Water Governance in the Arab Region

Managing Scarcity and Securing the Future

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Foreword by the Regional Director, UNDP Regional Bureau for Arab States

A child struggles in the arid countryside for a drink of clean water; a family flees a drought and relocates to a city not ready; a community sees its social fabric stretched by competition for the essentials of life; a country swept by famine: The impacts of the water crisis facing the Arab world are dire.

These struggles are the human face of the statistics provided in this report: that the terrain of the Arab region is over 87 per cent desert; that the rainfall we receive is well below the world average; that the average person in the Arab region accesses one-eighth the renewable water that the average global citizen enjoys; and that 14 of the world's 20 most water-stressed countries are here.

Water challenges can and must be addressed if the Arab region is to achieve the Millennium Development Goals, attain shared prosperity, and reach a future of sustainable human development. Addressing water challenges now can also help strengthen resilience by managing the risk of potential crises that could result from inaction: such as unplanned migration, economic collapse, or regional conflict.

Resolving the crisis will require enduring progress towards political, social, economic and administrative systems that shape the use, development and management of water resources and water delivery in a more effective, strategic, sustainable and equitable direction.

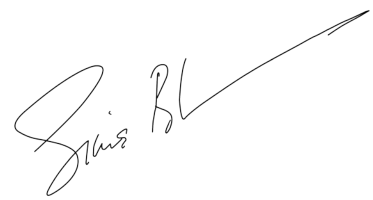
As this report presents the issue, the need to improve water governance requires much more than efforts to increase the supply of water. Rather, addressing the crisis requires strengthening technical capacities and national institutions and developing mechanisms to increase the transparency and accountability of public water services.

The task ahead is for all stakeholders — including government, civil society, and the private sector— to arrive at collective understandings of diverse needs and to develop approaches to water governance that yield the highest shared value of water resources.

Progress towards many of the solutions is already underway in different ways across the region. However the urgency of the current situation requires accelerated and improved collective effort. Already several Arab countries are on the verge of running out of renewable water. Droughts and famines have become more frequent and agricultural output is falling behind population growth.Moreover, the impacts of climate change and demographic and economic growth exacerbate the challenge. Current projections show that by the year 2025 the water supply in the Arab region will be only 15 per cent of what it was in 1960.

Progress requires integrated approaches to the water crisis that address the links between water and health, education, poverty alleviation, environmental protection, job creation, and food and energy security. It also requires increased political attention and commitment even amid the challenging political environment of the region today. The key right now is to more broadly disseminate knowledge, to bring more stakeholders into the dialogue, and to ensure that dealing with the water crisis remains a major priority even as the region continues to pass through difficult times.

My hope is that this report will serve as a vital tool in UNDP's cooperation with the Arab region, where we are on the ground in 18 countries working with governments and other stakeholders to develop national capacities and achieve results in moving towards sustainable development pathways that reduce poverty and inequality, towards inclusive and effective governance systems that deliver results for people, and towards resilience to the risks of natural disaster and conflict. Water governance sits at the crossroads of these development objectives and I hope that this report fosters progress towards advances in human development across the entire Arab region.



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Acronyms

BOT	Build-Operate-Transfer
DALY	Disability-Adjusted Life Year
FAO	Food and Agriculture Organization
GDP	Gross Domestic Product
IWRM	Integrated Water Resources Management
MDGs	Millennium Development Goals
MENA	Middle East and North Africa
NGO	Non-Governmental Organization
PWA	Palestinian Water Authority
R&D	Research and Development
UN	United Nations
USAID	United States Agency for International Development
WHO	World Health Organization

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Overview

Water security requires effective governance attention to water's vulnerability and value; to good management principles and practices; and to complex and rapidly changing social, economic, political and environmental circumstances.

Water scarcity threatens the livelihoods of countless people in the Arab region, particularly in rural and poor communities. Remote areas with inadequate water and sanitation are especially vulnerable. But water scarcity also affects urban dwellers, particularly in less developed countries. Twelve Arab countries have average per capita water availability rates below the World Health Organization threshold for severe scarcity.[1] Urbanization, population growth and climate change exacerbate the region's natural water scarcity and widen the gap between supply and demand.

To meet escalating demand, Arab countries must develop a responsive governance framework to better manage their vulnerable water resources, both conventional (surface water and groundwater) and nonconventional (desalinated water, treated wastewater, rainwater harvesting, cloud seeding and irrigation drainage water). Threats include natural variability, pollution, overexploitation and climate change. Most shared resources also lack comprehensive international agreements, threatening both water supply and political stability.

The water crisis is a crisis of governance.[2] All water resources urgently require efficient, sustainable management. As water becomes scarcer, governance must ensure that all sectors agricultural, industrial and municipal and users have equitable, reliable and sustainable access to water and are using water efficiently. Water security is inseparable from social, economic, environmental and health considerations. Food security, the water-energy nexus and the impacts of climate change require particular attention. Many factors impede progress in water governance, including unclear and overlapping responsibilities, inefficient institutions, insufficient funding, centralized decision-making, limited public awareness and ineffective regulations and enforcement.

Key elements of good water governance include equity, transparency, accountability, environmental and economic sustainability, stakeholder participation and empowerment, and responsiveness to socio-economic development needs. Cost-effectiveness analysis can guide governance by establishing water's proper value and identifying the most socially, economically and environmentally cost-effective policy options. By reorienting policy, reforming institutions, promoting education and awareness, increasing stakeholder participation, establishing international agreements and linking policy to research and development (R&D), governance can develop efficient water management practices. Effective governance must also remain flexible so that it can incorporate social and political changes of modernization and adapt to climate change. The Arab region's current political and economic transformations can assist efforts to reform water governance, while effective water governance systems can in turn catalyse region-wide aspirations for overall governance reform.

Managing and adapting to water scarcity

Water scarcity has physical and socio-economic causes. Physical scarcity arises from climate conditions (water shortage) and unsustainable management (overabstraction). The Arab region's low and variable rainfall, high evaporation rates and frequent droughts contribute to low water resource reliability and availability. With more than 5 per cent of the global population and about 10 per cent of the world's area, the region receives only 2.1 per cent of the world's average annual precipitation and contains 1.2 per cent of annual renewable water resources.[3] Renewable groundwater quantities are limited, and non-renewable groundwater supplies are threatened by unsustainable use patterns.

Overexploitation and pollution of renewable and non-renewable water resources threaten their availability. Using groundwater resources beyond their natural replenishment rates is rapidly depleting aquifer reserves and degrading water quality due to seawater intrusion. Groundwater resources in most Arab countries are also threatened by pollution from agricultural, industrial and domestic activities.

Urbanization and population growth are straining already scarce resources. The population of the Arab countries, estimated at 360 million, is expected to reach about 634 million by 2050.[4] The region's urban population is expected to increase from 57 per cent of the population in 2011 to 75 per cent by 2050, putting greater pressure on water infrastructure.[5] Rising living standards and a sizeable young population pressing for enhanced economic growth, will further boost water demand. The gap between water supply and demand, estimated at more than 43 cubic kilometres a year in 2009, is expected to reach 127 cubic kilometres a year by 2020–2030.[6]

Climate change, bringing greater climate variability and more frequent and severe droughts and floods, will exacerbate the already precarious situation created by chronic water scarcity. The Arab region is home to 5 of the top 10 countries at risk from the impacts of climate change. Many other Arab countries are considered extremely or highly vulnerable. By 2030 the effects of climate change will have reduced renewable water resources by another 20 per cent through declining precipitation, rising water demand as temperatures mount and expanding seawater intrusion into coastal aquifers as sea levels rise and groundwater overexploitation continues. Climate change has disproportionate consequences for the developing world. Women and poor and marginalized communities are especially at risk.

A society's adaptive capacity determines how scarcity affects it. Socio-economic scarcity arises from a society's economic inability to develop additional water resources or social inability to adapt to the conditions imposed by physical scarcity.[7] Forced scarcity arises due to occupation and political conflict. Water governance must address all types of scarcity. It is essential to strengthen adaptive capacity—a complex function of a society's infrastructure; wealth; economic structure; and physical, human and institutional resources.

Augmenting water availability

Conventional water resources comprise surface water and groundwater. The Arab region contains 23 major watersheds with perennial rivers or ephemeral streams, or wadis. Several countries with highly variable rainfall and transboundary waters have invested in water storage and conveyance networks to bolster water availability and sustainability and reduce the risk of water-related disasters. Other countries, especially in hyper-arid areas, have built dams. Although dams have yielded economic and social benefits, they have also reduced water levels and soil fertility.

Even countries fairly rich in surface water are relying more on groundwater to meet steadily rising demand. Shallow and deep groundwater resources, within or across national boundaries, are recharged by precipitation and by rivers. Vast areas, spanning many Arab countries, contain non-renewable groundwater resources, or fossil aquifers. These resources are being used mainly for agricultural expansion and development and mostly without integrated planning.[8] Groundwater overexploitation is not only depleting resources but also damaging the environment. Water salinization has dried natural springs and degraded or destroyed surrounding habitats and ecosystems.

Nonconventional water resources include desalination, treated wastewater, rainwater harvesting, cloud seeding and irrigation drainage water. The Arab region leads the world in desalination, with more than half of global desalination capacity. Desalinated water is expected to expand from 1.8 per cent of the region's water supply to an estimated 8.5 per cent by 2025. Most of the anticipated increase in capacity will be concentrated in the region's high-income, energy-exporting countries, particularly the Gulf countries. Desalination is energy- and capital-intensive, though technological advances have reduced production costs. Investments in infrastructure and R&D in solar and other renewable energies can lower desalination costs and make it more sustainable.[9] While desalination plants reduce pressure on conventional water resources, they have harmful environmental effects, including pollution and greenhouse gas emission.

To meet escalating demand in urban areas, Arab countries are using more treated municipal wastewater. Treated wastewater, estimated at 6.5 billion cubic metres a year and rising,[10] offers many advantages for the arid Arab countries. It lacks the uncertainties of surface water resources and can meet a substantial share of rising water demand from urbanization and population growth. Many factors prevent the expansion of water reuse, however, including social barriers, technical obstacles and institutional and political constraints. Regulations are needed to protect human health and the environment.

Several Arab countries are experimenting with water harvesting and cloud seeding. Improving water harvesting techniques requires a long-term government policy to support national research centres and extension services; adequate institutional structures; beneficiary organizations (associations, cooperatives); and training programmes for farmers, pastoralists and extension staff. Cloud seeding experiments have registered positive results, but cloud ownership disputes are a potential concern. Arab countries, especially Egypt and Syria, also draw heavily on reused irrigation drainage waters. A long-term policy and comprehensive monitoring are needed to improve the efficiency of drainage water reuse and limit its polluting impact.

As populations have grown and food demand has escalated, Arab countries have been forced to acquire water by importing agricultural commodities requiring large amounts of it. Because the Middle East and North Africa imports half of its grain, virtual water trade is necessary. The amount of virtual water imported in the region doubled from 147.93 billion cubic metres in 2000 to 309.89 billion in 2010.[11]

Water governance that focuses on sustainability, energy efficiency, investment and R&D in water technology is essential to maximize water supply. International coordination and agreements are also needed. More than two-thirds of surface water resources originate from outside the region, and large groundwater systems extend between neighbouring Arab countries and across the region's borders. Almost every Arab country depends for its water supply on rivers or aquifers shared with neighbouring countries (Table 1.6). But most shared resources lack comprehensive international agreements. With stress on the region's water supply mounting, cooperation in managing shared water resources is imperative to ensure their sustainability in serving socio-economic development.

Challenges to effective governance

Balancing multiple water uses amid water scarcity and competing interests can generate social and economic strains. Although agriculture contributes only 7 per cent of GDP, it consumes more water than industrial and municipal users.[12] But reallocating water to more productive sectors such as heavy industry and tourism would make Arab countries even more dependent on food imports and leave millions of unskilled labourers jobless. Rising domestic water consumption will also reduce the water available for agriculture. Countries will have to increase irrigation efficiency, use more nonconventional water, manage crops better and help agricultural workers find other jobs.

Water equity

Water equity is a challenge in many countries. Rural areas and poor people, as well as groups marginalized due to race, caste, tribe or gender, generally lack access to clean drinking water and improved sanitation. These inequities reflect social and political marginalization that systematically excludes poor people from opportunities and services.[13] Although access to water and sanitation has expanded in the Arab region, progress has been slow in many countries. In 2010, about 18 per cent of the Arab population still lacked access to clean water and around 24 per cent lacked access to improved sanitation.[14] Most of these underserved people live in lower income, occupied or conflict-ridden countries. Disparities are particularly large between rural and urban areas in water services, though several of the region's major cities also face water shortages. Effective water governance systems must ensure that all people have access to safe drinking water. Ensuring equity requires that all stakeholders, especially poor people and women, participate in water management.[15]

Drinking water and sanitation are basic human rights. The World Water Council, the Third World Water Forum, the Global Water Partnership, the Dublin Statement on Water and Sustainable Development and the United Nations have endorsed the view that the "human right to water is indispensable for leading a life in human dignity" and that access to water and sanitation is a "prerequisite for the realization of other human rights". In September 2010 Human Rights Council Resolution A/HRC/RES/15/9 affirmed that rights to water and sanitation were part of international law and confirmed that these rights are legally binding on states. It also called on states to develop tools to fully realize the human rights obligations of ensuring access to safe drinking water and improved sanitation for all.

Water-related conflict

Because water allocation often reflects and emphasizes social, political and economic inequities, it can cause conflicts to emerge or escalate. Competition over transboundary waters such as the Jordan River, shared by Israel, Jordan, Lebanon, the State of Palestine and Syria and the Jubba and Shabele rivers, shared by Ethiopia and Somalia, are at the heart of regional political conflicts. Inadequate governance of shared water resources continues to threaten the region's stability and impose uncertainty on water resource planning in the downstream countries.[16] Deprivation of water resources in occupied territories is another major issue requiring political movement.

Water's connection to food security and energy

Water security is inseparable from other critical issues such as food security and energy. Competition over increasingly limited water resources severely challenges Arab countries' ability to feed their growing populations. Futile attempts to achieve food self-sufficiency are behind much of the overexploitation of water in agriculture. Failure of these policies has led Arab governments to import more food. Grain imports have more than doubled since 1990, now accounting for almost 60 per cent of grain consumption (Figure 1).[17] To achieve national food security, governments can improve agricultural productivity, maximize water productivity, increase trade in virtual water by expanding food imports and work towards regional agricultural integration, including human, financial, and land and water resources.

Desalination, electricity generation and oil exploration and production manifest the interdependence of water and energy. Effective water governance requires understanding this interdependence. For example, Arab governments should link any future expansion in desalination capacity to investments in abundantly available renewable sources of energy,

Table 1 The expected cost and benefit of action and estimated rate of return on investment in improved water and sanitation provision for 2010-2020

Country	Required investments in water and sanitation services ($ million)	Potential benefit ($ million)[a]	Rate of return (%)	Average annual rate of return (%)
Algeria	3,622.3	19,303.3	432.9	39.4
Comoros	218.7	400.9	83.3	7.5
Djibouti	284.4	320.9	12.8	1.2
Egypt	4,484.4	11,073.6	146.9	13.4
Iraq	8,217.1	22,653.3	175.7	16.0
Jordan	135.3	1,635.5	1108.7	100.8
Mauritania	2,146.3	1,772.9	–17.4	–1.6
Morocco	8,484.2	9,608.4	13.3	1.2
Oman	259.7	1,756.0	576.1	52.4
Sudan	30,187.1	18,634.3	–38.3	–3.5
Tunisia	1,461.9	2,438.0	66.8	6.1
Yemen	12,722.4	9,767.5	–23.2	–2.1
Total	72,224.0	99,364.5	37.6	3.4

a. Avoided total cost attributable to low quality or no provision of improved water and sanitation

Source: Authors' estimates.

such as wind and solar. Arab countries must also enhance coordination and investment in R&D in water technologies, most of which are currently imported. Acquiring and localizing these technologies will make them more reliable, increase their added value to Arab countries' economies and reduce their cost and environmental impacts.

Environmental degradation

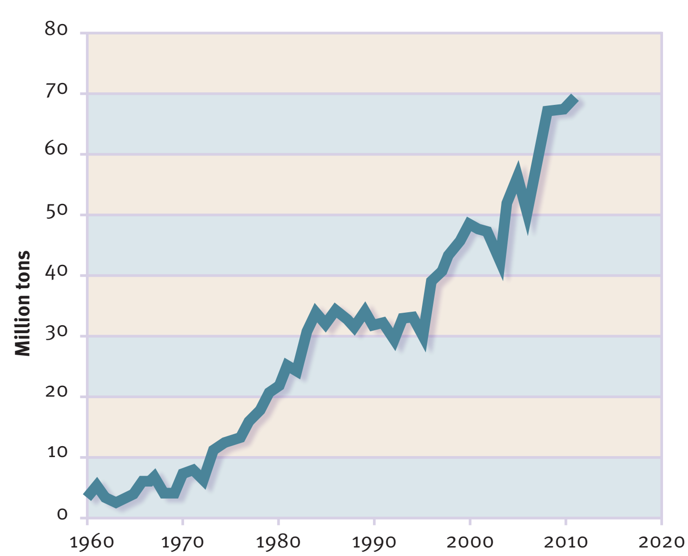
Water governance must also balance socio-economic needs and environmental protection. Overexploitation and pollution have led not only to lower water quality and quantity, but also to ecosystem degradation. Such environmental damage incurs both economic and social costs.

Impediments to improved water management

The water sector, predominantly publicly owned, has a large funding gap. While most Gulf oil-producing countries can afford the needed investments in water-source solutions such as desalination, many other Arab countries cannot. The Islamic Development Bank estimates that Arab countries may need to invest up to $200 billion in water-related infrastructure over the next 10 years to satisfy growing demand.[18]

International donors and lenders have

Figure 1 Net grain imports to the Arab Middle East and North Africa, 1960–2011



Source: Rasmussen 2012.

promoted privatization of water management and distribution to achieve full cost recovery and improve distribution efficiency. But privatization is controversial. Proponents argue that private corporations can better manage and distribute water and that allowing market forces to establish true water prices will force water users to adjust consumption and constrain waste. Opponents argue that privatizing water will create new barriers to common resources, leading to inequitable distribution as vulnerable groups are deprived of their basic water rights. A small group of capital owners will exploit a public good without regard for environmental consequences. Privatization can also reduce local control over natural resource management. Treating water as private property creates the possibility of "excluding others from access" to a life-sustaining element.[19]

Some Arab countries have taken steps to reform water governance, but impediments remain, including unclear responsibilities, lack of coordination, inefficient institutions, limited public awareness, highly centralized decision making and ineffective regulations and enforcement. Effective water governance is essential to development. The top-down approach to water governance has failed; the bottom-up approach, ensuring participation of all stakeholders, is the right one.

Achieving effective governance

The water crisis requires a multidimensional approach incorporating social, economic, political and environmental concerns. The social dimension demands equitable use of water. The economic dimension demands efficient water use and attention to water's role in economic growth.[20] The political dimension demands equal democratic opportunities for all stakeholders and water equity for women and other socially, economically and politically weak groups. The environmental dimension demands sustainable water use and ecosystem services.[21]

Key elements of good governance are efficiency, transparency, accountability, environmental and economic sustainability, responsiveness to socioeconomic development needs and stakeholder participation to balance competing interests and ensure social equity. Civil society and the private and public sectors must cooperate in reforming and implementing water governance. Governance needs continuous refinement and flexibility as new challenges arise. Each country requires its own model, though general guidelines can be laid out (Box 1).

Understanding, appreciating and properly establishing water's real value—including environmental and social as well as operational and construction costs—is essential. By properly valuing water and identifying the most

Box 1 **The World Water Assessment Programme principles of good governance**

- **Participation:** All citizens should have a voice in policy and decision-making, either directly or through intermediate organizations that represent their interests.
- **Transparency:** Information should flow freely within society; processes and decisions should be transparent and open to public scrutiny. Right to access this information should be clearly stated.
- **Equity**: All members of society, both men and women, should have equal opportunities to improve their well-being.
- **Accountability**: Governments, the private sector and civil society organizations should be accountable to the people or to those representing their interests.
- **Coherence:** Water issues, policies and actions, though inherently complex, must be coherent, consistent and easily understood.
- **Responsiveness:** Institutions and processes should serve all stakeholders and respond properly to preferences, changes in demand or other new circumstances.
- **Integration:** Water governance should enhance and promote integrated and holistic approaches.
- **Ethics:** Water governance must be based on the ethical principles of the society where it functions—for example, by respecting traditional water rights.

Source: Rogers and Hall 2003; IRG 2009.

Box 2 **Gender mainstreaming in water governance**

Good governance can help decrease gender inequalities by:

- "Ensuring that poor women's and men's human rights and fundamental freedoms are respected, allowing them to live with dignity.
- Introducing inclusive and fair rules, institutions and practices governing social interactions to improve outreach to the vulnerable, such as poor men and women, and the younger and older generations.
- Ensuring that women are equal partners with men in decision-making over development, use, technology choice, financing and other aspects of water management.
- Ensuring that the environmental and social needs of future generations are reflected in current policies and practices.
- Focusing water development policies towards eradicating poverty and improving the livelihoods of women and men."

Agriculture and the water sector must become gender aware, beginning with training programmes for water professionals and the community on gender approaches and methodologies. Reforms are also needed at the local level to effectively integrate gender-aware and participatory approaches into local and regional businesses, especially to empower women in conflict zones and agricultural and poor communities.

Source: UNDP 2003.

socially, economically and environmentally cost-effective policy options, cost-effectiveness analysis can help decision-makers narrow the gap between supply and demand. Assessing policy options, with attention to all variables, helps establish consensus among stakeholders. Cost-effectiveness analysis can weigh the costs of action against the costs of inaction, revealing the health, political and environmental benefits of providing improved water and sanitation. The goal should be to identify the intervention with the highest rate of return to achieve universal water and sanitation coverage (Table 1).

Building blocks of effective water governance include reorienting water policy, enforcing legislations and regulations, adequately financing the water sector, developing organizational capacities, monitoring and evaluating programmes, managing data and information, coordinating regional and international cooperation, educating and raising awareness, promoting stakeholder participation and empowerment, ensuring water rights and social equity, increasing water use efficiency and improving links between research and management.

The supply-driven approach to water management in the water-stressed Arab countries has failed to deliver water security. Acquiring water supplies while neglecting use and allocation efficiency has led to unsustainable water practices. Policies must shift from managing supply to managing sustainable demand. Policy must also shift from crisis management to long-term planning.

Most Arab countries have developed the institutional and legislative framework for good water governance but still lack legislative instruments to support its implementation. New challenges require innovative tools, such as decentralization, a participatory approach, strengthened technical and financial capacities of local authorities, dialogue and consensus, effective enforcement and compliance and better water institution performance.[22]

Good governance requires coordination and cooperative relationships among organizations with separate water mandates and responsibilities. As competition for water increases, so do such challenges as clarifying mandates, coordinating agencies, collaborating across sectors, managing disciplinary and administrative boundaries and planning multisector and multistakeholder consultations.

Deficiencies in human resources are key contributors to water scarcity. Capacity building, training, and organizational development constitute a cornerstone for developing the water sector. Capacity development requires enhancing human resources, strengthening institutional capacity and creating an enabling environment for sustainable development. Successful organizations have an efficient decision-making structure, an effective partnership with all stakeholders and a spirit of transparency and shared responsibility.

Monitoring is the vital link between policy reform and implementation. Effective monitoring allows fine-tuning policies and reallocating financing across reform priorities. Stakeholders must be able to monitor the quality of decisions and their implementation. Each Arab country should develop monitoring indicators for water reform progress and impacts. A regional monitoring system could improve the understanding of problems and promote solutions, particularly for transboundary waters. Indicators should be identified for monitoring and assessing the enabling environment, institutional frameworks and management instruments.

