 40 percent rely on trucked water; this figure is considerably higher for rural residents because fewer people are connected to public water networks. According to the World Bank, the cost of trucked water is up to 10 times that of network water.[12] The cost and effort involved in obtaining safe water are also considerably less for the well-to-do, compared to the poor. The high cost of water is forcing many rural women and girls to walk for hours fetching water.

45. The bulk of water resources is consumed by the agricultural sector, supported by generous diesel fuel subsidies. The share of the agricultural sector in water consumption remained relatively stable over the last decade, around 91 percent. Irrigating qat, a local cash crop and a mild stimulant, consumes around 40 percent of water used in agriculture. Similar to qat, a significant portion of agricultural exports, such as bananas, is also water intensive. The expansion of these crops has benefited from subsidies, which kept the price of diesel fuel, used in pumping groundwater for irrigation, extremely low until mid-2014.

46. The authorities have reduced fuel subsidies and raised the price of diesel by 50 percent since July 2014. While this move was largely motivated by the need to reorient public spending in favor of growth-oriented capital and development spending, it is expected to reduce the rapid depletion of groundwater resources and the distorted production costs that favor water-intensive crops such as qat. At the same time, to improve the poverty orientation of the budget, the authorities have increased the Social Welfare Fund monthly transfers to households by 50 percent.

47. Notwithstanding data limitations, a number of indicators point to significant socio-economic costs associated with water shortage in Yemen. The contamination of water sources and the decline in water availability to households have contributed to the spread of diseases in rural areas. Water and fuel shortages—particularly acute before the reduction in fuel subsidies—and more recently the increased production costs resulting from higher fuel prices have also placed farmers and agricultural workers at risk of unemployment, further exacerbating Yemen's economic situation.

48. Going forward, the water situation in Yemen is expected to deteriorate further. Assuming the continuation of the current consumption and production patterns, weak governance will impose a toll on the water sector. The fact that groundwater—which is by nature the most difficult to regulate—plays a key role in Yemen makes the governance of the sector particularly challenging. Recent estimates show that non-renewable water resources are expected to be exhausted within one to two decades in the most densely populated highlands, putting major Yemeni cities in a dire water situation. Sana'a, the capital city, is 2,000 meters above sea level in the water-scarce mountain ranges, where the groundwater table is dropping by more than six meters a

[12] World Bank 2012.

year. The location and altitude of the capital city are also making the cost of trucking or pumping water from coastal areas very expensive.

49. The government's response to the water crisis has been lagging. With help from the World Bank and GIZ, the government of Yemen introduced a water sector strategy in 2005, with the chief objective to gradually reduce the rate of groundwater depletion. The strategy has had no impact beyond enhancing awareness of water challenges in Yemen. Minimal impact on water usage and practices has been observed.

50. Political instability over the past four years hampered investments in the water sector and raised costs. The difficult security situation, lack of government presence in certain areas, and the inability to enforce the rule of law have all weakened the government's endeavors to rationalize water usage. The impact of the 2011 crisis on the water sector was severe. There has been widespread damage to installations and equipment and declining rates of water billing and collection.

51. Desalinization has been proposed as a long-term answer. However, this is an energy-intensive solution and will require large long-term investment. Without donors' support, this solution seems infeasible, especially as the country's fiscal balances can barely support its basic infrastructure needs. Furthermore, restoration of security in Yemen remains a priority to resume many of the foreign-financed water projects suspended following the 2011 crisis.

52. In summary, Yemen's water future appears challenging, and a broad reform agenda is needed to rationalize water consumption and improve efficiency. Unless addressed properly, the water sector difficulties could further delay the country's development, lead to internal migration and tribal conflict, and increase the cost of water in the major urban centers. Any viable solution should incorporate better management of water resources, public and private investments, foreign aid, closing the urban-rural water gap, and boosting water supply. As the largest water consumer, the agricultural sector in Yemen deserves special attention. Efforts should be scaled up and directed toward enhancing the efficiency of production and irrigation. The high urbanization rate in Yemen also requires the achievement of more inclusive growth to moderate the unbalanced growth of urban areas. Strengthening regulation and enforcement mechanisms is a priority to stop the widespread and unregulated extraction of underground water. Reforms should also encompass creating an enabling business and regulatory environment to encourage more active private sector participation in financing water projects and infrastructure.

53. The water sector will benefit from the full implementation of structural reforms embedded in the Extended Credit Facility program (ECF). Improving the overall efficiency of the economy through macro-critical structural reforms, particularly in terms of completing the phase-out of highly distortive energy subsidies, directing public resources to growth-enhancing investment and poverty-reducing transfers, and improving public sector management, will also benefit the water sector. These will be in the form of efficiency gains and water savings as farmers adapt their farming practices in response to changes in cost of inputs. Supporting the private sector's activity

and investments will also benefit from enhanced financial intermediation, better access to finance by small and medium-size enterprises, and an improved business environment.

54. The way forward: there is an urgent need for Yemen to improve its water resource management. A broad reform agenda, along with well-coordinated donor support, is needed to boost water supply, rationalize consumption, and improve efficiency. Most important, Yemen needs to implement price-based reforms and to change the legal and social understanding of water rights to reflect the true cost of water resources and minimize inefficient use.

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