Ensuring compliance and enforcement of water legislation will require updating water legislation using a participatory approach, disseminating information and providing technical assistance and economic incentives, and developing inspection and monitoring capacities to investigate and penalize violations.

The financial sustainability and viability of effective water governance depend on a clear water financing scheme that identifies financing sources and economic instruments for ensuring optimal funding allocation. Private sector participation in the water sector is growing in response to governments' inability to raise adequate capital to finance, operate and maintain water and sanitation infrastructure. All possible approaches to privatization should be weighed for effectiveness, efficiency, equity and other elements of effective water governance.

Access to data and information is also essential for effective water governance. Without good data, water cannot be allocated efficiently. Better water data support decision-making at every scale, from local crop decisions to larger planning efforts for balancing water demand from agricultural, municipal and industrial sectors. Data can also improve the equity and transparency of decisions and support water quality monitoring.

Regional cooperation in water governance is essential because of the high dependency on shared water resources. Arab countries must adopt a strategic approach that leverages their socio-cultural solidarity into a unified political position supporting the rights of all riparian countries to fair, just and equitable shares in international water resources. High-level cooperation with neighbouring non-Arab countries is also vital for setting priorities, building consensus, nurturing and strengthening institutions, and supporting action programmes to strengthen the joint management of water resources. Cooperation for effective governance of shared surface and groundwater basins will help to achieve sustainable development.

Social equity, a declared goal of effective water governance, should anchor policy choices. Policies should rely primarily on approaches that allow meaningful participation of all stakeholders. Regardless of social status or power, all social groups should be able to voice their claims and concerns in an open, transparent environment. Reflecting on social and gender equity concerns in policy formulation and programmes is a prerequisite for effective water governance (Box 2). To realize the goal of inclusiveness, countries must go beyond legislative arrangements and staged participatory processes to work towards cultural change.

Public awareness is the foundation for meaningful participation and tangible action. A long-term awareness programme needs to be instituted that takes local and regional socio-economic and ecological dimensions into account.[23]

Research and innovation are critical in setting the stage for effective water policies that ensure sustainability, efficiency and equity in access to and use of scarce water resources in the Arab region. Yet water research organizations are hampered by a lack of adequate human and financial assets and the absence of national science and technology policies. In particular, the links between R&D and production require strengthening.[24]

To succeed, any long-term vision for water governance requires a solid understanding of the social and cultural changes brought by modernization. As lifestyles evolve with rising education levels, accelerating urbanization and ongoing political and social reform, governance must evolve in tandem. Arab countries must also prepare for the impacts of climate change on water resource planning and augment their adaptive capacity. The Arab region's current economic and political transformation could advance water governance reform through increasing participation and accountability, and water governance reforms can in turn catalyse larger social change through water's effects on livelihoods and other socio-economic activities.

Endnotes

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[2] UNDP 2004.
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[4] UNDESA 2011.
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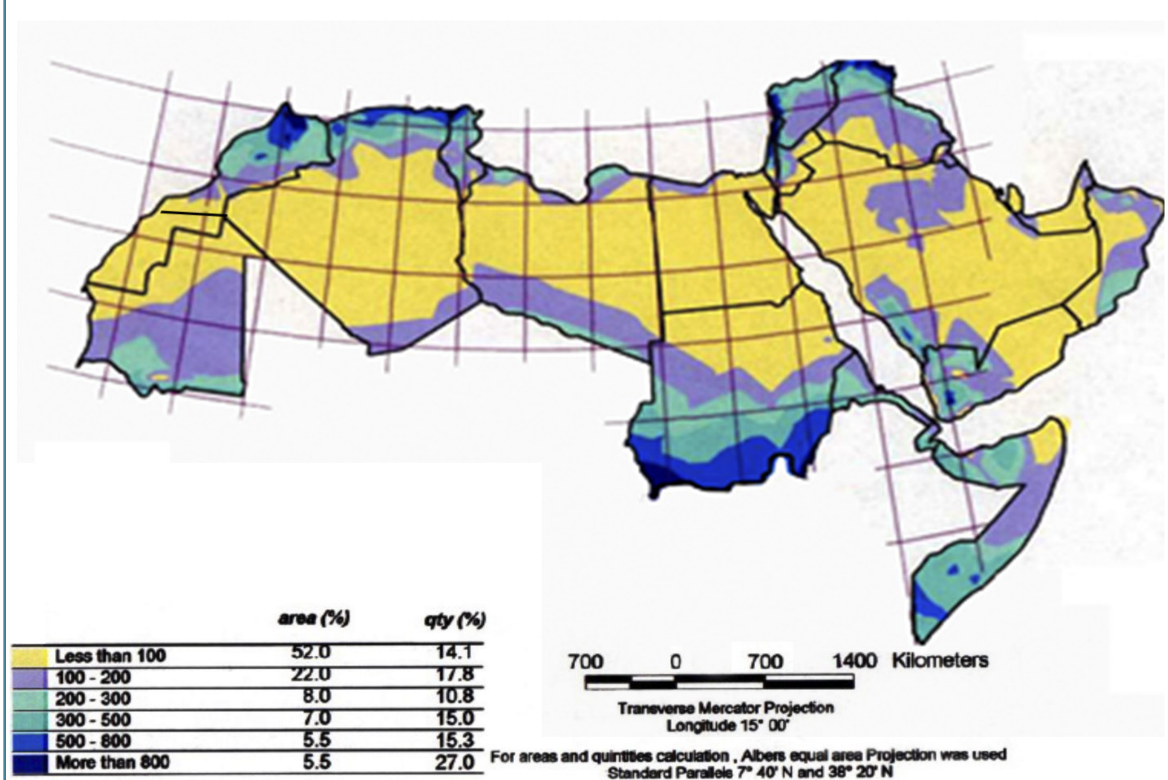
Chapter 1

Water in the Arab region: availability, status and threats

This chapter reviews the state of water resources in the Arab region, the threats to these resources and the impact of diminishing water sustainability.

Water scarcity threatens development in the Arab region. Rainfall is low and variable, evaporation rates are high and droughts are frequent, all contributing to low water resource reliability and availability.[1] Arab countries cover 10 per cent of the world's area but receive only 2.1

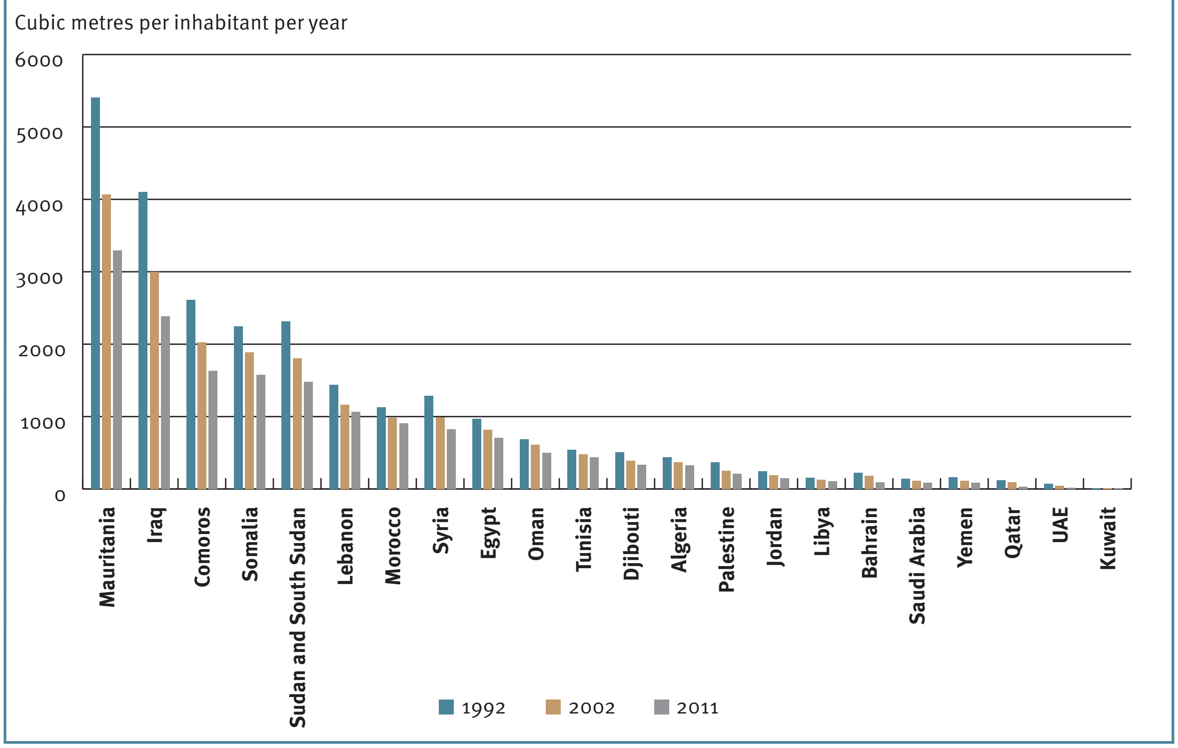
Map 1.1 Rainfall distribution in the Arab region



Source: Adapted from Droubi, Jnad, and Al Sibaii (2006).

Figure 1.1

Total renewable water resources per capita, 1992, 2002 and 2011



Source: FAO 2013.

per cent of its average annual precipitation. The region's annual internal renewable water resources amount to only 6 per cent of its average annual precipitation, against a world average of 38 per cent.[2] Most of the region is classified as arid or semi-arid (desert), receiving less than 250 millimetres of rainfall annually.[3] Only southern Sudan, the southwestern Arabian Peninsula and the Atlantic and Mediterranean coastlines receive high rainfall (Map 1.1).

Coupled with rapid population growth since the mid-1970s, these conditions have caused dramatic shrinkage in per capita renewable water resources, from an average of 2,925 cubic metres a year in 1962 to 1,179.6 in 1992 and to an alarming 743.5 in 2011 below the poverty line level of 1,000 cubic metres a year and far below the world average of 7,240 cubic metres a year (Figure 1.1).[4] Fifteen Arab countries already face water scarcity, with average water availability per capita below the poverty line of 1,000 cubic metres a year; twelve countries are under the 500 cubic metres a year threshold set by the World Health Organization for severe scarcity; and seven countries are below 200 cubic metres a year.[5] By 2025 Iraq, and possibly Sudan could be the only Arab countries with an average above 1,000 cubic metres a year.[6] And by 2030, the effects of climate change will have reduced renewable water resources by another 20 per cent and increased the frequency of droughts through falling precipitation, rising domestic and agricultural water demand as temperatures rise, and expanding seawater intrusion into coastal aquifers as sea levels rise and groundwater overexploitation continues.[7]

Water resources

To meet escalating demand, Arab countries rely on both conventional water resources (surface water and groundwater) and nonconventional (desalinated water, treated wastewater, irrigation drainage water, water harvesting and cloud seeding). Egypt, Iraq and Sudan depend primarily on surface water, while Jordan, Morocco and Syria depend more heavily on groundwater. All Arab countries are using more treated wastewater, and desalinated water is a rising share of water budgets in Gulf Cooperation Council countries.

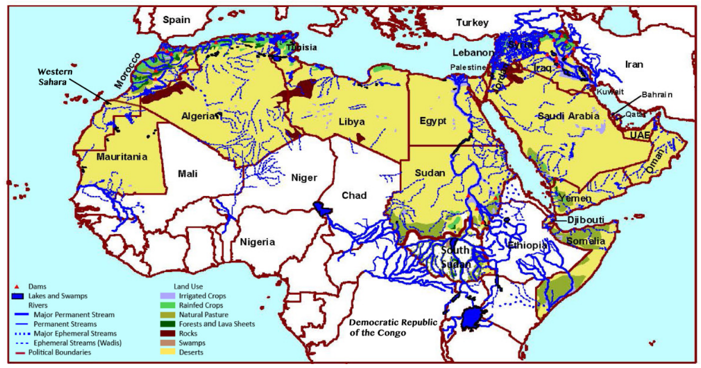
Conventional water resources

The two conventional water resources are surface water and groundwater. Both are under strain.

Surface water resources

The Arab region contains 23 major watersheds with either perennial rivers or ephemeral streams, or wadis (Map 1.2; Table 1.1). The few medium-size rivers mainly in Algeria, Lebanon, Morocco, Sudan, Syria and Tunisia originate and flow within a single country's national boundaries. Some major rivers, such as the Euphrates, Nile, Senegal and Tigris, originate outside the region, while some others are

Map 1.2 Major drainage basins in the Arab region



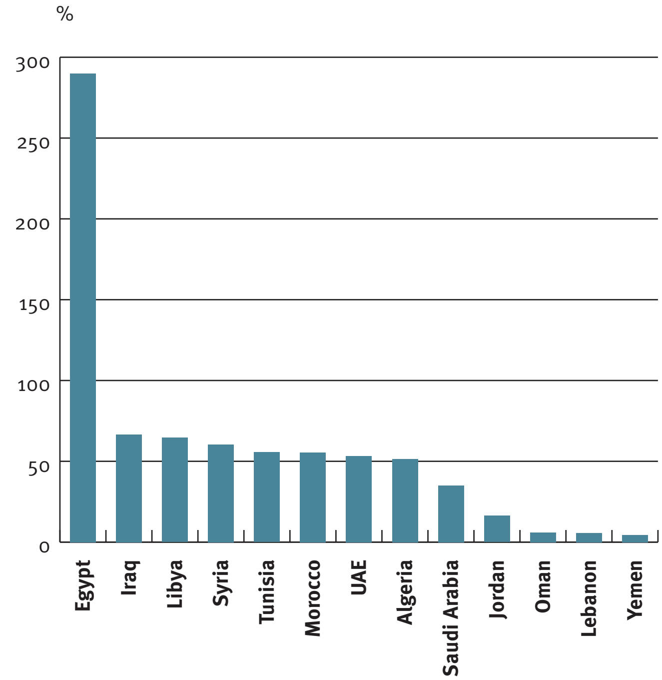
Source: CEDARE 2004.

Table 1.1 Size and discharge of major drainage basins in the Arab region

Basin	Tributaries	Basin size	River length	Average discharge	Riparian countries
		1000 km²	kilometres	million cubic metres per year	
Nile	Victoria Nile/Albert Nile, Bahr El Jabel, Bahr El Ghazal, White Nile, Baro Pibor-Sobat, Atbara, Blue Nile	3,173	6,693	109,500	Egypt, Sudan, South Sudan, Burundi, Democratic Republic of the Congo, Eritrea, Ethiopia, Kenya, Rwanda, Tanzania and Uganda
Euphrates	Sajour, Jallab/ Balikh, Khabour	647.075	2,330	32,000	Iraq, Syria, Turkey, Jordan and Saudi Arabia
Tigris	Batman, Khabour, Greater Zab, Lesser Zab, Adhaim, Diyala, Cizre, Wadi Tharthar	146.239	1,718	52,000	Iraq, Syria, Turkey and Iran
Jordan River	Upper Jordan (Dan, Hasbani, Banias, Huleh valley, Lake Taberias), Yarmouk, Lower Jordan	19.839	251	1,340	Lebanon, Syria, Israel, Jordan and Palestine
Orontes (Al-Assi)	Afrin and Karasu	37.900	448	2,800	Lebanon, Syria and Turkey
Nahr Al Kebir	Noura el Tahta-Aroussa and Safa-Raweel	0.991	90	330	Lebanon and Syria
Senegal	Falémé, Bafing and Bakoye rivers	300	1,800	22,000	Senegal, Mauritania, Mali and Guinea

Source: Nile Basin Initiative n.d.a, n.d.b; CIA 2003; Kibaroğlu 2004; Scheumann, Sagsen, and Tereci 2011; Al-Mooji 2004; OMVS 2003.

Figure 1.2 Share of total freshwater stored in reservoirs in selected Arab countries



Source: World Bank 2007.

shared among Jordan, Lebanon and Syria. A few wadis are also shared by some Arab countries in the Arabian Peninsula.[8]

Several Arab countries with highly variable rainfall and transboundary waters have invested heavily in water storage and conveyance networks. These networks preserve water sustainability, ensure water availability despite erratic rainfall and reduce the risk of water-related disasters (Figure 1.2).

Other countries, especially in hyper-arid areas, have built dams to recharge groundwater. The Arab region's dam capacity was about 356 cubic kilometres in 2008 (Table 1.2). More than 86 per cent of this capacity is in four countries with large, agriculture-dependent populations: Egypt (168.2 cubic kilometres), Iraq (151.8), Syria (19.7) and Morocco (16.9).[9] Demand has already outstripped supply, leaving little room to procure additional water economically.[10]

These investments have had advantages and disadvantages (Box 1.1). By shielding Egypt from the natural flow variations of the Nile, the Aswan High Dam, completed in 1971, offers many economic and social benefits, including

Table 1.2 Total and per capita dam capacity and share of individual countries in the Arab region

Country	Estimated total dam capacity (cubic kilometres)	Share of total dam capacity in the Arab region (%)	Per capita dam capacity (cubic metres per inhabitant)
Algeria	5.68	1.56	157.80
Egypt	168.20	46.30	2038.00
Iraq	151.80	41.79	4647.00
Jordan	0.27	0.07	43.43
Lebanon	0.23	0.06	53.53
Libya	0.40	0.11	59.89
Morocco	16.90	4.65	523.70
Oman	0.09	0.02	31.06
Saudi Arabia	1.00	0.28	35.75
Syria	15.90	4.38	893.00
Tunisia	2.50	0.69	237.10
UAE	0.06	0.02	7.74
Yemen	0.20	0.06	10.00
Total dam capacity	**363.27**	**100**	**672.1541** (average)

Note: Countries not listed have no dams.
Source: FAO 2013; World Bank 2007.

Box 1.1 The impact of the Aswan High Dam

Until the construction of the Aswan High Dam, Egyptian farmers divided the agricultural year into three main seasons: inundation (about 2 metres of water covered arable land for 6–8 weeks during flood time), coming forth and lack of water. Agriculture was abandoned during the river's low-flow periods. In the 20th century the government began to manage the Nile system by building large-scale water structures, including the Aswan High Dam.

The dam quickly became one of the world's most controversial large dams, as political, economic and environmental arguments were arrayed against it.

Most criticized was its reservoir, Lake Nasser, the world's third largest. Building the reservoir required the forced relocation of some 1 million Egyptian peasants and Sudanese Nubians to less fertile areas in Upper Egypt and Eastern Sudan. To the dismay of historians and archaeologists worldwide, flooding Lake Nasser also destroyed many monuments and historic sites of the Nubian civilization, one of Africa's oldest, though some were saved, including the temples of Abu Simbel.

Construction of the dam also caused enormous environmental damage. Water quality has changed, as the dam releases practically silt-free water at a quarter of the previous volume during flood discharge. Siltation in Lake Nasser has led to erosion and land loss in Mediterranean coastal areas and degradation of agricultural soil fertility, necessitating the application of chemical fertilizers. The dam has caused increased salinity and water-logging, the propagation of schistosomiasis and the northward migration of malaria mosquito vectors from Sudan. It has also hurt fisheries in the Nile system and coastal lakes, as the migration of some species of fish depended on the arrival of turbid floodwater, now impounded upstream.

The dam was caught up in the hydropolitics of the cold war, obscuring its positive agricultural, economic and social impacts. The total cost of the dam was recovered within two years of its construction: its estimated annual return to national income at the time was 255 million Egyptian pounds—140 million from agricultural production, 100 million from hydropower generation, 10 million from flood protection and 5 million from improved navigation. These would be remarkable economic returns for any development project. For farmers, the dam was an irrigation revolution, enabling them to make full use of Nile's water. It guaranteed irrigation water, protected farms from floods, enabled expansion to millions of acres of new agricultural land and conversion from seasonal to perennial agriculture by improving water supply management and generated hydropower for villages.

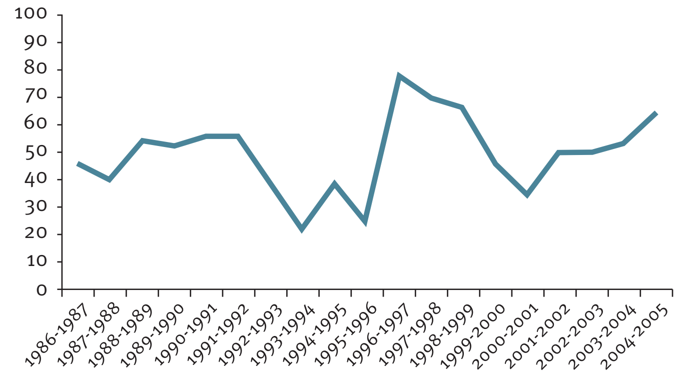
More than thirty years of operational data clearly indicate that the dam's impact has been overwhelmingly positive, contributing greatly to Egypt's overall social and economic development. And the environmental problems have proven to be substantially less severe than expected. As the former executive director of the United Nations Environment Programme noted, "The real question is not whether the Egyptians should have built the [Aswan High Dam] or not for Egypt realistically had no choice but what steps should have been taken to reduce the adverse environmental impacts to a minimum."

Source: Ahmed 1999; Biswas 2002.

land reclamation, energy generation, increased agricultural production, improved navigation and greater tourist capacity. The dam has generated annual net benefits of at least 2 per cent of Egypt's 1997 GDP, according to economic model estimates.[11] It has also led adaptive institutions to solve the hydrological and land quality challenges that arose after its construction.[12] It spared Egypt the costs of poor harvests in 1972–1973 and 1979–1987; protected the Nile Valley from major floods in 1964, 1975, 1988 and 1998; and has reduced uncertainty about water supplies for farmers and other consumers.[13] But the dam has also reduced soil fertility by preventing the nutrient-rich sediment from replenishing Nile Delta and Valley agricultural lands.[14] In addition, evaporation has reduced water levels in the dam's reservoir (Lake Nasser) by about 5 per cent of the Nile's total flow.[15]

Large fluctuations in rainfall can also impede dam functioning. Dams, constructed on the basis of past rainfall patterns, might not have enough water to meet customer demand when rainfall is lower than expected.[16] The fill rate of Jordan's dams, for example, sank from 46 per

Figure 1.3 Annual average fill of dams in Morocco, 1986–2005



Source: World Bank 2007.

cent in 2010 to 33 per cent in 2011,[17] while that of Morocco's dams fluctuated considerably over 1986–2004 (Figure 1.3).[18]

Groundwater resources

The Arab region's second major conventional water resource is groundwater. Shallow and deep groundwater resources, within or across national boundaries, are recharged by precipitation and by rivers. In Bahrain, Jordan, Lebanon, Oman, Tunisia, United Arab Emirates and Yemen, groundwater contributes more than

Table 1.3 Major groundwater systems in the Arab region

Groundwater system	Localities	Countries sharing the system	Area (1000 km²)	Remarks
Great desert sandstone aquifer systems in North Africa	Nubian Sandstone Aquifer System	Libya, Egypt, Sudan and Chad	2,200	Sandstone
	Continental Intercalary	Algeria, Libya and Tunisia	600	Sandstone
	Terminal Complex	Algeria, Libya and Tunisia	430	Sandstone
	Bechar	Western Algeria	240	
	Fazzan	Southwestern Libya	450	
Eastern limestone/ carbonate Mediterranean aquifer system	Cenomanian-Turonian limestones in Lebanon, Palestine and Syria; and the Wadi as Sir limestone in Jordan	Jordan, Lebanon, Palestine and Syria	48	Contributes to the flow of the Orontes, Litani, other Lebanese rivers and the Jordan River
Hauran and Arab Mountain basaltic aquifer system		Jordan, Saudi Arabia and Syria	15	Contributes to the flow of the Azraq and Yarmouk basins through El-Hamma, Azraq and Mazreeb springs
Eastern Arabia tertiary carbonate aquifer system	Umm er Radhuma dolomite and limestone aquifer in the Arabian Peninsula and Iraq; Dammam limestone and dolomite aquifer in the Arabian Peninsula (except Yemen); and the Neogene aquifer in Bahrain, Kuwait, Oman, Qatar and the UAE	Bahrain, Iraq, Jordan, Kuwait, Oman, Qatar, Saudi Arabia, Syria, UAE and Yemen	1,600	Primarily a limestone and dolomite aquifer; hydraulically interconnected; a recharging-discharging aquifer system

Note: The Continental Intercalary and the Terminal Complex together form the North Western Sahara Aquifer System, which has an area of 1 million square kilometres extending over Algeria, Libya and Tunisia.

Source: Adapted from Ksia (2010); Sokona and Diallo (2008); Khater (2010).

Box 1.2 Great Man-Made River in Libya

"It was a dream come true, to open the tap and find water all the time at my house" one Libyan man commented to the BBC in a 2006 interview when the Great Man-Made River project finally reached Tripoli. Libya, lacking rivers, lakes and rain, is one of the driest countries on Earth. To meet rising demand accompanying urbanization and population growth, sea water desalination offered the only option—Libya has the longest coast on the Mediterranean (about 1,900 kilometres).

Then in 1953, during oil explorations in the Libyan Desert, large quantities of underground freshwater were discovered in the Nubian aquifer, sparking the idea of installing a huge network of pipes to bring this non-renewable water to the cities. In the past, people moved to water; this new project would move water to the people. Economic analysis indicated that the long-term network costs of the 26-year $20 billion project would be 10 times lower than for desalination. Critics denied these claims and warned that the project was rife with corruption. Many called for abandoning the project and reinvesting in desalination.

At 2,820 kilometres and with more than 1,300 wells, most of them deeper than 500 metres, the Great Man-Made River remains the world's largest pipe and aqueduct network and the largest irrigation project. It supplies some 6.5 million cubic metres of water daily to Benghazi, Sirte and Tripoli, among other Libyan cities. Official sources claim that at 2007 rates, the aquifer would last for some 4,625 years, although independent estimates warn that it might be depleted in a century or less. More recent reviews mention the gradual drying of the aquifer's nearby oasis. And while former Libyan president Muammar Qaddafi described the project as the eighth wonder of the world, a critic countered that "this is basically a wonder of the world because it's exactly like the pyramids—it's huge and massive and probably not cost-effective, as 70 per cent of the water is used in irrigation and none reserved for heavy industry," adding that "if the farmers had to pay the full cost of pumping and shipping the water to them, they wouldn't break even on their agriculture."

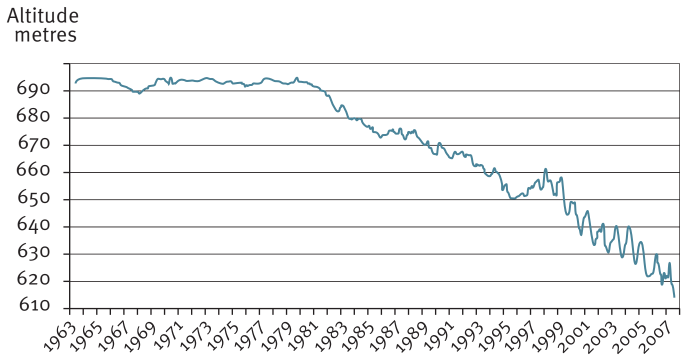
Source: UNEP 2010b.

50 per cent of total water withdrawals. In the Arabian Peninsula it accounts for 84 per cent. Even countries fairly rich in surface water are relying more on groundwater to meet steadily rising demand. And in some areas, such as the southern oases of some North African countries, groundwater is the only water resource available. Vast areas, spanning many Arab countries, contain non-renewable groundwater resources, or fossil aquifers. These resources are used mainly for agricultural expansion and development and with few exceptions without integrated planning.[19] As surface water quality deteriorates, groundwater could become the main water resource for domestic use.

Major geological structures and sedimentation processes control groundwater movement, exploitation and quality in both shallow and deep aquifers. Extensive, deep sedimentary formations in northern Africa and the Arabian Peninsula contain major non-renewable fossil aquifers, with very limited recent recharge (most recharge occurred during wet periods 15,000–25,000 years ago). Unconsolidated deposits, mainly sand and gravel from the Neogene and Quaternary periods, form the shallow renewable aquifers under riverbeds, flood plains, deltas, wadi beds, major depressions and the interior coastal plains. Water quality varies widely, with a salinity range of 200–20,000 milligrams per litre. In some aquifers, water requires treatment before use, and in others, temperatures of 40°C-65°C limit the water's suitability for domestic consumption. However, geothermal water can be used for greenhouses (for warming and some irrigation) before being used for agriculture at more appropriate temperatures. The aquifers of the Tigris-Euphrates and the Nile and its delta, the intermountain valleys in North Africa and the wadis in the Arabian Peninsula store adequate reserves, with good water quality, and are frequently recharged from river flow and floods. These aquifers are used extensively for domestic water consumption and irrigation.[20] Iraq, Jordan, the Arabian Peninsula and North Africa share many of the deep aquifers (Table 1.3).[21]

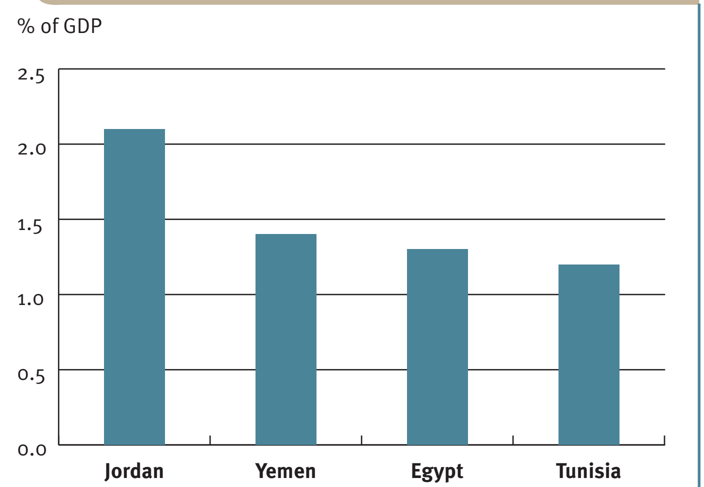
Overexploitation of groundwater resources. Most Arab countries, especially in the Arabian Peninsula[22] and the Maghreb region, draw heavily on groundwater resources (renewable and non-renewable) to meet rising demand

Figure 1.4 Observed declines in the groundwater level of the Saïss basin, Morocco, 1963–2007



Source: ABHS and others 2007.

Figure 1.5 Value of groundwater depletion in Jordan, Yemen, Egypt and Tunisia, 2005



Source: Ruta 2005.

for water, particularly for domestic consumption and irrigation (Box 1.2). Non-renewable groundwater resources are used in planned ways (for example, the Sarir basin in Libya and Al-Sharqiyah Sand and Al-Massarat basin in Oman) and unplanned ways (for example, Saq Aquifer, Disi Aquifer, Tawilah Aquifer and Sana'a basin in Yemen and the Palaeogene aquifer in the Arabian Peninsula), with unplanned use far more common.[23] Using groundwater resources beyond their natural replenishment rates has resulted in rapid depletion of aquifer reserves and salinization and deterioration in water quality due to seawater intrusion. In addition to overexploitation and quality deterioration, groundwater resources in most Arab countries are threatened by pollution from agricultural, industrial and domestic activities.[24]

In Saïss basin, near the Moroccan cities of Meknes and Fez, overexploitation led to a decline in groundwater levels of about 70 metres over 1981–2006 (Figure 1.4).[25] In Gaza, excessive water pumping has resulted in seawater intrusion of about 70-80 per cent of the coastal aquifer.[26] In the Amman-Azraq basin in Jordan, excessive abstraction has increased groundwater salinity from less than 400 milligrams per litre in 1994 to 1,800 in 2004 due to encroachment of underlying salt water.[27] In the Tunisian oases of Kébili, overexploitation has led to deep groundwater decline and near extinction of shallow aquifers.

Groundwater overexploitation and depletion have also had severe environmental impacts. Water salinization has dried natural springs and degraded or destroyed their surrounding habitats and ecosystems, diminishing these areas' historical and cultural value. For example, most springs in the Syrian Palmyra oasis have dried up, including Afka, former site of the Kingdom of Zanobia.[28] The South Algerian oases, natural springs in Bahrain, most of the oases of the Egyptian Western Desert, the Al Kufrah oasis in Libya, the Al Ahsa oasis in Saudi Arabia and the natural springs used to irrigate Tozeur and Kébili in southern Tunisia have all been lost through excessive pumping and sinking groundwater levels. In the United Arab Emirates, intensive groundwater abstraction in the eastern coastal plains increased water salinity, leading to abandoned irrigation wells and dying date plantations.[29] In Yemen, excessive groundwater withdrawal for extensive irrigated agriculture has led to seawater intrusion in several coastal areas, especially Abyan Delta along the Gulf of Aden, the Tihama area and Wadi Mawr.

Overpumping groundwater also depletes national assets. While economic activities based on extracted water boost GDP in the short term, groundwater overexploitation, especially mining fossil water resources erodes a country's natural capital and threatens irrigated areas in the long term. The value of national wealth consumed by overexploiting groundwater is estimated at as much as 2 per cent of GDP in four Arab countries (Figure 1.5).[30]

Sustainable management of groundwater resources.
It is vital, therefore, to manage groundwater resources in the Arab countries as public goods by observing their natural recharge rates (Box 1.3). In this way, these resources can continue to support their dependent ecosystems and contribute to sustainable human development. The Tunisian oases of Kébili exemplify efforts to control groundwater overexploitation: satellite images measure the irrigated area and any illegal extensions and help control the number of deep wells.[31]

A regional meeting of water experts in Arab countries in 2005 stressed that achieving sustainability for non-renewable resources is a challenge for water resource managers.[32] Participants agreed that sustainability must be clearly defined in socio-economic and physical contexts that fully account for the immediate benefits as well as the longer term negative consequences. They emphasized the need to prepare an exit strategy, one ready to be deployed once an aquifer is depleted and that covers replacement water resources, balanced socio-economic solutions for aquifer reserves and a transition to a less water-dependent economy.

Groundwater reserves must be used with maximum hydraulic efficiency and economic productivity; this implies full re-use of urban, industrial and mining water and careful control of irrigation waters. The management goal would be to use aquifer reserves responsibly, in accordance with expected benefits and predicted impacts over a specified time frame. In Arab countries, investing in desalination and treatment technologies is essential to reduce costs and environmental impact. Investing in modern agricultural technologies is also important if agricultural development is to continue. Establishing the social conditions conducive to aquifer management will require public awareness campaigns on the nature, uniqueness and value non-renewable of groundwater, highlighting full user participation wherever possible.

Box 1.3 **Groundwater use rights**

Groundwater resources must be treated as public property (or common property) resources. The state, as steward of these resources, must be able to introduce measures to prevent aquifer depletion and pollution.

It is important to create a system of groundwater abstraction rights consistent with hydrogeological realities. That means that well owners become well users who must apply to the state for water abstraction rights. For non-renewable groundwater, it is also important to identify the government level with the highest authority to make decisions on mining aquifer reserves. Monitoring water quality, levels and extraction amounts in an aquifer is the foundation of groundwater resource management. Monitoring should be carried out by the water resource administration, stakeholder associations and individual users. Time-limited permits subject to initial review will normally induce permit holders to provide regular data on wells. The water resource administration must make appropriate institutional arrangements through law enforcement and create an aquifer database for archiving, processing, interpreting and disseminating information.

Source: Foster and others 2005.

Nonconventional water resources
With demand rising and supplies dwindling, Arab countries have drawn heavily on nonconventional water sources, including desalinated water, treated wastewater and other sources such as rainwater harvesting, cloud seeding and use of irrigation drainage water.

Desalination

With more than half the world's desalination capacity, the Arab region leads the world in desalination (Box 1.4).[33] Although desalinated water contributes only a very small share of Arab countries' total water supply (1.8 per cent), it contributes nearly all the water supply for many cities.[34] The overall share is expected to grow as a result of industrialization, accelerated urbanization, population growth and depletion of conventional water resources. Some countries, such as Jordan and Tunisia, desalinate brackish water at a low cost and promote it for domestic use.[35]

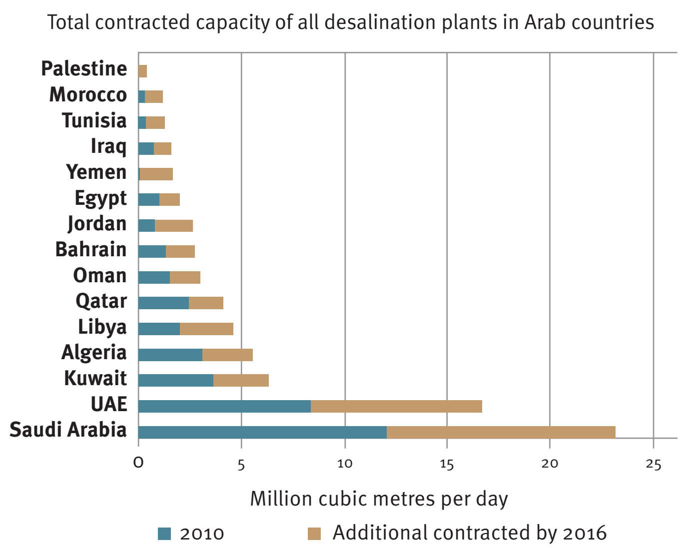
Desalination plants in Arab countries have a cumulative capacity of about 24 million cubic

Box 1.4 **Desalination processes and the dominant technology used in the Arab countries**

The two main types of desalination technology are thermal and mechanical. Thermal, the older technology, separates water from minerals through evaporation-distillation using multi-stage flash technology, a very energy-intensive process. Mechanical processes use reverse osmosis to force pressurized saline water through membranes that exclude most minerals. In the Arab region, the multi-stage flash technology still dominates, particularly in the Gulf Cooperation Council countries, although installed capacity for reverse osmosis is growing. The reverse osmosis technology, easily scalable due to its high modularity, requires no thermal energy and less or equivalent amounts of electric energy than distillation. Most Gulf countries still prefer the thermal technology, however, because they use the disposed heat in cogeneration systems. More recently, hybrid reverse osmosis and multi-stage flash systems are being used in cogeneration systems.

Source: Al-Jamal and Schiffler 2009; World Bank and BNWP 2004; Bushnak 2010; GWI 2010; Jagannathan, Mohamed, and Kremer 2009; World Bank 2005.

Figure 1.6 **Accumulated desalinated water in selected Arab countries, 2010 and 2016.**



Source: AFED 2010.

metres a day. The highest desalination capacity is in the Gulf countries (81 per cent), Algeria (8.3 per cent), Libya (4 per cent) and Egypt (1.8 per cent; Figure 1.6). Growth is expected to remain high for the next decade to meet escalating domestic water demand. Desalinated water will expand from 1.8 per cent of the region's total water supply to an estimated 8.5 per cent by 2025. Most of the anticipated increase in capacity will be concentrated in the region's high-income, energy-exporting countries, such as the Gulf countries, where it will be used to supply water to cities and industry. More than 55 per cent of the water supplied to cities in the Gulf countries comes from desalinated water, used directly or blended with groundwater. This share is expected to rise as groundwater resources continue to deteriorate.

High financial and energy costs of desalination

Desalination is an energy- and capital-intensive process, with costs depending on energy requirements, water production costs, technology growth trends and environmental impact. Costs per delivered cubic metre of desalinated water are as high as $1.50—and even $4 in extreme cases. The water is subsidized, however, and sold for as little as 4 cents per cubic metre in some Arab countries.

With improvements in desalination technologies, production costs are dropping. New technologies, such as reverse osmosis, electrodialysis and hybrids, are more energy efficient and better suited to different types of water. These advances drove down global prices for multi-stage flash over 1999–2004, from an average of $1.0 per cubic metre to $0.50–$0.80 (Figure 1.7).[36] For reverse osmosis, the average cost of desalinated water is estimated at $0.99 per cubic metre for seawater and $0.20–$0.70 for brackish water. Energy requirements vary from 4–8 kilowatt hours per cubic metre for reverse osmosis seawater, as in the Carboneras desalination plant in Spain, to 3.5–5.0 for multi-stage flash technology (Table 1.4). This downward trend in the cost of desalinated water indicates that desalination technology is becoming more viable for poorer countries.

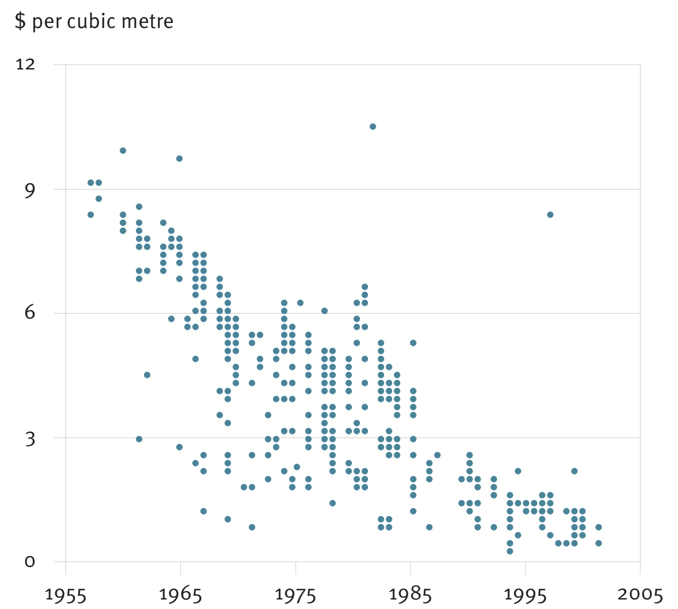
However, a joint World Bank–Arab Gulf Program for Development study found that while the average production cost of desalinated seawater from recently completed large plants in the United States and many other places has fallen to around $0.70 per cubic metre (excluding distribution costs and varying according to plant size, depreciation duration and energy costs) average costs in the Gulf Cooperation

Council countries remain at $1–$2 per cubic metre.[37] Many factors account for the higher costs, including public sector dominance of the industry and the enormous investment costs for new desalination plants, especially under heavy government subsidies for the water sector. These factors will make it difficult to meet rapidly rising water demand and will place an intolerable burden on national budgets.[38]

Arab countries plan to increase desalination capacity from 36 million cubic metres a day in 2011 to about 86 by 2025. Most of this investment will be in the Gulf countries, Algeria and Libya. Investment needs to 2025 are estimated at $38 billion, $27 billion of it in the Gulf countries (Table 1.5). The energy costs of the anticipated expansion in desalination capacity to 2025 can be estimated using the cost breakdown of a typical reverse-osmosis desalination plant (see Table 1.4), though costs would vary with interest rates and energy prices. At a 10 per cent interest rate, the cost would be $0.62 per cubic metre.[39] Arab countries are expected to desalinate about 19 billion cubic metres in 2016 and about 31.4 billion in 2025, 30 per cent of unmet demand, at an average cost of $0.525 per cubic metre.[40] The predicted annual desalination costs are estimated at $10 billion in 2016 and $15.8 billion in 2025, of which energy costs will be about $4 billion in 2016 and $6.4 billion in 2025. The annualized capital cost is estimated at $5.4 billion.[41]

Desalination is very energy-intensive, so energy efficiency should be a key criterion in commissioning new plants and upgrading old ones.[42] Saudi Arabia, with 35 per cent of the Arab region's desalination capacity, uses 25 per cent of its oil and gas production to generate electricity and produce water in cogeneration power–desalination plants. If water demand continues to grow at the current rate, this share will top 50 per cent by 2030.[43] In Kuwait, cogeneration power–desalination plants account for more than half of total energy consumption; the energy required to meet desalination plant demand is expected to equal the country's current fuel oil production by 2035.

Figure 1.7 Reduction in the unit cost of multi-stage flash desalination plants, 1955–2003



Source: Zhou and Tol 2005.

Despite having half the world's desalination capacity, Arab countries devote little R&D to these technologies, which are all imported. In addition, the desalination industry contributes only limited added value in fabricating

Table 1.4 Cost breakdown for typical reverse osmosis desalination plant in the Arab region

Parameter	Cost ($ per cubic metre)
Capital cost, 800 cubic metres per day capacity	
Energy consumption, 3.5 kilowatt hours per cubic metre	
Annualized capital cost (at 5 % interest rate)	0.180
Energy cost (at $0.06 a kilowatt hour)	0.210
Membrane replacement cost	0.035
Labour and chemicals	0.100
Total cost	0.525

Source: Al-Jamal and Schiffler 2009.

Table 1.5 Desalination cost in selected Arab countries

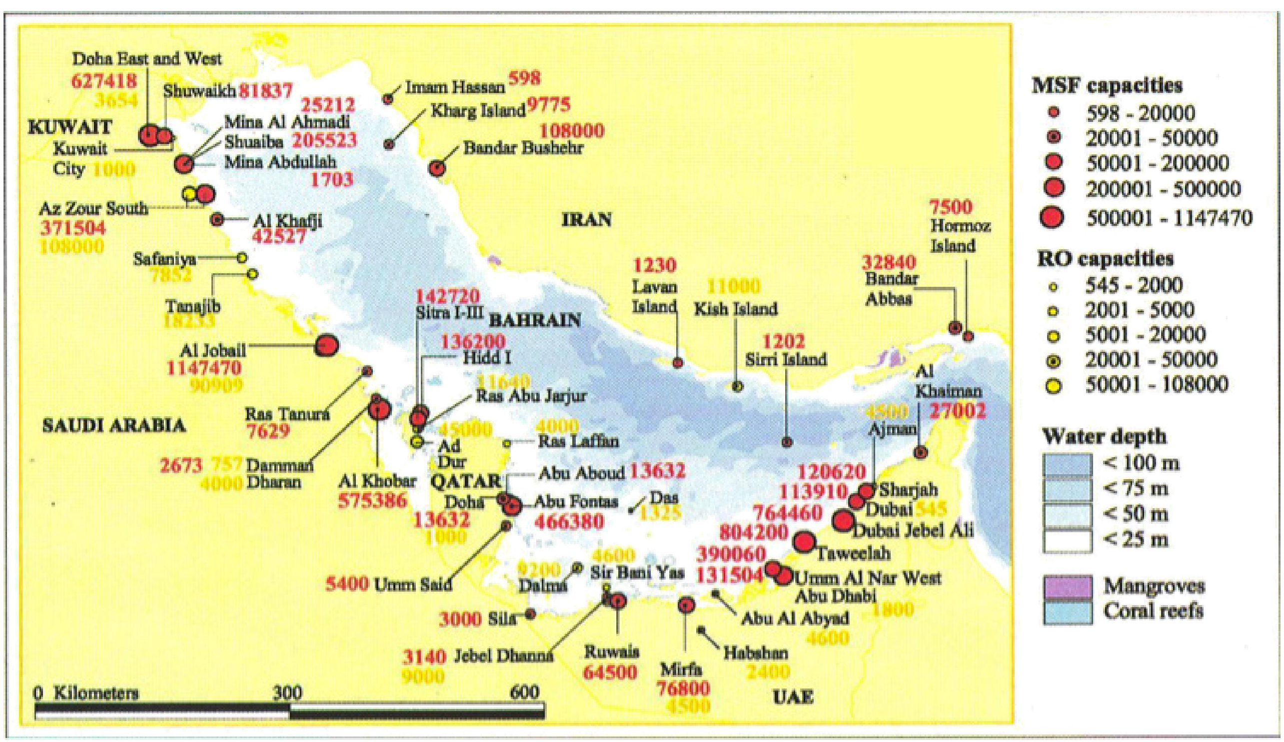
$ million, unless otherwise indicated

Country	Desalination capacity forecast 2025 (million cubic metres)	Capital cost at $0.18 per cubic metre at 5% interest rate	Required additional capacity until 2025 (1,000 cubic metres a day)	Investment cost at $800 a day capacity	Energy cost at $0.21 per cubic metre and $0.06 per kilowatt hour	Total cost at $0.525 per cubic metre
Algeria	8.214[a]	1.48	5,023	4,018	630	1,574
Egypt	1.536	0.28	1,008	806	118	294
Libya	7.206	1.3	5,337	4,270	552	1,381
Morocco	0.862	0.15	577	462	66	165
Tunisia	0.481	0.09	286	229	37	92
Jordan	1.541	0.28	1,000	800	118	295
Saudi Arabia	26.816	4.83	14,252	11,402	2,055	5,139
Kuwait	6.725	1.21	3,279	2,623	515	1,289
Bahrain	3.406	0.61	2,223	1,778	261	653
Qatar	3.93	0.71	2,254	1,803	301	753
Oman	3.713	0.67	2,573	2,058	285	712
UAE	18.27	3.29	9,240	7,392	1,400	3,501
Total	**82.7**	**14.9**	**47,052**	**37,642**	**6,339**	**15,847**

a. Extrapolated.

Source: Al-Jamal and Schiffler 2009.

Map 1.3 Multi-stage flash (MSF) and reverse osmosis desalination plants in the Gulf, 2008



Source: Lattemann and Höpner 2008.

equipment, refurbishing plants, localizing operations and maintenance, manufacturing key spare parts and training local labour.[44]

Harmful environmental impacts

While desalination plants produce freshwater that augments supply and reduces pressure on conventional water resources, they have harmful environmental effects. New technologies have reduced some of these, but others remain, including air pollution from oxide emissions, seawater and marine life pollution from discharged brine, increased salt concentration from effluents and emission of trace elements and residual treatment chemicals (such as anti-foaming and anti-scaling agents).[45] The regional impact of the water discharged from thermal desalination plants has not been studied in depth,[46] but countries surrounding the small, enclosed Arabian Gulf are increasingly concerned about the threat to marine life and damage to the fragile marine ecosystem (Map 1.3).[47] The growing number of desalination plants along the Gulf coast and the rising temperature of its water warrant close study.

Another major environmental concern is the greenhouse gasses emitted while producing electricity and steam to power desalination plants. In the Arab region, large desalination plants using multi-stage flash cogeneration technology are typically powered by fossil fuel. They emit 10–20 kilograms of carbon dioxide per cubic metre, depending on the heat cycle rate.[48] Almost none of the thermal plants built in the Gulf countries uses low heat cycle technology, which would lower their carbon footprint but increase capital costs.[49] Power generation plants emit 0.5–0.8 kilogram of carbon dioxide per cubic metre, depending on the fuel used and plant efficiency.[50]

Policy implications

The energy requirements for desalination can be met through renewable sources, such as wind, solar and possibly wave power. Until recently, only small desalination plants in remote areas with no access to electricity from the grid used renewable energy, but as R&D has intensified, several pilot desalination plants have operated successfully using solar, wind or geothermal energy.[51] The Arab region has vast solar energy potential. If Arab countries used only 5 per cent of their deserts to build concentrated solar power plants, they could satisfy the world's energy needs.[52]

Developing solar-powered desalination technologies should be a top priority in Arab countries. R&D investments to identify optimal

Box 1.5 **Recommended actions for enhancing water desalination sustainability**

The large anticipated expansion in desalination plants requires a review of policies and practices, including ways to increase capacity, knowledge and value added to the local economy. In the Arab region, local capacity and knowledge focus on operations and maintenance, ignoring plant design, manufacturing and construction, even in countries that depend heavily on desalination to meet domestic water demand. The current local talent is not adequate to meet the enormous demand for technicians and engineers. By designing incentives for local businesses, governments can attract local investments in manufacturing key desalination plant components and cultivating local innovations to attain economic sustainability.

Government agencies involved in water policy should consider shifting their role from desalination plant procurers to water purchasers, to enable the most efficient technology and operation. Such a shift would also contribute to building local skills and capabilities and enlarging the private sector's role in desalination. More critically, the government's role would shift from operator to regulator, to guarantee access and affordability. However, if government enterprises continue to build and operate large desalination plants, steps should be taken to manage these assets in a way that minimizes the life-cycle cost of water. Like private enterprises, government enterprises should value energy at world market prices and provide incentives for in-house R&D departments to promote innovations in technology and operation.

Source: Bushnak 2010.

Box 1.6 Wastewater reuse: grey water

The term "grey water" refers to domestic wastewater generated from less polluted sources, such as kitchen sinks, washing machines, dishwashers, hand-washing basins and showers. Grey water, at around 50-70 per cent of domestic wastewater, is recognized as a potential water saver and demand management tool. Like harvested rainwater, grey water can be generated on one's premises, thus circumventing trust issues, one of the major obstacles in wastewater treatment and reuse in the Arab region. Treatment is simple. Grey water kits consist of four connected barrels. The grey water flows from the house gravitationally into the barrels, where treatment occurs in stages; the fourth barrel receives treated water, clean and ready for reuse. Domestic grey water users include not only private homes but also mosques, kindergartens and gardens. More recently, the Lebanese Ministry of Energy and Water incorporated grey water into its Ten-Year Water Plan for Lebanon.

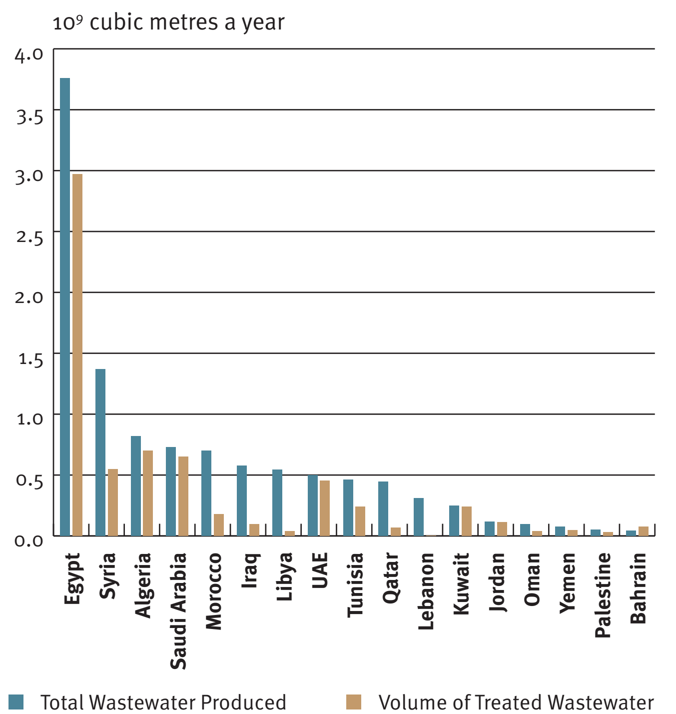
To explore grey water potential in the region, the Canadian International Development Research Centre has supported grey water treatment in Jordan, Lebanon, State of Palestine and Yemen, equipping more than 2,000 houses with grey water treatment systems over 1998–2008. These projects revealed not only the high regional potential for using such forms of treated wastewater but also the absence of any health risks. Annual economic saving was estimated at more than $300 per family, but successful implementation will require government incentives, continuous quality monitoring and enforcement of local standards and regulations.

Source: AFED 2010.

technical solutions and products for solar desalination and cogeneration could improve the region's social and economic condition. The Arab Forum for Environment and Development strongly recommends that Arab countries develop joint R&D programmes in desalination and renewable energy and maximize the value of new ideas and research findings emerging from institutional knowledge hubs such as Masdar City in Abu Dhabi, King Abdullah University for Science and Technology, the recently established King Abdullah City for Atomic and Renewable Energy and the Qatar Foundation's ambitious R&D programmes in solar energy and desalination.[53]

Unconventional water production plays a large role in preserving groundwater. While desalination is now a necessity rather than an option, large-scale projects, with their high financial and environmental costs, should be considered only after more cost-effective and sustainable supply and demand measures have been implemented (Box 1.5). These measures include effective pricing, reducing nonrevenue water in the distribution network and rationing and conserving water in the domestic sector. Both existing and future desalination plants must also include mitigation measures to reduce their environmental impact, particularly strengthening and enforcing environmental laws for building and operating desalination plants (such as maximum limits on carbon emissions). Also important are reactive measures involving physical changes to plants or processes. Reactive measures include optimizing the

Figure 1.8 Wastewater produced and treated in some Arab countries, 2009–2010



Source: World Bank and others 2011.

siting of plants, using more energy-efficient technologies and employing design and treatment techniques that reduce damage to the marine environment (such as using appropriate sea outfalls and mixing brine with seawater before discharge).

Treated wastewater

Arab countries are using more treated municipal wastewater to meet escalating demand in urban areas. Treated wastewater is estimated at 4.7 billion cubic metres a year and rising.[54] Water scarcity, financial capacity and agricultural sector importance shape wastewater treatment and reuse.[55] While most of the region has programmes for reusing treated wastewater in irrigation (fodder crops, cereals, alfalfa, and olive and fruit trees are irrigated mostly with treated water), few countries have institutional guidelines for regulating treated wastewater (Box 1.6).[56]

Data on generated, treated and reused wastewater in the Arab region are outdated and span so many years (1991–2006) that analysis and comparison across countries are difficult. Arab countries produce about 13.2 billion cubic metres of wastewater a year and treat about 40 per cent of it; they discharge the rest to open water channels, the sea or ground reservoirs, raising concerns for public health and the environment. The Arab region treats a higher share of its wastewater than some other regions (35 per cent in Asia, 14 per cent in Latin America and the Caribbean and 1 per cent in Africa),[57] but the share ranges widely across countries, from almost none to almost 100 per cent (Figure 1.8). If all wastewater were properly treated and reused, including domestic wastewater, it could support water demand in some sectors, such as agriculture

Box 1.7 Wastewater regulatory management in the Arab countries

Arab countries need to develop guidelines and instructions for treated wastewater reuse—from the plant to the field—to control and ensure visibility and transparency from production to reuse. They also need achievable and enforceable standards and regulations to ensure sustainable wastewater treatment and reuse. Most Arab countries have standards to protect public health and the environment, but the main factor driving strategies for wastewater reuse is the cost of treatment and monitoring. In several cases, treated wastewater does not meet specified quality standards because specified procedures are not followed or enforcement is allowed to slide because of a lack of qualified personnel. In many Arab countries, monitoring and evaluation of wastewater reuse systems are irregular and underdeveloped because of weak institutions, a shortage of trained personnel, lack of monitoring equipment and high monitoring costs.

Arab countries fall into three broad categories of wastewater disposal practices:

Category 1. This group includes Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates. All Gulf Cooperation Council countries follow similar methods in wastewater effluent disposal. A high percentage of treated wastewater is reused in irrigation while the remainder is discharged in the sea after many advanced treatment steps. Strict quality standards are followed before disposal and reuse, but certain parameters could be relaxed to fully use the ever-increasing volume of secondary treated effluent.

Category 2. This group includes Egypt, Iraq, Jordan, Morocco and Syria. These countries have moderately strict regulations for disposal of effluent from wastewater treatment plants, but actual practice does not meet national or international standards. This may be due to the inability of treatment plants to cope with large volumes of raw wastewater. A high percentage of the wastewater effluent is disposed of in surface water bodies for later use in irrigation, following regulations on the types of crops that can be irrigated with this treated water. This water may also be used for landscaping and industrial purposes. The governments do not allow raw wastewater to be disposed of in wadis or through land discharge. Violations may occur in rural areas not connected to the sewer (collection) system.

Category 3. This group includes Lebanon, the West Bank and Yemen, where large amounts of wastewater effluent are disposed of in wadis and subsequently used to irrigate crop lands without treatment. In the West Bank, raw sewage is disposed of in wadis, where it is used to irrigate all kinds of crops and vegetables. No environmental or health controls protect the workers, products or soil or prevent groundwater contamination. In Yemen, raw wastewater is used for irrigation without treatment.

Source: AHT 2009; Fatta and others 2005; Choukr-Allah and Hamdy 2004; Choukr-Allah 2010.

and industry, while avoiding many health and environmental problems.

Treated wastewater deserves particular attention in the Gulf countries, with their large urban populations averaging 87 per cent of the total population and financial strength. In most of these countries, treatment facilities operate with tertiary and advanced treatment capabilities. These countries use about 40 per cent of treated wastewater for fodder, landscaping and irrigation of non-edible crops. About half of municipal wastewater is discharged untreated into wadis to infiltrate shallow aquifers or into the sea, severely polluting coastal and marine environments.[58] All the Gulf countries have ambitious plans to reclaim more wastewater to meet the demand for irrigation water and to reduce groundwater abstraction for agricultural use.[59] Egypt treats and reuses a substantial amount of wastewater outside the Nile Delta for landscaping, desert reforestation schemes and food, industrial, cosmetic and energy crops.[60] In Jordan, treated wastewater blended with freshwater irrigates food crops on some 10,600 hectares and provides about 20 per cent of the country's irrigation water.[61] In Libya, some 40 million cubic metres (6.6 per cent) of the 600 million cubic metres of wastewater generated annually is treated and reused on fodder crops, ornamental trees and lawns. In Tunisia, around 30 per cent of treated wastewater is reused in agriculture and other areas.

Treated wastewater offers many advantages for the arid Arab countries. It lacks the uncertainties of surface water resources and can meet a proportion share of the rising water demand from urbanization and population growth. Many factors prevent the expansion of water reuse, however, including social barriers, technical obstacles and institutional and political constraints.

Policies are needed for wastewater treatment to protect human health and the environment (Box 1.7). Awareness and government subsidies are not enough to promote the reuse of treated wastewater when another water source is available, even if that source is scarce and insufficient. A cost effectiveness analysis could help decision-makers choose a sustainable course of action. Drainage capacity building is also needed (Box 1.8).

Ensuring social acceptance of treated wastewater is a major issue. Appropriate technologies, proper regulations and participatory management practices can all help. Political will and commitment to expand the use of treated wastewater are essential. Arab governments can help by exercising regulatory and managerial tools, allocating required resources and establishing incentives. Multiple strategies are needed, including monitoring and evaluation, sponsoring public awareness campaigns

Box 1.8 Drainage capacity building in North Africa

The International Programme for Technology and Research in Irrigation and Drainage is a specialized programme for promoting drainage capacity building in Africa. In its workshop on North Africa, the programme presented an overview of the existing systems and key recommendations to develop the drainage sector, including the following:

- All countries need to strengthen their national drainage capacity. Depending on the country, the emphasis may be on surface or subsurface drainage systems. Most countries require a combination of systems: subsurface drainage systems to control water logging and salinity and surface drainage systems to control surface run-off.
- Few drainage engineers are available. All participants prioritized more intensive networking to facilitate information exchange.
- Knowledge enhancement through international courses (involving case studies and site visits in the North African countries to appreciate the different drainage solutions) is essential.
- Collaboration should be international and include R&D institutions from North Africa, Europe and elsewhere.
- Capacity building requires comprehensive attention from beginning to end of a drainage project: identification, design, construction, implementation and socioeconomic aspects, such as farmer participation. Greater focus on environmental aspects is necessary. It is important to place the drainage issue in the context of overall water management and to integrate it with water quality control.
- The financial and technical assistance required for capacity building requires medium- to long-term commitment and planning. Participants expressed the need for international collaboration. The details of such collaboration could be discussed with donors and elaborated on and coordinated as appropriate by international agencies and national governments.

Source: IPTRID 2002.

to improve public attitudes towards treated wastewater, setting national standards for reuse and protection of public health, making reclaimed wastewater a more reliable alternative to groundwater or surface water in irrigation and implementing effective plans to increase crop value and conventional water resource conservation.[62] As social barriers to wastewater reuse (such as farmers' disinterest and religious prohibitions) diminish, the public will begin to accept the need for reuse, especially for nonedible crops, ornamental gardens and the like.[63]

Other nonconventional water sources

Several Arab countries have investigated alternative water supply strategies. Jordan highlights rainwater harvesting for irrigation and water supply. Water harvesting techniques have been used in the Arab region since ancient times. Water harvesting offered a necessary, low-tech solution to increase water use efficiency, intensify agricultural production during dry seasons and minimize environmental degradation.[64] In one of the driest regions of the world, sustainable water harvesting should be a priority to ensure optimal use of precipitation, limit water resource depletion and satisfy people's needs.[65]

The main conservation methods in the Arab countries include cisterns (limited quantities of water for short periods), micro-catchments (adjacent to cultivated areas), small dams and underground storage. Spreading systems include terraces (masateh, in Oman, Saudi Arabia and Yemen), irrigation diversion dams, sloped catchment areas next to fields (meskat, in the Maghreb region), artificial recharge and check dams. Shallow dug wells and pit galleries also abstract water from shallow aquifers (for domestic supply as well) and exploit groundwater in the coastal sand dunes. These diverse systems manage rainfall, protect soil moisture and control soil erosion and desertification.[66]

Among the main constraints to greater use of rain harvesting are inadequate data on rainfall and run-off, inefficient catchment conditions and hydrological techniques, and the high cost of installing, monitoring and maintaining water harvesting infrastructure. Socio-economic constraints include farmers' outdated knowledge of water harvesting methods and land tenure weaknesses that reduce the motivation to invest in new water harvesting structures.

Improving water harvesting techniques requires a long-term government policy to support national research centres and extension services, adequate institutional structures, beneficiary organizations (associations, cooperatives), and training programmes for farmers, pastoralists and extension staff.

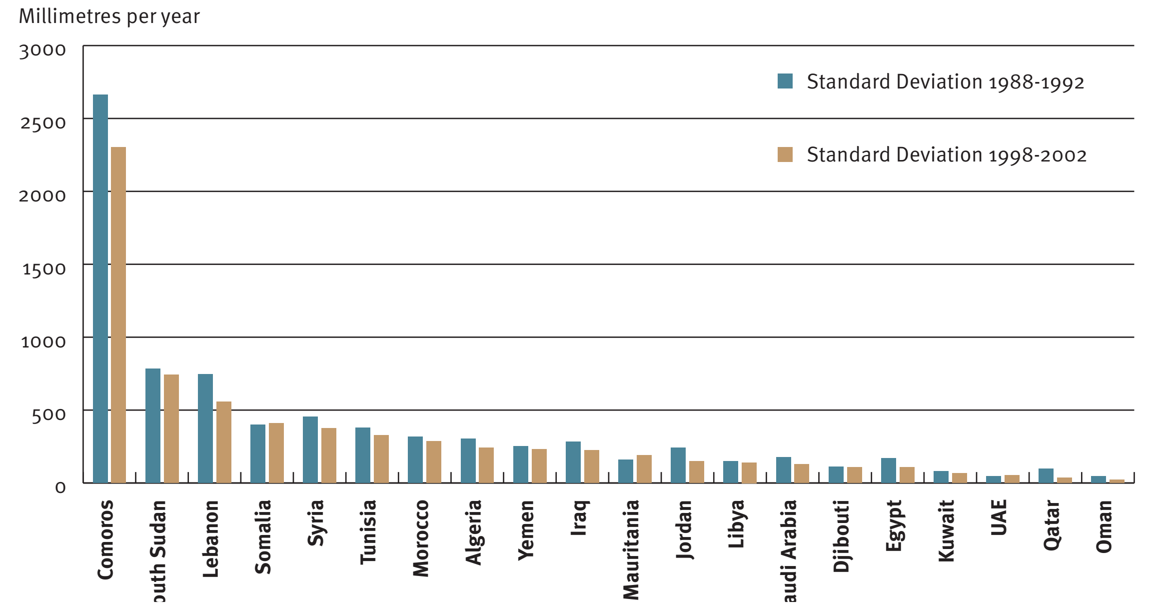
Weather modification through cloud-seeding technologies is also being tested in the region. United Arab Emirates reported positive results with cloud seeding in May 2008.[67] Jordan reported a 13 per cent average increase in rainfall after 10 rainy seasons following cloud-seeding experiments. Saudi Arabian cloud seeding experiments also registered positive results.[68] The Saudi National Centre for Meteorology and Environmental Protection is also implementing a weather modification project.[69] The practice has raised concerns over cloud ownership between countries, however.[70]

The Arab region also draws heavily on reused irrigation drainage waters. Among Arab countries, Egypt and Syria use the most nonconventional irrigation water: Egypt uses about 7.5 billion cubic metres a year of reused agricultural drainage water, and Syria uses 2.3 billion.[71] Egypt adopted a national policy for drainage reuse in 1975 to enhance water use efficiency and increase cultivated area. The amount of drainage water reused for irrigation is expected to reach 8.7 billion cubic metres a year by 2017.[72]

Despite the benefits, reusing drainage water damages the Nile's water quality; salts, pesticides and industrial and municipal effluents in the water harm human health and the environment. A long-term policy and a comprehensive monitoring programme are needed to improve the efficiency of drainage water reuse and limit its polluting impact. Egypt has operational guidelines for reusing drainage water as part of its horizontal land expansion programme, including evaluating water availability, assessing water quality and examining the socio-economic aspects for landholders.[73]

Figure 1.9

National Rainfall Index for Arab countries, standard deviations for 1988–1992 and 1998–2002



Note: There are insufficient data for Bahrain and Palestine. The index measures the variation of total annual precipitation from the long-term average for 1986–2000.
Source: FAO 2013.

Vulnerabilities of Arab water systems

Arab water systems have multiple vulnerabilities, from large variability in water resources to shared water resource, water pollution and the impacts of climate change.

Natural variability of water resources

Arab countries face serious challenges in managing their variable water resources. The extremely arid Gulf countries have adapted by relying on desalination. Egypt, Iraq and Syria have hastened to develop renewable, mostly transnational, water resources. Their efforts to secure historical rights to these resources have placed them in competition and potential conflict with upstream countries. Countries with limited renewable water resources and weak financial capability, such as Jordan, have pursued water reuse and demand management initiatives. Several countries now draw heavily on non-renewable fossil aquifers to offset the negative water balance. Most Arab countries have already exhausted their water supply development potential. Consequently, managing demand, in addition to improving water efficiency across sectors, offers effective and realistic options. Water supplies, exploited to their maximum levels, must be developed and maintained to ensure reliability.

The Arab region's rainfall variability is not only seasonal and geographic but also annual. Natural variability may result in five-year runs with rainfall at 10 per cent above or below average, though in 9 years out of 10, variability is less than 10 per cent. This high rainfall variability is reflected in the National Rainfall Index, which measures the variation of total annual precipitation from the long-term average for 1986–2000. Rainfall variability decreased from 1988–1992 to 1998–2002 (Figure 1.9).[74] The region's year-to-year rainfall variations have enormous implications for water systems[75] and require inter-annual water management, storage and conjunctive use between surface water and groundwater.

Shared water resources

More than half of total renewable water resources (surface water and groundwater) in the Arab region (about 174 billion cubic metres a year of a total of 315 billion) originate from outside the region (water dependency ratio).[76] These include major rivers such as the Euphrates, Nile, Senegal and Tigris. Many smaller rivers are also shared between Arab countries, including the Yarmouk River in Syria and Jordan and the Orontes (Al-Assi) and El-Kabir Al-Janoubi rivers in Lebanon and Syria. Large regional groundwater systems, both renewable and non-renewable, extend between neighbouring Arab countries and across the region's borders. The region's shared aquifers include the Nubian Sandstone Aquifer (Chad, Egypt, Libya and Sudan); the North Western Sahara Aquifer System (Algeria, Libya and Tunisia); the Mountain Aquifer (Israel and West Bank); Disi Aquifer (Jordan and Saudi Arabia); Rum-Saq Aquifer (Jordan and Saudi Arabia) and the Great Oriental Erq Aquifer (Algeria and Tunisia). Most of these aquifer systems are non-renewable; encompass vast areas, mainly in the Sahara Desert and the Arabian Peninsula; and are shared by many Arab and non-Arab countries. These aquifer systems store substantial water in deep geological formations, but the water has a finite lifespan and quality limitations.[77]

Almost every Arab country depends for its water supply on rivers or aquifers shared with neighbouring countries. The water dependency ratio (for surface water) of some Arab countries is extremely high (Table 1.6). Egypt, Iraq and Syria rely almost exclusively on transboundary water resources originating from outside their borders, while Jordan and the State of Palestine depend almost entirely on the Jordan River, which is transboundary and essentially controlled by Israel. For some countries the ratio rises when shared groundwater aquifers are included. Algeria, Libya and Tunisia share vast amounts of groundwater, and most of the countries on the Arabian Peninsula share water from the Palaeogene aquifer system, extending from the northern to the southern end of the peninsula.

Water pollution

In addition to overexploitation, pollution from agricultural, industrial and domestic activities threatens the Arab region's groundwater and surface water resources (Box 1.9). As water quality deteriorates, water usability diminishes, reducing water supplies, intensifying water scarcity, increasing health risks and damaging the environment, including fragile ecosystems.[78]

In Gaza, for example, nitrate levels have risen to 600–800 mg per litre due to agricultural and wastewater pollution, much higher than the

Table 1.6 Water dependency ratio in the Arab region (surface water only, 2011)

Country	Water dependency ratio (%)	Country	Water dependency ratio (%)
Kuwait	100.0	Qatar	3.4
Egypt	96.9	Palestine	3.0
Bahrain	96.6	Lebanon	0.8
Mauritania	96.5	Morocco	0.0
Sudan and South Sudan	76.9	Djibouti	0.0
Syria	72.4	Oman	0.0
Iraq	60.8	Yemen	0.0
Somalia	59.2	Saudi Arabia	0.0
Jordan	27.2	Libya	0.0
Tunisia	8.7	UAE	0.0
Algeria	3.6	Comoros	0.0

Note: The water dependency ratio refers to surface water only. Many of the countries with zero water dependency ratio share transboundary groundwater aquifers with other countries.

Source: FAO 2013.

Box 1.9 The social cost of groundwater overexploitation and depletion: Bahrain

Groundwater in the Dammam aquifer is the only natural source of freshwater in Bahrain. The aquifer's safe yield is about 110 million cubic metres per year, estimated as the steady-state underflow rate received from the equivalent aquifers upstream in eastern Saudi Arabia. Since the early 1970s, the rapid increase in oil revenues has strengthened the country's economic base and improved standards of living, resulting in rapid population growth, industrialization, urbanization and expansion of irrigated agriculture, substantially boosting water demand. The heavy reliance on groundwater to meet escalating water demand has increased groundwater abstraction rates beyond the aquifer safe yield—rates more than doubled in the late 1990s. This prolonged overexploitation has led to severe deterioration in water quality due to seawater intrusion and saltwater upflow from the underlying strata and the complete loss of naturally flowing springs. Most of Bahrain's original groundwater reservoirs have been lost to salinization.

The social impact of groundwater depletion depends on the level of reliance on groundwater and the marginal cost (the cost of providing replacement supplies). Moreover, the opportunity cost for alternative or competing uses must also be considered, along with groundwater's functional value in maintaining ecosystems and providing emergency water.

For Bahrain, the marginal cost is enormous—equal to producing about 110 million cubic metres per year of desalinated seawater or treated wastewater at an estimated cost of $160 million a year. In addition, the loss of groundwater to salinization affects the country's socio-economic development as well as agriculture and the environment. As groundwater used for irrigation has become more saline, productivity losses and desertification have forced the abandonment of traditional agricultural areas. Cultivated area dropped from about 65 square kilometres to 41 square kilometres in the late 1970s, prompting Bahrain's government to step up its efforts to maintain agricultural lands at their previous level by reclaiming new lands and reusing treated wastewater. Groundwater depletion has also damaged wetlands and biodiversity. The drying of all natural springs and their surrounding environments has destroyed wildlife habitats, eliminated animal species and compromised the ecosystem and its tourism investment potential (see photos).

Examples of natural springs drying and loss of natural habitat, Ain Al-Ruha region in Bahrain, 1950s and 1990s

Source: Zubari 2001; Abdulghafar 2000.

maximum allowable limit of 50 mg per litre for drinking water and posing a serious health risk.[79] In the Ra's Al Jabal region in Tunisia, nitrate concentrations from agricultural pollution have reached 800 mg per litre.[80] Nitrate causes methemoglobinemia (blue baby syndrome) in infants, a condition that can result in death or developmental disability.[81] In the Maghreb countries, examples of human-induced pollution include eutrophication (oxygen depletion) of dam reservoirs, nitrate pollution of groundwater by fertilizers, cadmium-rich water releases from phosphate mines and pathogenic pollution of water resources from untreated municipal wastewater effluents.[82]

The Nile River's northern wetlands are experiencing eutrophication at many locations. In Egypt, excessive application of nitrate and phosphate fertilizers are another source of pollution.[83] In addition, domestic sewage, industrial waste and agricultural return flows from Cairo pass mostly untreated through the 70-kilometre Bahr El Baqar channel, discharging into Lake Manzala in the northeast Nile Delta. The discharge from Bahr El Baqar is heavily loaded with contaminants, including bacteria, heavy metals and toxic organics. This contamination has resulted in high fish mortality and malformation and a widespread unwillingness to consuming the lake's fish, formerly a third of Egypt's fish harvest.[84] In Sudan, the alarming levels of phytoplankton, water hyacinths and sediment carried by surface waters constitute major problems for water management and treatment and result in high reservoir siltation rates (increased concentration of suspended and fine sediments). Insufficient potable water supplies and wastewater collection and treatment facilities can also create health hazards.[85]

In Lebanon, the Upper Litani basin offers another stark example of the negative long-term impact of poor wastewater management. Fed mostly by freshwater springs, it has become a sewage tunnel for most of the year.[86] Uncontrolled use of fertilizers has further contaminated underlying aquifers.[87]

In Egypt, Jordan, Lebanon, the State of Palestine and Syria (Mashreq), dumping raw and partially treated wastewater from agriculture, industry and municipalities into water courses has caused grave health concerns and has severely polluted agricultural lands and water resources, especially during low discharge periods. Contamination of the underlying aquifers is also evident.[88] River basins show similar symptoms of pollution.[89] For example, the nitrate concentration in some domestic wells in the State of Palestine may reach 40 milligrams per litre.[90] Most villages in the Mashreq lack adequate wastewater disposal systems and rely on individual household cesspits, contributing to the contamination of groundwater, often a source of untreated drinking water. Extensive use of manure as fertilizer aggravates the problem, as run-off seeps into aquifers. Once groundwater becomes polluted, it is difficult and usually

Box 1.10 **Climate change: impact, vulnerabilities and risks**

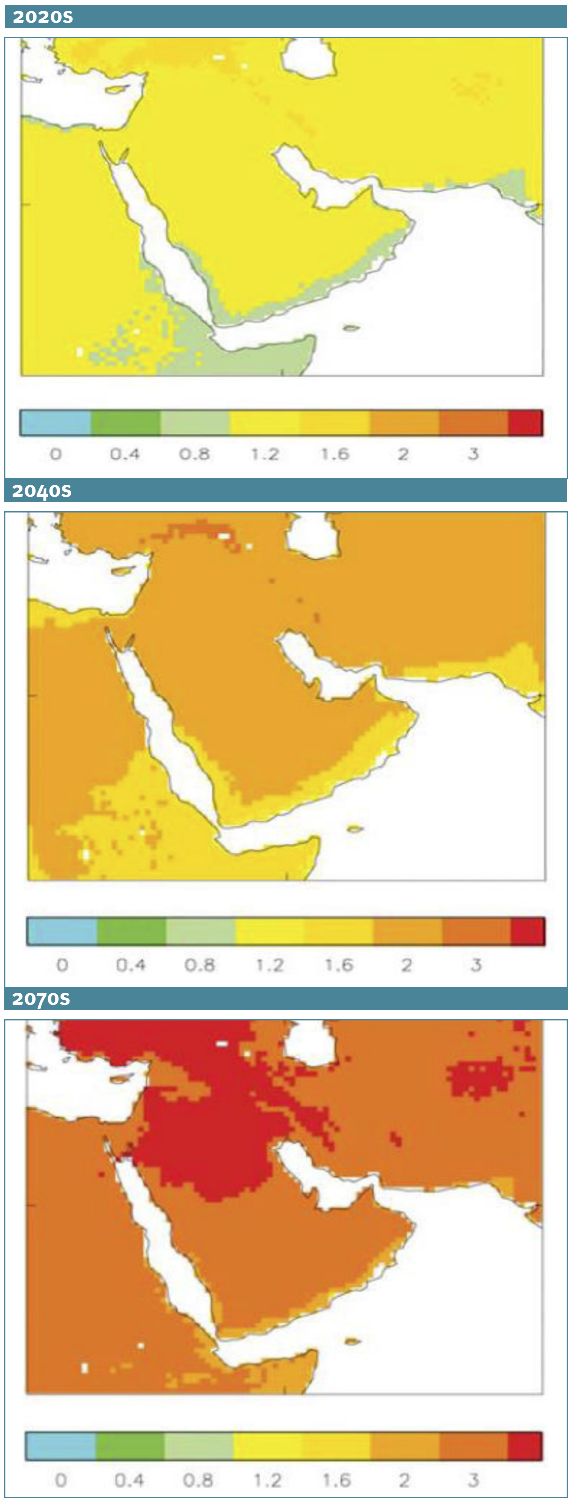
Climate change will alter the hydrological cycle, affecting water infrastructure and natural ecosystems (see maps below). No country is immune to climate change's effects, but some countries will be affected more than others due to economic and geographic factors. Lack of financial and technological resources will make developing countries more vulnerable to the impacts of climate change. The World Bank estimates that a 2.0°C rise in temperature could put 100–400 million more people at risk of hunger and that 1–2 billion more people might not have enough water to meet their needs. With disproportionate consequences for the developing world, climate change is expected to further widen inequality between rich and poor countries and could seriously affect or reverse development progress.

The risk of climate change depends on the probability of an event and the severity of its impact. The Intergovernmental Panel on Climate Change defines vulnerability as "the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change impacts, including climate variability and extremes." Vulnerability relates to sensitivity and extent of exposure to a potential hazard. Consider flood hazards. Sensitivity manifests as reduced food security after floods, while exposure increases when floods occur more frequently. Thus, vulnerability to the effects of climate change is a function of sensitivity, adaptive capacity and the character, magnitude and rate of climate change and variation. While efforts to mitigate climate change can reduce exposure, a society's adaptive capacity determines how seriously people will be affected. Strengthening adaptive capacity—a complex function of a society's infrastructure; wealth; economic structure; physical, human and institutional resources; and other factors—is the key to successful adaptation.

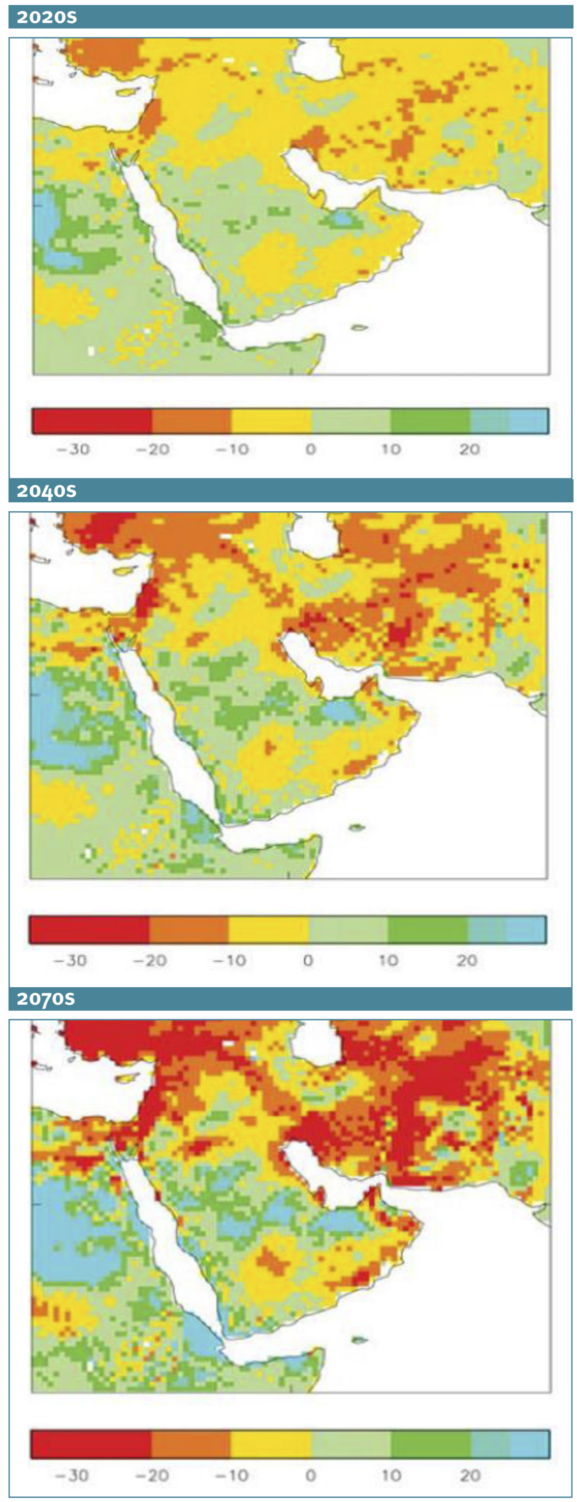
Source: World Bank 2010b; IPCC 2001, 2001a cost-prohibitive to rehabilitate, especially in a region with very low groundwater recharge rates.

Several Arab countries have acknowledged the problems associated with polluted groundwater and have taken steps to protect valuable water resources from further degradation.

Map 1.4.a: Regional climate model projections of average temperature changes (°C) for the 2020s, 2040s and 2070s, relative to 1990s



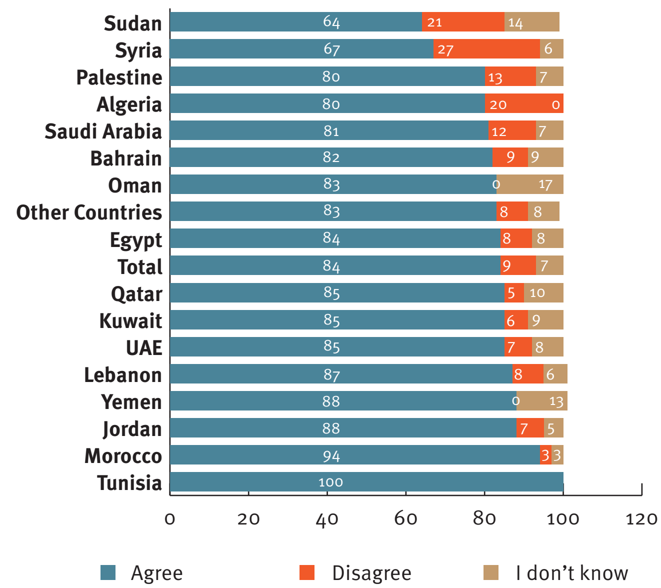
Map 1.4.b: Regional climate model projections of precipitation changes (%) for the 2020s, 2040s and 2070s, relative to 1990s



Source: Adapted from Hemming, Betts, and Ryall (2007).

Wastewater treatment has improved substantially in many countries, particularly Egypt and Jordan. Algeria, Egypt, Morocco and Tunisia began to regularly monitor groundwater quality in the 1990s. Groundwater assigned to domestic water use is now under state control. In Egypt, directly disposing of untreated industrial effluents into the Nile has been banned since 1999.[91] In 2001 the Sultanate of Oman issued a law to protect sources of drinking water from pollution and has since developed drinking water well-field protection zones for all of its groundwater basins.[92] With the help of the Arab Centre for the Studies of Arid Zones and Dry Lands, the UN Economic and Social Commission for West Asia, Germany's Federal Institute for Geosciences and Natural Resources, and the German Development Cooperation, Jordan, Syria and Yemen have mobilized technical and financial resources to formulate water quality management policies, specify required legal procedures and define responsibilities in institutional frameworks that allow effective coordination between concerned parties, with particular focus on groundwater protection.[93]

Figure 1.10 Survey on recognition of the problem of climate change in the Arab region, February–May 2009



Note: Totals might not sum to 100% due to rounding.
Source: Tolba and Saab 2009.

Climate change

The scientific evidence shows that the climate is already changing.[94] In the Arab region, climate change is manifesting as more severe droughts, storms and flooding (Box 1.10 ; Map 1.4 a & b).[95] The Arab Forum for Environment and Development report on climate change in the Arab region (2009) states that Arab countries are among the most vulnerable to climate change's effects. For that report, the forum surveyed public attitudes towards climate change: 84 per cent of respondents thought that climate change posed a serious threat to their countries (Figure 1.10). Public opinion in Arab countries recognizes climate change as a reality and accepts that it is caused mainly by human activities. The survey indicates that the Arab public seems ready to accept and participate in concrete national and regional action to deal with climate change.[96]

Simulated ranges of warming indicate that annual average surface air temperature for the Arab region will likely rise a further 2.5°C to 4.0°C by 2100.[97] The temperature rise is expected to increase evapotranspiration rates, reducing soil moisture, infiltration and aquifer recharge. Projected annual average precipitation ranges for the 21st century will fall 10-20 per cent in the Mediterranean region and the northern parts of the Arabian Peninsula. Simulated ranges also indicate that precipitation will fall 30-40 per cent in Morocco and northern Mauritania. But a 10-30 per cent increase in precipitation is predicted in the southwestern part of Oman, Saudi Arabia, United Arab Emirates and Yemen. Increased rainfall intensity, which usually leads to flash floods, is expected to reduce infiltration and potential aquifer recharge. Simulated impacts of climate change on long-term annual average diffuse groundwater recharge find that the increase in surface temperature and reduction in rainfall will result in a 30-70 per cent reduction in recharge for aquifers in the eastern and southern Mediterranean coast.[98]

A warmer climate brings greater climate variability and higher flood (Box 1.11) and drought risk, exacerbating the already precarious situation created by chronic water scarcity. Drought is one of the most serious

Box 1.11 Flood management and mitigation

With climate change, extreme flooding events are becoming more probable. A 2000 United Nations Economic Commission for Europe paper on sustainable flood prevention presented guidelines for flood prevention and protection, including preliminary flood risk assessments and flood hazard and risk maps. Effective land planning is vital to ensure some preparedness. Dwellings, critical infrastructure (such as hospitals) and sensitive land uses should be located in areas with lower flood risks or greater capacity to withstand extreme floods. The paper also recommends flood studies, flood prediction and drainage design methodologies, special technical and emergency case studies of river basins, and training and development to meet new demands and expectations.

The Arab region is especially threatened by flash floods, which occur with little warning. They frequently take place in remote mountain catchments where few institutions are equipped to deal with disaster mitigation. In 2009 and 2010 heavy rains led to flash floods in Aswan and Al-Arish in Egypt, Jeddah in Saudi Arabia, Gaza in the State of Palestine, and many other areas that killed many people, downed power lines and destroyed roads.

Flash flood risk assessment, the core of the disaster risk management process, identifies potential risk reduction measures. Risk assessment must be integrated into development planning to identify actions that meet development needs and reduce risk.

Recommended management and assessment tools to be developed for flood management include environmental assessments, flood loss assessments, basin flood management plans, rapid legal assessment tools, community participation, reservoir operations and managed flows, land planning, adaptation to climate change, flood mapping and prediction, case studies and experiences, flood emergency planning, transboundary aspects, river restoration and wetlands conservation, and flash flood, mud flow and landslide management.

Source: Adapted from UNESCO (2010b) and UNECE (2000a).

water-related disasters threatening the Arab region. Higher temperatures will increase the incidence and impact of drought in the region. Drought frequency has already risen in Algeria, Morocco, Syria and Tunisia. Recent droughts in Jordan and Syria were the worst recorded in many decades. In addition, many countries will experience greater variability in precipitation and reduced water resource availability.[99]

Climate change research identifies the Arab region as home to 5 of the top 10 countries at risk from the impacts of climate change: Djibouti, Egypt, Iraq, Morocco and Somalia. Djibouti, ranked as the most exposed to the impact of climate change, is regularly subjected to tropical storms from the Indian Ocean and will be more vulnerable to inland flooding as sea levels rise. Egypt ranks as the region's second most exposed country. With the vast bulk of its population concentrated in the Nile Valley and Delta, it is at high risk of inland flooding. The Nile's flow will also be uncertain because of unreliable rainfall. Iraq, Morocco and Somalia, the next most vulnerable, are at high risk of coastal flooding and exposure to extreme temperatures. The Gulf countries of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates are expected to suffer severe consequences of climate change. Bahrain, with its relatively small land mass, is in danger of inundation as sea levels rise. Qatar is especially susceptible to inland flooding. Bahrain, Qatar, Kuwait and Yemen are considered to be "extremely" vulnerable. Jordan, Lebanon, Libya, Oman, Saudi Arabia, Tunisia and the United Arab Emirate are rated "highly" vulnerable.[100]

To reduce vulnerability, Arab countries need to enhance their adaptive capacity and consider the impacts of climate change in their water resource planning. But national plans and regional investment portfolios do not yet reflect a sense of urgency on these vital matters. Key capacities for adaptive governance for climate-induced water scarcity are underdeveloped. Attention needs to focus on good governance, human resources development, institutional structures, public finance and natural resource management. And Arab countries need to foster regional cooperation on adapting to climate change.

Water resources in the Arab region are in an alarming state. Natural water scarcity, rapid population increases, changing lifestyles, the demands of economic development and growth, and inappropriate governance and water management practices have created a vicious cycle. The effects of climate change and growing competition over water resources are cause for more concern. Effective water governance is the only way out of a rapidly deteriorating situation.

Endnotes

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94 The International Panel on Climate Change defines climate change to a change in the state of the climate that can be identified (for example, using statistical tests) by changes in the mean or the variability of its properties and that persists for an extended period, typically decades or longer. It refers to any change in climate over time, whether due to natural variability or as a result of human activity. This usage differs from that in the United Nations Framework Convention on Climate Change (UNFCCC), which defines climate change as a change in climate attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods. Detection of climate change is the process of demonstrating that the climate has changed in a defined statistical sense, without providing a reason for that change. Attribution of causes of climate change is the process of establishing the most likely causes for the detected change, with some defined level of confidence. Both detection and attribution rely on observational data and model output. Climate change patterns or "fingerprints" are no longer limited to a single variable (temperature) or to the Earth's surface. More recent detection and attribution work has used precipitation and global pressure patterns, and analysis of vertical profiles of temperature change in the ocean and atmosphere (IPCC 2007).
95 IPCC 2007.

[96] Tolba and Saab 2009.
[97] UNESCO 2010a.
[98] Khater 2010; Doumani 2008.
[99] FAO 2002.
[100] Khater 2010.

Chapter 2

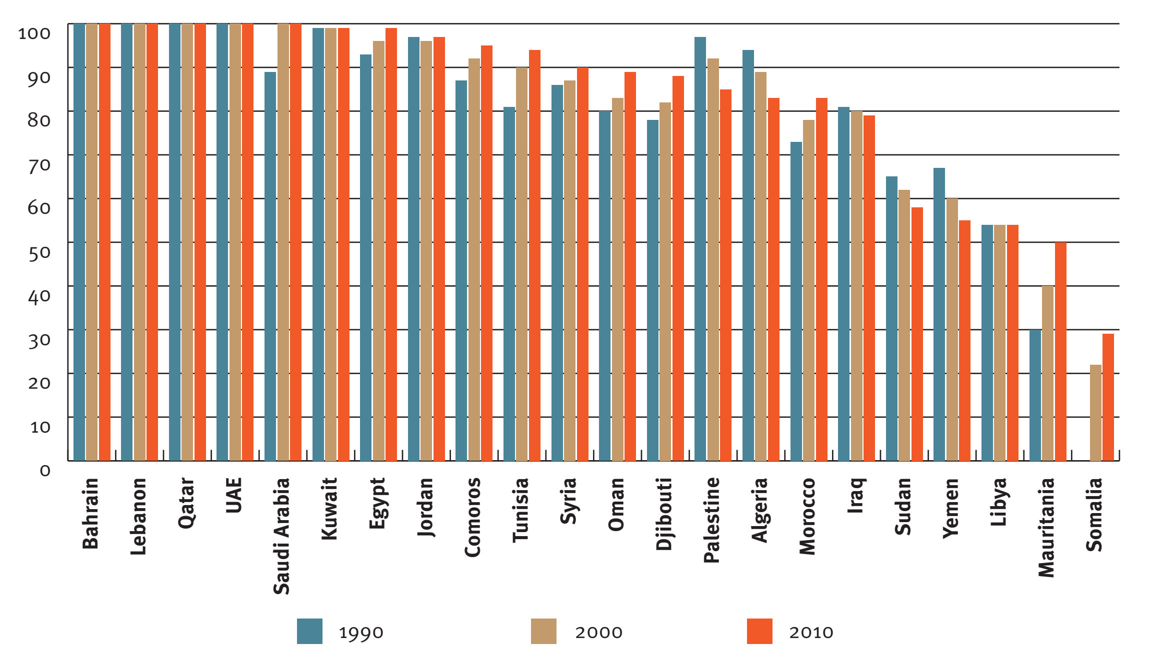
Challenges to water governance in the Arab region

This chapter addresses major water governance challenges in the Arab region. It emphasizes policy choices and relevant interests, laying a foundation for an effective water governance system.

Water coverage and distribution

Despite conditions of water scarcity and a dramatic shrinkage in per capita renewable water resources in recent decades, many Arab countries have made progress in providing improved water and sanitation to their populations. About 82 per cent of people in the region have access to improved drinking water (Figure 2.1) and about 76 per cent to improved

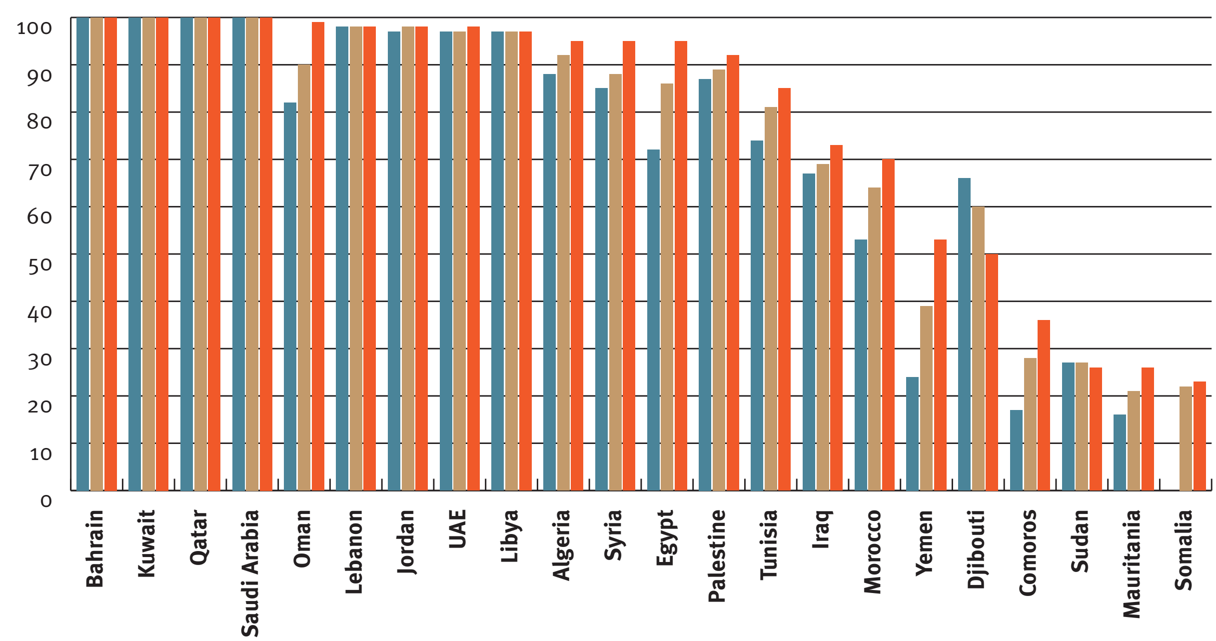
Figure 2.1 Trends in population with access to improved drinking water sources in Arab countries, 1990, 2000 and 2010



Note: Somalia has insufficient data for 1990.

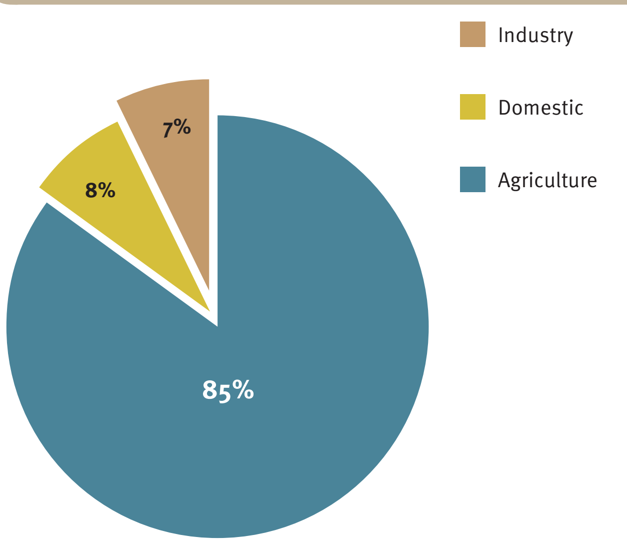
Source: WHO and UNICEF 2013.

Figure 2.2 Trends in population with access to improved sanitation in Arab countries, 1990, 2000 and 2010



Note: Somalia has insufficient data for 1990.
Source: WHO and UNICEF 2013.

Figure 2.3 Water uses in the Arab region



Source: World Bank n.d.

sanitation (Figure 2.2).[1] But supplying water to growing populations is becoming increasingly challenging. Shrinking water availability, with demand outpacing supply, is triggering competition among water use sectors: industrial, agricultural and municipal. Water managers have responded by providing a little water for all and a little more for some, depending on government priorities. Macroeconomic arguments are being made for reallocating water supplies from one sector to another, to boost economic development. Such decisions have extensive political and social ramifications, especially when strong advocacy groups represent water use sectors.[2] Each sector has its own arguments for why it needs and deserves more water. Agriculture currently dominates water use in the Arab region (Figure 2.3).

Agriculture sector

Although urban demand for water has been rising steadily, agriculture continues to consume the most water. Agricultural water use rose

Box 2.1 **Agricultural expansion based on fossil groundwater resources**

In the Gulf Cooperation Council countries, trade protection, price supports, lack of restrictions on groundwater extraction, and agricultural subsidies for wells, fuel and other inputs have contributed to large expansions of irrigated land and depletion of aquifers. Over the last two decades, irrigated areas in Gulf countries grew 100-300 per cent. Irrigation water is often used inefficiently, without considering the economic opportunity cost for urban domestic and industrial purposes. Although agriculture contributes less than 2 per cent of GDP in Gulf countries, it receives a disproportionate share of water (85 per cent of total withdrawals from natural water resources) and overexploits groundwater (mostly non-renewable fossil groundwater) resources. Aquifers are being depleted, and water quality is deteriorating as seawater infiltrates the aquifers. Countries have no clear exit strategy for how to replace these resources once they are exhausted.

In Saudi Arabia, generous subsidies have encouraged the rapid expansion of irrigated areas, nearly tripling agricultural water use. Water use rose from about 7.4 billion cubic metres a year in 1980 to a high of 20.2 billion in 1994, before falling to 18.3 billion in 2000, and now stands at 17.5 billion. By 1995, about 35 per cent of non-renewable groundwater reserves in Saudi Arabia were already depleted. This use of groundwater for irrigation is unsustainable; water levels have dropped more than 200 metres in some aquifers over the last two decades. Since 2000, the Saudi government has taken steps to reduce groundwater depletion by encouraging efficient irrigation water use and reducing fiscal burdens by ending land distribution and reducing input subsidies. It has also introduced incentives to use water-saving technologies such as drip irrigation and soil moisture sensing. These policies have had a considerable effect on irrigation water demand.

Recently the Saudi government introduced a sustainable agricultural strategy to cut water consumption in half. The plan calls for an end to planting green fodder for livestock feed and for reducing wheat production by 12.5 per cent year by discontinuing a 30-year-old wheat plantation project that had achieved total wheat self-sufficiency but at a cost of draining the country's groundwater resources. Under the new plan, government subsidies will support only the least water-consuming crops. Green fodder imports will offset the drop in local production. The five-year sustainable agriculture plan also calls for developing the distribution chain and promoting organic crop agriculture. A new Saudi drive focuses on agricultural investment in countries such as Egypt, Ethiopia, India, Indonesia, Pakistan, the Philippines, Sudan, Thailand, Turkey and Ukraine, to replace local production. Following negotiations with the Saudi Ministry of Trade and Industry, the Philippines agreed to allocate an area of 100,000 hectares in Mindanao Island to cultivate rice and other grains for export to Saudi Arabia.

Source: LAS, UNEP, and CEDARE 2010; Al-Zubari 2008; Al-Turbak 2002; World Bank 2005; El-Ashry, Saab, and Zeitoon 2010; Sadik 2013.

from about 160 billion cubic metres in 1995 to more than 200 billion in 2003.[3] But despite the increase, agricultural performance and food production failed to advance in many Arab countries.[4]

Over the last three decades, the Arab region has experienced a development boom, with rapid population growth. To meet the accompanying rising demand for food, many countries have prioritized food security and socio-economic development through policies to expand agricultural land and irrigated cultivation. But they have failed to consider water's limited availability and the need for conservation and demand management (Box 2.1).[5]

Water scarcity has become a critical constraint to agriculture. About half of irrigation water is wasted because of inefficient methods, such as deep percolation evaporation and surface run-off use (Figure 2.4).[6] Surface irrigation, practiced on 80 per cent of the irrigated area, is the most widely used method in the region, followed by sprinkler irrigation, which is practiced on 23 per cent of the area. The more efficient micro-irrigation is practiced on only 2.8 per cent of irrigated area.[7] Some studies estimate that irrigation efficiencies in the Arab region are as low as 30-40 per cent.[8] Such waste leads to weak agricultural performance and, more dangerously, salinization and water-level decline due to overuse. In many countries, food self-sufficiency is declining as land and water resources are depleted and population grows. Agricultural practices are also contributing to increased soil and water salinity, toxic pollution from agrochemicals, loss of biodiversity through wetlands destruction and the construction of new dams.[9]

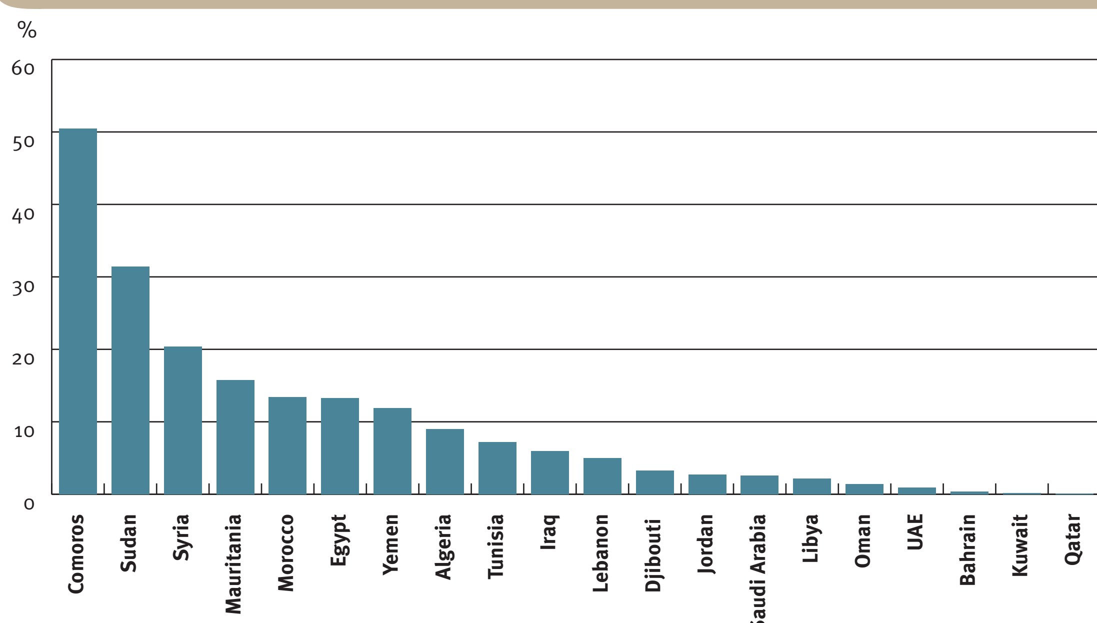
The International Fund for Agricultural Development identified four major pressures on the agricultural sector in the Arab region:[10]

- The need to produce more food to reduce Arab countries' enormous food imports bill ($28 billion in 2006).
- As the largest employer of people in the rural and marginal areas, the agricultural sector needs to halt its decline in job creation, especially for young people. In

Figure 2.4 Flood irrigation practices in Bahrain use water inefficiently

Source: Al-Zubari 2008.

Figure 2.5 Contribution of agriculture to GDP in selected Arab countries, 2010



Source: AMF 2011.

Box 2.2 **Water demand management strategies in Tunisia and Morocco**

Tunisia was one of the first countries to adopt a national water-saving strategy for urban and agricultural water use, continuing a tradition of frugal and patrimonial management of water, a scarce resource in Tunisia. Thanks to this policy, water demand for irrigation has stabilized despite droughts and increasing agricultural development. The policy has also ensured the water supply for tourism, a source of foreign currency, and cities, a source of social stability. The underlying principles of the Tunisian strategy are:

- A transition from isolated technical measures to an integrated strategy.
- A participatory approach that makes users more responsible (960 water user associations were created, covering 60 per cent of the public irrigated area).
- A gradual introduction of reforms and adaptation to local situations.
- Financial incentives to promote water conservation equipment and technologies (40-60 per cent subsidy for purchasing such equipment).
- Income support for farmers, allowing them to invest and hire more labour.
- A transparent and flexible pricing system that complements national goals of food security and allows a gradual recovery of costs.

Morocco's strategy for managing agricultural water demand focuses on the comparative cost of saving 1 cubic metre with the cost of developing an equivalent amount of new water resources. Adopting drip irrigation costs less than developing new water sources. The water saved is optimized by improving market gardening and tree growing yields. The productivity gains have been profitable, generating extra added value. Benefit-cost analysis reveals a return of more than 30 per cent of the capital costs. The benefits of the new strategy are not only economic but social (increase in farmers' income) and environmental (reduction of water abstraction).

Source: Benoit and Comeau 2005.

2006 thirty seven per cent, or 47.6 million people in an economically active population of 126 million, were engaged in agriculture, down from 47.8 per cent in the 1990s. More employment in the rural and marginal areas would reduce rural–urban migration and end the decline in the sector's contribution to GDP (Figure 2.5). In 2005 the agriculture's average contribution to GDP was a low 12.5 per cent, ranging from 0.3 per cent in Kuwait and Qatar to 34 per cent in Sudan.

- To meet the growing water needs of cities and industries, demands are mounting to force agriculture to redirect rising amounts of its share of clean water. To meet that demand today, governments have to resort to expensive desalination, an unaffordable option for some countries. Agriculture has to depend more on reusing water and using water of marginal quality to meets its requirements for production.
- Agriculture needs to adapt to climate change, as severe droughts, flash floods and crop-threatening weather anomalies are expected to increase.

These pressures point to a need for major reform of water policy in the agriculture sector. Agricultural performance indicators show that irrigation management is weak, characterized by deteriorating infrastructure, centralized administration, a large irrigation bureaucracy, low irrigation service fees and limited participation of water users in maintenance tasks. Water policies have focused on enhancing supply to meet growing demand rather than on managing demand and regulating water use. Irrigation water is widely subsidized and sold below operational costs despite the economic and environmental costs of overexploitation.

New policies and laws to regulate water use and manage demand are urgently needed. Groundwater extraction, like surface water allocation, must be metred and tariffed. Efficient agricultural techniques should be promoted through regulations, institutional reform, tax exemptions, pricing subsidies and capacity building for farmers (Box 2.2).

Several Arab countries are reducing irrigation water subsidies. Morocco and Tunisia have introduced volumetric pricing for public irrigation, charging farmers by the amount of water they use rather than by hectares under cultivation. Metring is a condition for estimating water balance and a technical tool for preserving water. Irrigation charges almost completely cover operations and maintenance costs in Tunisia and are approaching full coverage in Morocco.[11]

Institutional reform, including capacity building, effective coordination, proper organizational structures, and accountability and transparency, is urgently needed. Many Arab countries have implemented institutional changes in their agricultural and water sectors. A major step was separating the water authority from the agricultural authority. Growing awareness of the value of decentralization and farmer participation in water distribution has also led several Arab countries to adopt participatory irrigation management. Egypt, Jordan, Libya, Morocco, Oman, Tunisia and Yemen have promoted water user associations as active partners in operating and managing irrigation systems. Users help determine service levels, charges and water allocations. Elected governing boards follow clearly established, transparent procedures and members must finance part of the infrastructure and the operations and maintenance costs.[12]

Incentives, particularly financial, are needed to improve irrigation efficiency. Managing irrigation water demand, including adopting water-saving technologies and crops, is essential. Economic and financial mechanisms include permits, rebates, tax incentives, targeted subsidies, price controls and water rights. Relevant R&D must also be promoted and properly targeted. Research can focus on developing crops that tolerate drought and salinity. Other areas of development should involve livestock management and support. R&D should not be limited to technological improvements but should also address knowledge transfer and identify optimal governance and management options at local and national levels.

Better procedures are needed for assessing irrigation performance, along with better systems to manage water conveyance, allocation and distribution.[13] North African Arab countries, which allocate more than 80 per cent of their water resources to agriculture, should increase irrigation efficiency, as the opportunity to save water is notably higher there than in other sectors. For instance, reducing transport losses by 50 per cent and improving irrigation efficiency from 40-50 per cent to 80 per cent could save nearly 52 cubic kilometres a year, or more than 40 per cent of the region's water losses, and thus provide an additional supply of nearly 20 per cent of demand. Possible irrigation savings constitute more than 70 per cent of water savings.[14]

The availability of inexpensive, heavily subsidized water has led to overuse and waste. Yet water remains a scarce resource in almost every Arab country, so conservation is thus essential. Many argue that pricing is the most effective method to ensure conservation, but a major governance issue is how to provide the public with adequate, inexpensive water. An answer lies in imposing progressive tariffs for drinking water and rationing water in agriculture, while demanding water pricing at actual cost in commercial activities and industry. A progressive water tariff ensures that basic human needs for fresh water are met at a low, subsidized price, while excessive use is priced at a tariff that reflects cost.

Municipal water sector

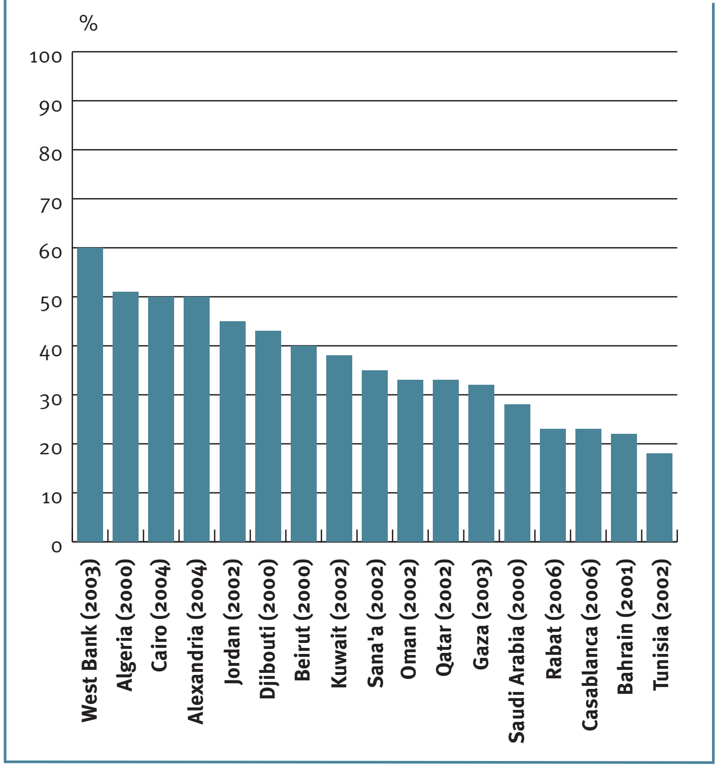
In almost all Arab countries, rapid urbanization challenges efforts to meet rising domestic water demand, especially in countries with tight budget constraints. Urbanization has risen from nearly 45 per cent of the population in 1980 to 56 per cent in 2010 and is expected to exceed 60 per cent in 2020.[15] Domestic water consumption is expected to rise more than 60 per cent from 1998 to 2025, increasing from about 13.2 billion cubic metres to about 30, an average increase of 4.5 per cent a year.[16]

Domestic water consumption per capita varies considerably in the Arab region, both among and within countries. In the Gulf Cooperation Council countries, it ranges from 300 litres per day to 750 among the world's highest. The rise is attributable to many factors, including government subsidies, the absence of price signalling and demand management, and a government focus on water production from aquifers and desalination plants. Government subsidies mean that water tariffs are low, at around 10 per cent of the cost, providing no incentives for consumers to save water.[17]

One of the municipal sector's major challenges is to reduce unaccounted-for water (or nonrevenue water) in the distribution network. The World Bank defines unaccounted-for water "as the difference between the amount of water delivered by the water utility and the amount actually billed. [Unaccounted-for water] includes distribution network losses by leakage, illegal water use and inaccurate metring. The [unaccounted-for water] can reach more than 60 per cent in poorly maintained distribution networks in some Arab cities, including the financially incapable and capable" (Figure 2.6).[18] The volume of unaccounted-for water in Arab countries, ranging from 15 per cent to 60 per cent , greatly exceeds that in developed countries, where it ranges from less than 10 per cent for new systems to 25 per cent for older systems.[19]

Governance schemes need to take unaccounted-for water into account. Particularly in water-scarce Arab countries, this lost water carries a high opportunity cost, equivalent in the Gulf countries to the cost of desalination and pumping.[20] Reducing unaccounted-for water by improving water distribution systems should thus be a major governance objective.

Figure 2.6 **Nonrevenue water in water supply utilities in selected Arab countries and cities**



Source: World Bank 2007.

Competition among users

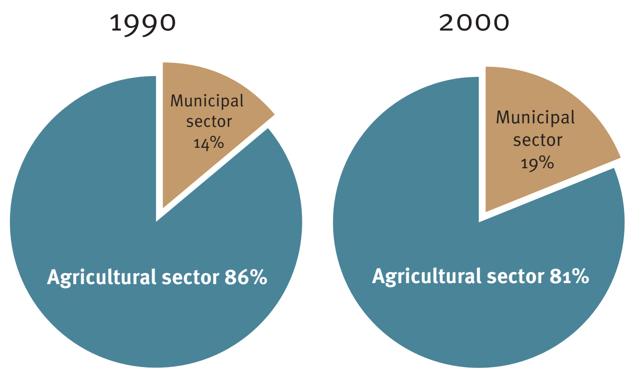
Balancing multiple water uses amid water scarcity and competing interests can generate social and economic problems. Agriculture produces only a small share of GDP, for example, but its abandonment in favour of more productive sectors such as heavy industry and tourism would make Arab countries even more dependent on food imports and leave millions of unskilled labourers jobless. This could further stimulate the exodus to cities, increasing socio-economic pressure on overpopulated, inadequately served poor urban areas. The proportion of agricultural workers in Arab countries is about 30 per cent, excluding Mauritania, Sudan and Yemen. Several studies indicate that agricultural employment has been declining in recent years. In Egypt, the employment rate in agriculture fell from 41 per cent in 1983 to below 32 per cent in 2008; in Syria, from 31 per cent to 15 per cent; and in Jordan, from 7 per cent to below 3 per cent.[21]

Rising domestic water consumption will reduce the water available for agriculture. Although domestic water consumption accounts for only about 10 per cent of the region's water use, it is expected to increase with urbanization and population growth (Figure 2.7). In the Gulf countries, the municipal sector's share rose from 14 per cent in 1990 to 25 per cent in 2010,[22] as the urban population rose from 78 per cent to 88 per cent.

Domestic water consumption is expected to continue to rise due to high natural population growth rates and intercity and rural–urban migration.[23] Growth from migration is particularly pronounced in Gulf Cooperation Council countries, which rely on a substantial foreign labour force, and in conflict-ridden areas. Jordan is receiving influxes of refugees from Iraq, Syria, and the State of Palestine.

Although Arab countries recognize that water is a public good, ambiguous water rights frequently cause local tension and conflict. Water rights take different forms. In Egypt, water rights, tied exclusively to land, apply only for irrigation. Allocations are thus tied to

Figure 2.7 Water use distribution between the municipal sector and agricultural sector in the Gulf Cooperation Council countries



Source: Al-Zubari 2011.

landholding and the types of crops licensed to be grown on each allotment. In Lebanon, the allocation law concerning private water rights focuses on water extraction. Water from wells drilled on private land, where flow does not exceed 100 cubic metres a day and 150 metres in depth, is exempt from permitting or other authorization requirement and is subject only to a declaration fee. Morocco allocates all water held in the public domain through a permit system administered by catchment basin authorities. Well-established systems of water rights and trading have been practiced for decades, despite more recent government regulations restricting farmers' sale of fresh water to urban users.[24] Morocco uses a system based on the Jrida, a publicly available list of water rights defined as hours of full flow.

Unclear water rights and weak infrastructure management can lead to confusion and conflict among government agencies and water users about entitlement to water. In most Arab countries, specialized government agencies distribute water permits and manage large-scale irrigation networks. Many countries lag in establishing legal instruments to regulate water allocation. Creating a reliable legal permitting system for drilling water wells and managing groundwater is essential, though permits are often issued based on unscientific rules such as distance between wells. Rules for trading water rights will also support the development of water markets.[25]

Severe competition for scarce water resources will inevitably put more pressure on the agriculture sector, with costly social and political repercussions. Governance options should address this issue carefully. Through transparent, participatory approaches, water can be allocated among sectors to meet pressing, prioritized needs. Using agricultural water more efficiently is essential to ensure the highest possible return. The agriculture sector particularly needs transforming measures, such as using more nonconventional water, managing crops and helping agricultural workers transfer to other jobs.

Water rights, social equity and economic development

In the water-scarce Arab region, using water resources equitably and reasonably is a key challenge for effective water governance. "Equity in this sense does not mean that everyone should be given an equal amount of water. Rather, it means that everyone should have fair opportunities to the access, use and control of water resources. It also means that everyone should be aware of the drawbacks of water exploitation so that no part of the society would be disadvantaged."[26] Balancing economic efficiency, social equity (Box 2.3) and environmental sustainability is a major goal for effective water governance.

Many countries face water equity challenges. Access to clean drinking water and sanitation is often lacking for rural areas, poor people and groups marginalized because of race, caste, tribe or gender. These inequities reflect social and political marginalization that systematically excludes poor people from opportunities and services.[27] Especially in the poorest countries, rural areas lag behind cities in access to drinking water and sanitation (Figures 2.8 and 2.9), but inequity exists even in cities, where people in unserviced areas rely on private water supplies, often at much higher costs. Increasing the proportion of people with access to water and sanitation will require

Box 2.3 Human rights to water and sanitation

The Action Plan of the United Nations Water Conference in March 1977 recognized the human right to water for the first time. It declared that "all peoples, whatever their stage of development and social and economic conditions, have the right to have access to drinking water in quantities and of a quality equal to their basic needs." The fourth principle of the Dublin Statement on Water and Sustainable Development in 1992 indicates that "water has an economic value in all its competing uses and should be recognised as an economic good. But within this principle, it is vital to recognise first the basic right of all human beings to have access to clean water and sanitation at an affordable price. Past failure to recognise the economic value of water has led to wasteful and environmentally damaging uses of the resource. Managing water as an economic good is an important way of achieving efficient and equitable use and of encouraging conservation and protection of water resources."

In July 2010, the UN General Assembly Resolution A/RES/64/292 formally recognized the right to water and sanitation and acknowledged that clean drinking water and sanitation are essential to realizing human rights. The resolution calls upon states and international organizations to provide financial resources and help capacity building and technology transfer within countries, especially developing countries, to provide safe, clean, accessible and affordable drinking water and sanitation for all.

The World Water Council, the Third World Water Forum, the Global Water Partnership, the Dublin Statement on Water and Sustainable Development and the United Nations have endorsed the view that the "human right to water is indispensable for leading a life in human dignity," and that access to water and sanitation is a "prerequisite for the realisation of other human rights."

In September 2010 Human Rights Council Resolution A/HRC/RES/15/9, following the UN General Assembly resolution, affirmed that rights to water and sanitation were part of existing international law and confirmed that these rights are legally binding upon states. It also called upon states to develop appropriate tools and mechanisms to fully realize human rights obligations of access to safe drinking water and sanitation, including in currently underserved areas.

Source: UN 1992b, 2010a,b; Camdessus and Winpenny 2003, p. 7.

increasing the empowerment, participation and social mobilization of poor people, who are often more vulnerable to livelihood insecurities and water-borne diseases.

Socio-economic and political disparities usually result in unequal decision-making powers among stakeholders, so that water policy outcomes tend to favour already powerful groups. Effective water governance systems must pursue social equity to ensure that all people have access to drinking water of sufficient quantity and quality. The best way to ensure equity is through participation in water management by all stakeholders, especially poor people.[28] To ensure that women and poor people receive a fair share of water, they must be represented in the institutions that decide how to allocate water.

Gender equity and women's empowerment are declared goals for all Arab countries. Women should play effective roles in identifying water governance options at all levels. A first step can be training programmes on gender awareness and analysis for water professionals and the community. Gender issues and participatory approaches must be integrated into local and regional businesses, especially in conflict zones and agricultural and poor communities. Reforms must also be introduced at the local community level. Water governance and integrated water resources management (IWRM) must promote gender analysis tools to investigate the effect of planned developments on local women (Box 2.4).

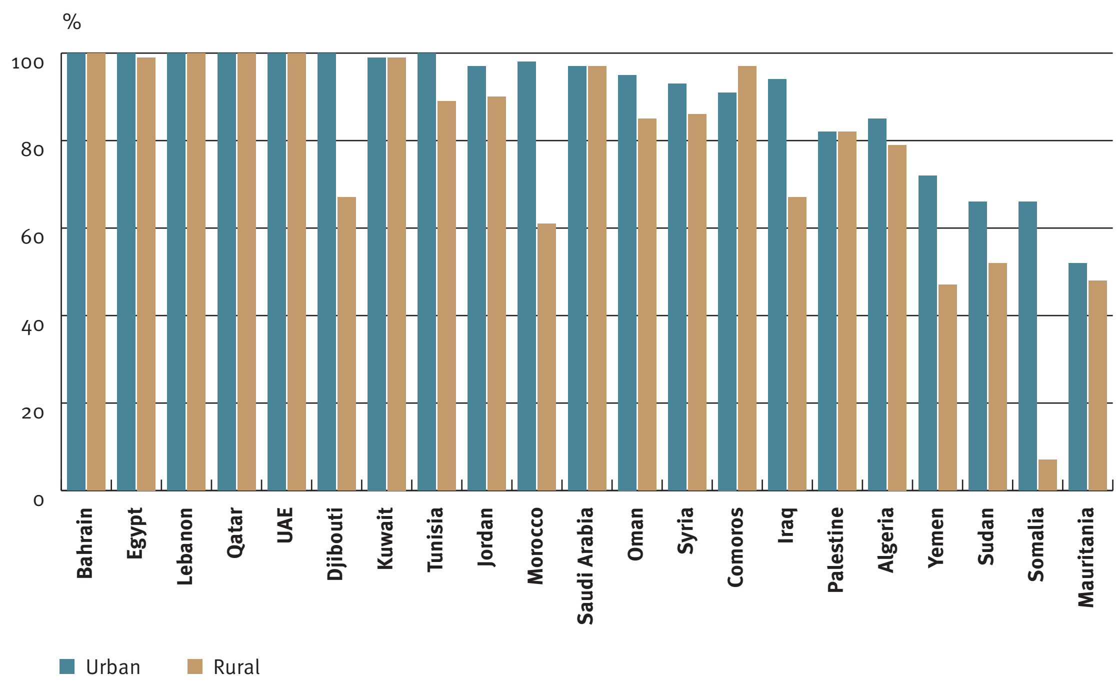
Social impact of water scarcity

Water scarcity creates complex social dynamics. Societies have varying adaptive capacities to cope with water deficits—countries with little rainfall and surface water availability differ in adaptive capacity from countries with oases and rivers. And competition over an increasingly limited resource in often unhealthy, overcrowded and insecure environments is pitting unequal power-wielding interests against each other: urban versus rural, rich versus poor, economy versus ecosystems.

When water scarcity is severe, water allocation often reflects and emphasizes social, political and economic inequities and can cause

Figure 2.8

Access to improved water source in Arab countries in urban and rural areas, 2011

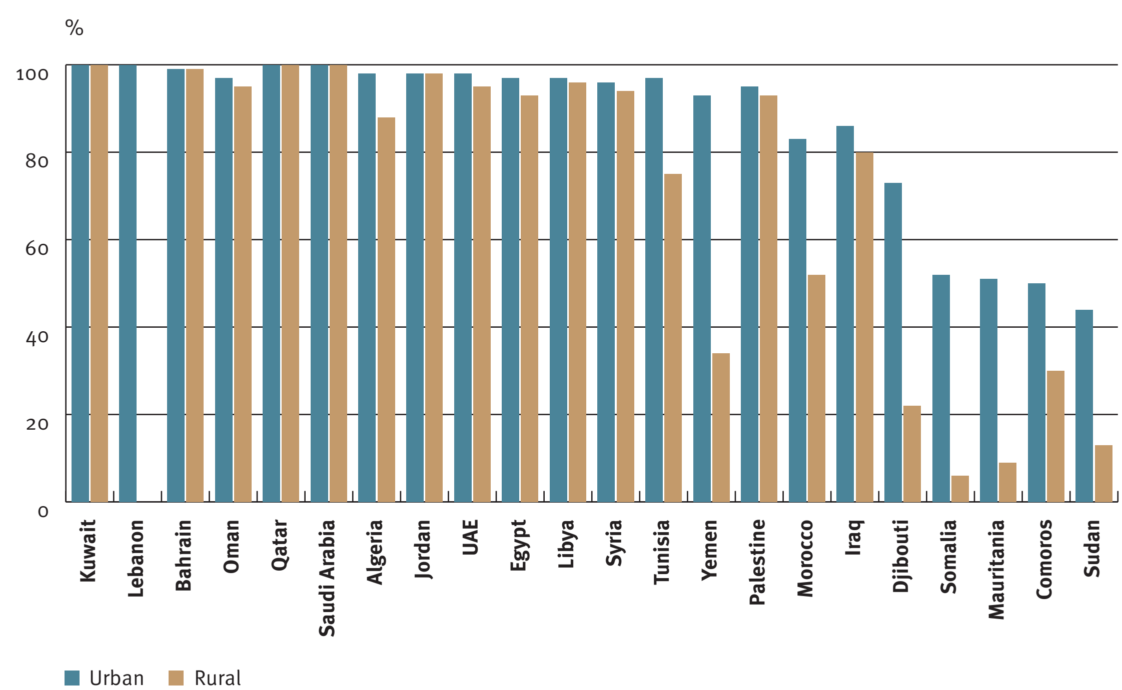


Note: No complete estimates available for Libya.

Source: WHO and UNICEF 2013.

Figure 2.9

Access to improved sanitation in Arab countries in urban and rural areas, 2011



Note: No complete estimates available for Lebanon.

Source: WHO and UNICEF 2013.

conflicts to emerge or escalate, especially within countries. Influential positions in politics and society are often linked to water access, a problem now facing the decentralized traditional governance frameworks in Yemen (Box 2.5).[29]

A study in the northern Jordan Valley on the impact of water shortages on the region's cultivated area, income and labour concluded that cutting back irrigation water reduced cropping intensity, minimized cultivated area, reduced labour and lowered net income. Decreasing the water supply by 20 per cent reduced the cultivated area by about 14 per cent, leading to a net income decline of 15 per cent.[30]

Water conflicts can also exacerbate other tense socio-political issues, including border disputes, environmental problems, political identity and megaprojects (such as dams and reservoirs). In the Arab region, water scarcity is thus a threat to national security, social well-being and political stability.

Meeting water-related Millennium Development Goals

Access to improved water and sanitation services in the Arab region rose during the 1990s (see Figures 2.1 and 2.2), in line with the international community's adoption of the Millennium Development Goals (MDGs).[31] Water and sanitation had also moved to the top of many Arab countries' agendas as important to development and human well-being, but in many countries progress is still slow.

Between 1990 and 2008 about 73 million people in the Arab region gained access to improved drinking water, and about 94 million to improved sanitation.[32] But in 2010 about 18 per cent of the Arab population still lacked access to clean water and about 24 per cent lacked access to improved sanitation.[33] Most of these people live in low-income, occupied or conflict-ridden countries. And disparities in water services are large between rural and urban areas. In 2010 only 71 per cent of the population in rural areas had access to improved drinking water sources compared with 91 per cent in urban areas. In sanitation the disparity is even greater: 62 per cent of the population in rural areas had access to improved sanitation compared with 88 per cent in urban areas.[34]

Meeting the water and sanitation target for MDG 7 of halving the proportion of the world's population without sustainable access to safe drinking water and sanitation by 2015 would cost about $62 billion for water and $100 billion for sanitation.[35] Low-income countries do not have the financial resources to make this kind of investment. Rapid urbanization in several Arab countries is greatly increasing the share of the population without adequate water and sanitation. Even in countries with freshwater resources, water pollution creates challenges. In Egypt's Nile Delta region, for example, the potential health benefits of government-ensured access to water are eroded by high pollution

Box 2.4 Women are especially vulnerable to the effects of climate change

Women, as other disadvantaged groups, are especially vulnerable to climate change. Current socio-economic and cultural constraints affect women disproportionately. Women in Arab countries, especially the poorest ones, already suffer high rates of illness and death related to pregnancy and other reproductive functions. The average maternal mortality rate in Arab countries is around 270 deaths per 100,000 live births, but it rises to more than 1,000 deaths in the poorest Arab countries (Mauritania and Somalia) and falls to 7 for every 100,000 births in Qatar. The impacts of climate change could put more pressure on vulnerable Arab women, causing serious health problems and diseases.

A study in western Sudan indicated that women are usually the last to migrate when drought strikes their lands. Men usually leave their lands first in search of work and income, leaving women and children behind. Women then shoulder the responsibility of managing the household's dwindling resources.

When disasters strike, they hurt whole communities, but women often bear the brunt. Floods frequently claim far more female victims because women's mobility is restricted and they are not taught how to swim. The devastating flash floods accompanying the tropical storm that hit the Hadramawt governorate in Yemen in October 2008 killed 80 people and displaced 20,000–25,000. Most of the displaced were women and children. One school sheltered 900 women and 550 children (with 100 people staying in one room). A recent paper on gender and climate change in the Arab region concluded that the prevailing socio-economic inequalities in the Arab region could render women more prone to a range of climatic and socio-economic impacts.

Source: UNDP 2006; Osman-Elasha 2007, 2008

Box 2.5 **Scarcity, conflict and adaptation in the Sa'dah basin**

Over the past thirty years, the very dry Sa'dah basin in Northern Yemen has experienced a huge population explosion as a result of natural growth, returning migrant workers and internal migration in response to economic opportunity, especially in agriculture. Investment in the land suited this tribal region's traditional values. The government improved agricultural profitability by imposing a fruit import ban so that farming would be an attractive investment. The soaring demand for qat has made this crop very attractive to farmers.

Agriculture's profitable growth was based on the rapid groundwater development. Until the 1970s most land in Sa'dah was communally owned grazing land, but the run-off rights from this land belonged to individual landowners in the lowlands. Agriculture was not allowed on the grazing lands because it would reduce run-off, so tubewell irrigation could not develop on the slopes. A deal was negotiated allowing the tribal owners of the pasture rights to convert half of the slope land to agriculture if they compensated the owners of the run-off rights with the same right on the other half of their land. In 1976 a local cleric promulgated this as a fatwa, and the rule change has been followed ever since.

As agriculture became more profitable and remittance capital became available, many tribal communities privatized their common lands and distributed them to households. New elite commercial farmers have emerged in the Sa'dah area, and land and water resources have been widely redistributed by market forces. Qat (previously scorned by proud tribesmen as "the tree of the devil") is being planted on a large scale.

As a result, the water table has plummeted and springs have dried up. Conflicts over water and land have intensified. These tensions may be spilling over into the region's growing fundamentalist sectarianism and civil strife. Sa'dah exemplifies economic growth and the capacity to adapt to market opportunities, but its communities have not shown a comparable "downside" capacity to adapt to scarcity. "Tribal communities and villages are not yet addressing the groundwater problem cooperatively."

Source: Lichtenthaler 1999.

levels from raw sewage.[36]

Although a fairly large share of the region's population has access to improved drinking water, access is not always reliable, especially in low-income areas. Water shortages are a major problem in key cities such as Amman (Jordan), Damascus (Syria), Sana'a and Taiz (Yemen), and in the West Bank and Gaza (State of Palestine). In Yemen, annual groundwater extraction rates exceed natural recharge rates by about 50 per cent; rate differentials are even higher in the Sana'a basin.[37] Rapid population growth (3.6 per cent a year) is outpacing new water supply networks. Sana'a faces severe water shortages. Less than half of its population receives water from the public network; the rest rely on private water distributors. Around six public wells run dry every year, and water well depth now reaches down to the southern part of the Sana'a basin.[38] In Amman, shortages have become so severe that many residents receive water only one day a week. The government is addressing the problem, including piping water to the city from the Rum-Disi aquifer about 325 kilometres away. But the largely fossil water aquifer is already showing signs of depletion and increasing salinity.[39] In Beirut, overuse of the thousands of wells under the city, despite average annual precipitation of 800 millimetres, is leading to salt intrusion.

Damascus, long blessed with abundant clean drinking water, has experienced more frequent shortages as the population grew to 3.8 million in 2000. The city now experiences long water shut-offs (16–20 hours a day) during several months. The situation worsens during the summer when water demand rises. In the West Bank and Gaza, water is available for only a few hours a day. In Oran, Algeria, water is supplied every other day during drought years. In several of the region's major cities, water is available only once or twice a week, depending on the district. The intermittent supply of urban water accelerates infrastructure degradation and increases the percentage of nonrevenue water. In addition to population growth and severe and persistent drought conditions, inefficient irrigation and large volumes of unaccounted-for water due to distribution network leakage contribute to water shortages.[40]

Reaching the MDG for water supply and sanitation requires large investments and improved water technology across the region. Many Arab countries rely mainly on imported water-technology equipment, and the domestic private sector is not filling the gap left by governmental agencies. Without effective, government-funded agricultural extension programmes, for example, many Arab countries are not moving into crops with lower water requirements or using newer, water-saving irrigation techniques. Rural areas and small communities also need cost-effective, reliable technologies for wastewater treatment to improve sanitation.

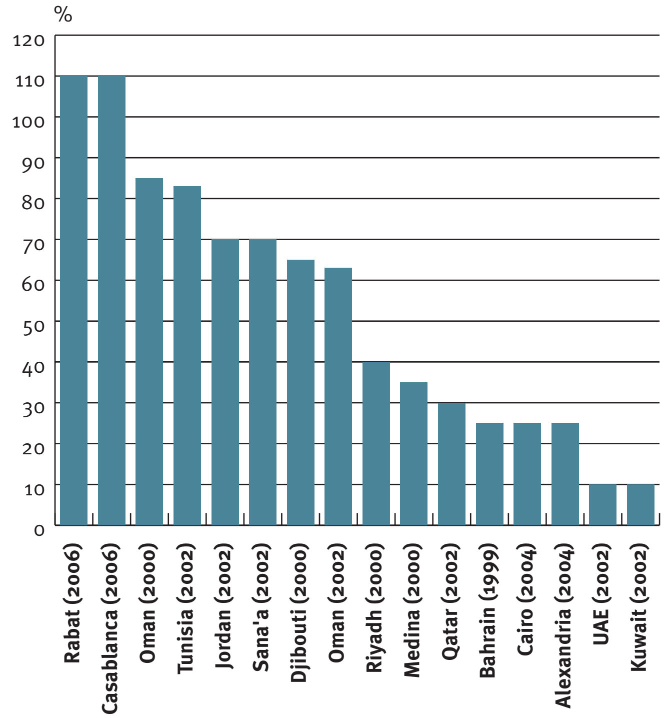
Most water utilities in the Arab region are caught in a vicious cycle of poor services, low tariffs because of subsidies, and low consumer expectations about services, leading to consumer resistance to price increases.[41] Many countries heavily subsidize connections to the domestic water supply network, water consumption, or both, so that consumers pay only a fraction of the water's true cost. In almost every city, insufficient revenue is collected to cover water supply and operations and maintenance costs, let alone depreciation of assets (Figure 2.10).

Water governance should aim to secure sufficient water of appropriate quality at an affordable price. But direct subsidies of services usually lead to misuse, abuse and service deterioration, particularly in times of financial strain. Lack of incentives for improvement makes the situation even worse.[42] Without adequate cash flow from service users, water agencies must depend on government budget transfers. As these transfers are often based on precedent, they become biased towards paying wages rather than creating effective operations and maintenance and caring for existing assets (such as water/wastewater plants and distribution networks) rather than developing new ones. Deferred maintenance leads to premature deterioration of assets and eventually to more costly rehabilitation. Routine maintenance for irrigation and the domestic water supply could prevent this situation and lower costs.

Socio-economic policies on water pricing prevent cost recovery, discourage maintenance spending, lower service quality and threaten the financial sustainability of utilities. Water users should pay the full cost of the services they use. Full cost recovery could create the incentives needed to improve water services. Carefully and transparently targeted subsidies could ensure that poor people have access to water services, avoiding any negative social equity impacts.[43]

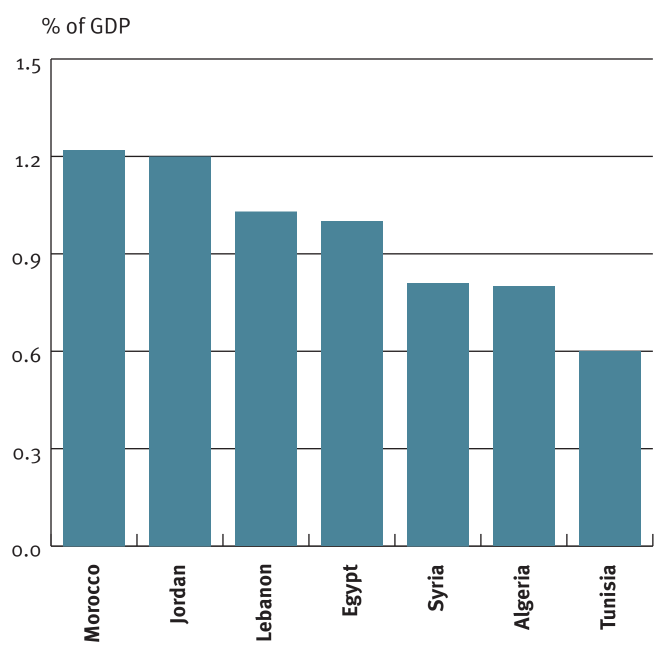
Informal settlements—slums constructed without permits on the outskirts of large cities

Figure 2.10 Operating cost recovery ratio for utilities in selected countries and major cities in the Arab region, latest year available



Source: World Bank 2007.

Figure 2.11 Annual cost of environmental degradation of water in selected Arab countries



Source: World Bank 2007.

Box 2.6 **Somalia food crisis: origins and threats**

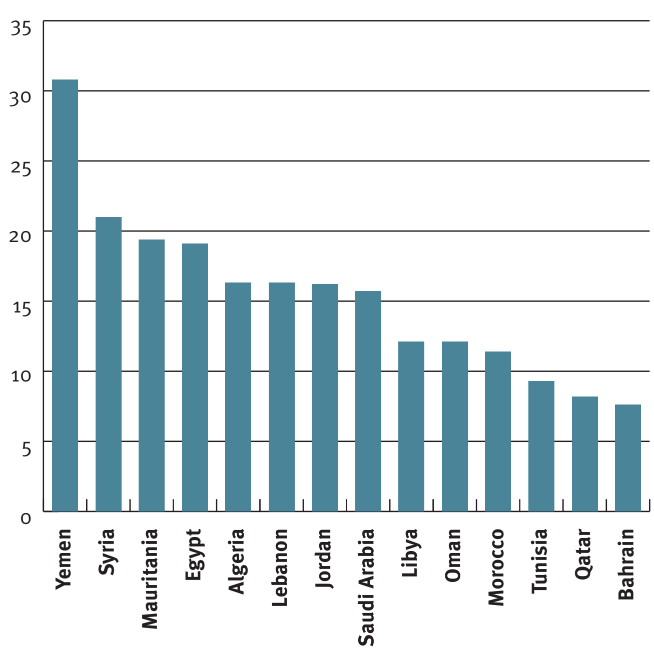
In summer 2011 the United Nations declared a state of humanitarian disaster in Somalia and parts of Ethiopia and Kenya. The region is experiencing an acute food and livelihood crisis, the first in the 21st century. Severe and recurrent droughts, the worst in six decades, have devastated pastoral livelihoods in Somalia, where 60-65 per cent of the population relies on livestock. Soaring global food prices have exacerbated the situation. According to the United Nations Food and Agriculture Organization, maize and sorghum prices were 150 per cent and 200 per cent higher in 2011 than in July 2010. A long civil war, by blocking international aid from reaching affected areas, further impeded efforts to prevent famine.

Some 3.7 million Somalis, or nearly half the population, are in crisis, 2.8 million of them in the south. People have been forced to abandon their homes and land in search of food and water, crossing into neighbouring countries. The international community is contributing large amounts of humanitarian aid to resolve Africa's food crisis, but the assistance falls about $1.1 billion short of the $2.4 billion needed, according to UN humanitarian agencies.

Simply increasing aid is not enough to ensure food security for the region. Additional solutions include investing more in agriculture and infrastructure and improving adaptive policies for weather patterns.

Source: FAO 2011.

Figure 2.12 **Food imports in selected Arab countries, 2010 (% of merchandise imports)**



Source: World Bank n.d.

present another challenge. Governments must decide whether to deny drinking water services to illegal settlements or to recognize people's right to clean water.

Effective water and sanitation governance practices are vital for achieving the MDG targets for water and sanitation. To integrate the targets into the region's national development plans and foster trust, partnerships need to encompass communities, financing institutions, consumer associations, businesses and decision-makers and to ensure effective collaboration among all these stakeholders.[44]

Water and economic development

Effective water governance is linked with economic development. Water governance and policy formulation should recognize national and regional economic dimensions, and economic policies should consider water status and sustainability in quantitative and qualitative terms. Water quality has economic ramifications: the cost of water's environmental degradation may reach well beyond 1 per cent of a country's GDP, as in Jordan and Morocco (Figure 2.11).

Where water scarcity is severe, water resource management problems have been viewed as the exclusive domain of the water sector, insulating the water economy from market forces.[45] As a result, water's economic value is rarely considered in setting agricultural and trade policies. Despite water's scarcity, high water-consuming crops such as rice, sugarcane and banana are still being grown and irrigated in several Arab countries, including Egypt and Jordan. Water is a key driver of macroeconomic and sectoral policies in the region.[46] But key political, environmental and social drivers of water policy lie outside the sector.[47] Energy, global trade, agricultural policy, fiscal policy, food security, self-sufficiency and urbanization with its associated changes in demography and land use directly influence the political choices that affect water use.

Most Arab countries are pursuing policies to transform their economies. Reform of water governance should be among these structural economic reforms. Water affects almost all economic activities, so good water governance to ensure sustainability is essential to economic growth.

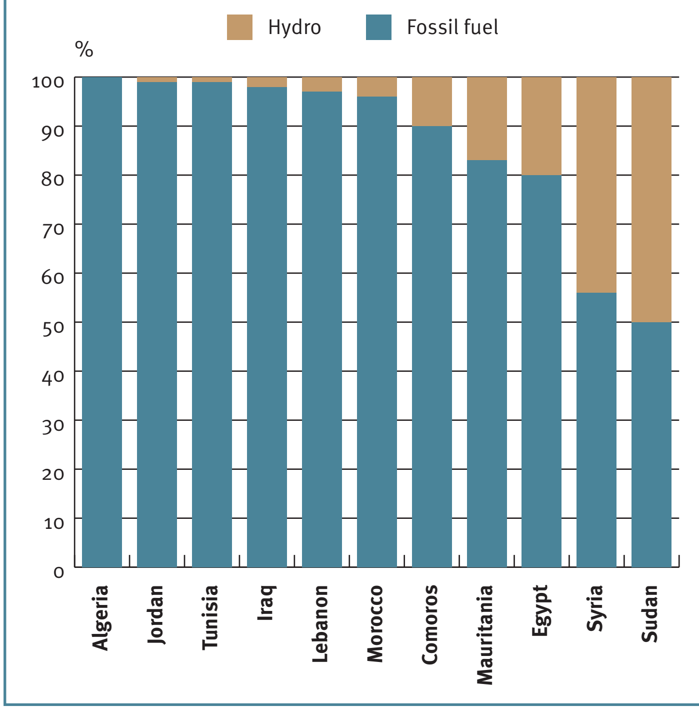
Water and food security

Global food security is highly unstable. Biofuels, export bans, poor harvests, fluctuating energy prices and rising demand from growing populations have pushed up food prices, sparking riots and instability and driving millions of people in developing countries further into poverty and hunger. The 1996 World Food Summit emphasized that "food security, at the individual, household, national, regional and global levels is achieved when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life."[48]

Competition over increasingly limited water resources severely challenges Arab countries' ability to feed their growing populations (Box 2.6). Governments have responded by providing some water for all and more for others according to government priorities. But reallocating water from one sector to another has political and social implications as well as economic. Although most water in the Arab region goes to agriculture, crucial for food production and rural employment, agriculture's contribution to GDP is low. Many people argue that water should be reallocated from agriculture to the industrial and municipal sectors, despite the negative repercussions for agriculture and rural employment.

Even though Arab countries lack adequate water to grow enough food to feed all their people, self-sufficiency at any cost was a goal during the 1960s and 1970s. The unsustainability of this approach led Arab governments to look at alternative ways to achieve food security, such as improving agricultural production, maximizing water productivity and relying more on food imports (Figure 2.12).

Figure 2.13 Electricity production by source in selected Arab countries



Source: CIA 2003.

Table 2.1 Estimated energy consumption for desalination processes
Kilowatt hours per cubic metre

Process	Steam energy	Electric energy	Electric energy equivalent
Seawater multistage flash	7.5 – 11.0	2.5 – 3.5	10.0 – 14.5
Multiple effect boiling	4.0 – 7.0	2.0	6.0 – 9.0
Vapour compression	—	7.0 –15.0	7.0 – 15.0
Seawater reverse osmosis	—	2.5 – 8.0	2.5 – 8.0
Brackish water reverse osmosis	—	0.5 – 2.5	0.5 –2.5

Source: Al-Jamal and Schiffler 2009.

Box 2.7 Water in customary laws and traditions

Because water was scarce in early agrarian and nomadic Arab societies, fairly complex systems of tribal laws and Islamic doctrine developed to manage and share it. A good illustration is the Falaj, an underground aqueduct water system in Oman. The Falaj's main structure consists of the mother well, which can be as deep as 65 to 200 feet; the main channel; and the access shafts, which are built every 50 to 60 metres along the channel. "Each farmer has a share of water depending on the size of his farming plot(s) and on his contribution to the Falaj construction. As water is considered a source of life within the Omani society, the Falaj system is managed and maintained by local communities." The system is based on accountability and transparency and has been functioning successfully for decades. The Qanat underground system, the Saqia (waterwheel) and other traditional water allocation schemes have lasted to this day. The very strong collective values that prevail in Arab societies have been essential for these practices' success and sustainability. In Spain, farmers are still using the sequia, the old water distribution networks established by the Arabs during their conquests.

Source: Majzoub and others 2010, p. 27; Jagannathan, Mohamed, and Kremer 2009.

More than half of the food calories consumed in the region are now imported; this share is expected to rise to 64 per cent over the next two decades.[49] A 1994 study showed that the region's food imports were equivalent to 83 billion cubic metres of virtual water (the amount of water used to produce food or other products), or 11.9 per cent of the region's annual renewable water resources. For some countries, this share was much higher: Saudi Arabia (580 per cent), Libya (530 per cent), Jordan (398 per cent), Algeria (87 per cent) and Egypt (31 per cent).[50] With population growth and an improved standard of living, these figures must be much higher today.

Arab food security could be achieved through regional agricultural integration that combines the advantages of all the Arab countries human, financial and land and water resources. Joint agricultural projects could be implemented using advanced agricultural methods supported by active R&D programmes and effective water and land governance.

In April 2008, in a unified effort to address the food crisis, Arab countries issued the Riyadh Declaration on Promoting Arab Cooperation to Face the Global Food Crisis under the auspices of the Arab Organization for Agricultural Development. The declaration calls for sound trade and investment policies to enhance food security in the short and long terms, through public-private partnerships and enhanced inter-Arab agricultural trade.[51]

As water is essential to sustainable development, low-income regions with scarce water resources are especially threatened by food crises. The Arab countries most vulnerable to food price fluctuations are Iraq, the State of Palestine and Yemen, with their high poverty levels, and Jordan and Lebanon, large importers of food and fuel.

To reduce vulnerability, governments should actively support agriculture and efficient use of water and land resources. Implementing food security policies at the regional, national and household levels, governments in the Arab countries should focus on:[52]

- Improving food shortage early warning systems.
- Increasing the capacity of strategic food reserves.
- Securing better trade deals with major food exporters.
- Supporting social safety nets to benefit vulnerable populations.

Water-energy nexus

Water and energy use have much in common. Both are essential for healthy, productive human societies. Both also derive from natural resources, and their use by people affects ecosystem sustainability. And in Arab countries, both require major improvements in reliability and quality.

Water and energy are also strongly interdependent. Energy is required to use water: energy is needed to lift, move, process and treat water at every phase of its extraction, distribution and use. And water is needed to use energy: water is used directly and at various intermediate phases in power generation. Desalination, electricity generation and oil exploration and production manifest this interdependence. Both energy and water are threatened by waste.

In consuming energy to use water, unreliable electricity service leads farmers to use oversized engines, urban dwellers to pump water into storage tanks and industrial consumers to invest in backup power and water systems. In consuming water to generate electricity, power plant inefficiencies result in serious deterioration of water and other environmental resources.

Although intricately linked, water and energy have not always been managed as interrelated resources. Water and energy are run by separate utilities that do not always share the same interests or priorities; combining them could improve coordination. The energy sector in many Arab countries is dominated by state-owned monopolies of low efficiency, and mismanagement is common. Awareness of water and energy perspectives and their interdependence are essential for effective water governance and management.

Energy economics are driving greater awareness of the energy-water nexus as capital markets shift their focus to renewable energy development in response to diminishing fossil fuel supplies, higher energy prices and emerging environmental and utility regulatory actions. For most of the past century, hydropower was the renewable energy source, offering substantial flexibility and the ancillary benefits of water storage. Today, few feasible opportunities remain for new hydropower development (Figure 2.13).

The scarcity of fresh water in the region has promoted and intensified the application of desalination technology and co-production of electricity and water (Table 2.1).[53] Energy consumption in the region is growing at an annual rate of 3–4 per cent, twice the world average. Electricity generation is growing at a rate of 6-8 per cent a year, three times the world average. This rapid growth is due mainly to subsidized electricity rates, in addition to harsh summer weather and growing urbanization and populations. In Saudi Arabia up to 9 per cent of annual electrical energy consumption is attributable to groundwater pumping and desalination. Other Gulf countries are devoting 5–12 per cent or more of electricity consumption to desalination.[54]

Desalination is energy-intensive. Given the large market size and desalination's strategic role in the Arab region, installing new capacity will increase energy consumption. As energy production is based mainly on non-renewable fossil fuels, countries will need to develop renewable energy sources to power desalination plants. To address concerns about carbon emissions, Arab governments should link any expansion in desalination capacity to investments in abundantly available renewable sources of energy. The Arab countries must cooperate to enhance coordination and investment in R&D in water technologies. Acquiring and localizing these technologies will make them more reliable, increase their added value to the Arab economies and reduce their cost and environmental impacts. Renewable and environmentally safe energy sources such as wind and solar hold enormous potential for Arab regions located in the world's "sun belt."

Water institutions and policy formulation

Institutions and policy-making bodies responsible for water governance in the Arab region have always faced continuously escalating demands. Almost always operating in crisis mode, they aim to enhance supply to provide the required water. Structural institutional problems mar their operation, including low capacities, suboptimal performance, unclear distribution of roles and lack of effective coordination.[55] Shortcomings in water governance and management may become even more significant obstacles than water scarcity.

Water reforms are progressing unevenly in the region. Some countries, such as Bahrain, Djibouti, Egypt, Jordan, Lebanon, Libya, the State of Palestine, Saudi Arabia, Syria, Tunisia and Yemen have national water policies, plans or strategies that incorporate many elements of IWRM. Eleven of 22 countries assessed needed major water policy enhancements to implement integrated management plans.[156] Some countries have addressed the impacts of poor water management across the economy. Others have improved accountability and stakeholder

Table 2.2 Regional examples of shared resources in the Arab region

	Egypt and Libya	Iraq and Syria	Egypt and Sudan	Jordan and Syria	Lebanon and Syria
Basin	Nubian Sandstone Aquifer System	Euphrates	Nile River	Yarmuk	Nahr-El-Kabir
Dates	08-Jul-91	17-Apr-89	08-Nov-59	03-Sep-87	20-Apr-02
Principal issue	Water quantity	Water quantity	Water quantity	Water quantity, hydropower/ hydroelectricity	Water quantity
Allocation	Water share	Flow percentage	Water share	River share	Flow percentage
Other issues	-	No	-	Joint dam	Joint dam
River basin organization	No	No	No	No	No
Monitoring	No	Joint technical committee	Yes	No	Joint commission
Joint management	Joint authority	Yes	Yes	No	No
Groundwater[a]	Yes	No	No	No	No
Information exchange	Yes	Informal[b]	No	No	Yes

a. The Agreement contains provisions for groundwater resources.

b. There appears to be information exchange, but no formal document or guide to describe how this cooperative instance is to be implemented.

Source: IWLP n.d.; TFDD n.d.

involvement in water decisions. But improved water management policies are not fully reaching their intended goals in most countries. And even as policies develop, they often neglect social and economic goals, such as alleviating poverty and reducing unemployment. The region's ineffective and fragmented water management structures have also affected water decision-making, and weak regulatory frameworks and enforcement have led to degradation of water resources, public health risks and poor service coverage and delivery.

Solutions will differ, but certain actions can prepare the way for reforms, such as education about the multisectoral aspects of water governance and management, focusing on the region's water challenges. Government institutions responsible for water management must improve their governance and management practices and enable water institutions to function efficiently. Coping with scarcity and high variability in a context of population growth and economic change will involve difficult choices and painful changes. But recent progress in several Arab countries indicates that the region can meet its water governance and management challenges.

Legislation and regulation

Water legislation is essential to implement water policies and strategies (Box 2.7). It provides the legal framework for water governance, institutional reform, regulatory standards, management systems and regulation enforcement. Most Arab countries have recognized the importance of water legislation and regulation to promote water efficiency.[57] Consequently, they have started to reform and update existing laws or introduce new legislation. They are also encouraging decentralized and participatory governance at the national level to involve all stakeholders in decision-making. For the last 15 years Egypt, Jordan, Lebanon, Morocco, Oman, Palestinian National Authority (PNA) and Yemen have taken steps to reform their water legal systems. Morocco and Yemen have enacted framework water laws that reflect modern water principles and attempt to address their country-specific issues.[58]

Almost all Arab states have approved legislation to manage and protect their scarce water resources and improve water governance. But most efforts have failed due to inadequate compliance or poor enforcement. The "Laws and Regulations Standards and Permits" approach has been highly ineffective. Existing laws should be embedded in the region's socio-economic, political and cultural specificities. They should also consider the differences between rural and urban areas and adapt standards and legislations for industries to harmonize with priorities within Arab societies. Arab policy-makers should integrate water-related legislation to develop a coherent, effective water policy.

Several Arab countries, including Morocco, have amended their water management systems to be more flexible and adaptive to growth and economic diversification. Faced with large arid areas, demand outstripping supply and unevenly distributed rainfall since 1975, Morocco has witnessed intensive surface water use and unsustainable aquifer depletion. But the country has a long history of sophisticated water institutions. In the mid-twentieth century, national water policy, led by well-educated technical elites from the Civil Engineering Corps, focused on growing dam infrastructure to modify natural flows and catalyse a shift from traditional to intensive agriculture.[59] The transition to water demand management started in 1998 with institutional reforms that paved the way for solid regional decentralized institutions (Watershed Basins). A comprehensive water law in 1995, a major breakthrough in Moroccan water policy, provided the country with some effective technical, financial and institutional tools to face the most crucial challenges in the water sector.[60] Lebanon also voted institutional reforms in 2000, but their application was hindered by political instability. Institutional changes cannot be witnessed over a short period of time, however. J. A. Allan noted in a 2008 keynote speech to the geography departments of King's College and SOAS that in many countries changes take at least 25 years to take hold.

The main legislation challenge, besides adequacy and modernity, remains enforcement and compliance. Water pollution is an obvious example. Many of the region's water resources, including rivers, lakes and groundwater, are becoming more polluted. The most frequent sources of pollution are chemicals, human and industrial waste and extensive agricultural

Box 2.8 **Water security issues in Sudan after the separation of South Sudan**

The South Sudan Government is developing an agricultural policy to guarantee food security for its population. This policy will focus on rain-dependent agriculture but will also include plans for agriculture irrigated with Nile waters. Domestic water supply schemes for urban and rural areas will depend mostly on groundwater and water harvesting systems, as rainfall in South Sudan amounts to about 600 billion cubic metres a year. These schemes are not expected to have any significant impact on White Nile flows.

All major hydropower projects planned in South Sudan fall within the reach of Bahr El Jabal before the Nile enters the Sudd swamp area, where it loses about 50 per cent of its flow. These hydropower projects are not likely to reduce the White Nile's annual flow and will thus have no negative impacts on socio-economic development in Sudan and Egypt. They are expected to bring large economic benefits to South Sudan through power trade with neighbouring countries, which are suffering from power shortages. The planned hydropower dams in South Sudan will also regulate the flow of the White Nile, thus leading to a more sustained flow during the low-flow season.

The water needs for major future irrigation projects amount to about 1.7 billion cubic metres. These projects are strongly linked to long-standing plans to increase Nile flows through water conservation projects in South Sudan. In addition to conserving water for Sudan and Egypt, these projects will provide substantial areas of fertile land through wetlands reclamation. Some projects proposed along the tributaries of Bahr Al Ghazal and Sobat are mainly rain-dependent but could be supplemented with surface water. The effect on Nile flow would be insignificant, however. In the northern part of South Sudan proposed irrigation schemes along the White Nile's banks encompass an area of about 400,000 feddans (one feddan is 4,200 square kilometres) and have water needs of about 1.3 billion cubic metres. These projects are to be irrigated using Jabal Awlia reservoir in Sudan, which extends up to the Malut area in South Sudan. Implementing these projects requires cooperation between Sudan and South Sudan. This cooperation would provide a good opportunity to resume the Jongoli canal, which could conserve 4 billion cubic metres a year, to be shared between Sudan and Egypt.

Irrigation development in South Sudan is thus not likely to have negative impacts on Sudan and Egypt. On the contrary, cooperation between Egypt, South Sudan and Sudan on Nile issues presents a great opportunity. The three countries must focus on sharing the benefits rather than continuing the vicious circle of water shares. Consolidating cooperation between the 11 riparian countries could open the way to a holistic agreement on the Nile River.

Source: Abdo and Abdalla 2011 , background paper for the report; Nile Basin Initiative n.d.b.

Box 2.9 Managing shared water resources: the Arab region's experience

Eleven African countries share the Nile river. Two of these, Egypt and Sudan, have signed bilateral agreements and accords, most notably in 1959. A wider constructive dialogue with other riparian countries has been established through the Techno-Nile Coalition and the Council of Ministers of Water Affairs of the Nile Basin States, which agreed to form a panel of experts and other negotiating committees to reach common grounds. This may lead to a comprehensive international agreement to regulate shared water usage. The River Nile Cooperative Framework Agreement has been developed, but only six of the riparian states have signed it: Burundi, Ethiopia, Kenya, Rwanda, Tanzania and Uganda. The Democratic Republic of the Congo is also expected to sign, but Egypt and Sudan are not.

The Jordan river, shared by Israel, Jordan, Lebanon, the State of Palestine and Syria and controlled mainly by Israel since 1967, is at the centre of the Arab-Israeli conflict. The Oslo Declaration of Principles, the current regulating document for relations between Israel and the State of Palestine, vaguely referred to water. Oslo II states that the Palestinians have water rights, but fails to define these rights. The Wadi Araba Agreement between Israel and Jordan also did not pay adequate attention to water issues. Water distribution remains a controversial issue: Israel overextends its water usage extraction (or diversion) and rights, leaving the Arab countries (Jordan, Lebanon and the State of Palestine) with limited access to their share. This problem highlights the urgent need to draft a fair and comprehensive agreement among the parties to regulate the distribution and protection of surface and underground resources.

Iraq, the Syria and Turkey share the Tigris and Euphrates rivers. Many bilateral agreements have been formed between the three countries, including the protocol signed by the Syria and Turkey in 1987 to control the flow of the Euphrates. The countries also formed a joint committee in 2008, but meetings were very irregular.

Iran and Iraq also share rivers—namely, the Shatt el Arab and Karon rivers—but Iranian authorities used these waters unfairly. Iraq submitted several objections, relying on international laws regulating water allocation among riparian countries. Unfortunately, no substantial agreement has been reached.

The Jubba and Shabele rivers, shared by Ethiopia and Somalia, are at the heart of many conflicts between these two countries. No efforts have been made to establish an arrangement over the rivers' use and exploitation. There is an urgent need to raise the issue and take the necessary measures to protect Ethiopian and Somalian water rights.

Source: Ksia 2009.

practices (overuse of pesticides and fertilizers). Inadequate institutional and structural arrangements to treat municipal, industrial and agricultural waste worsen the situation. Waste is commonly dumped into waterways, polluting most downstream sources. Such degradation of water resources poses national and international problems.

Managing shared water resources

Inadequate governance systems for shared water resources constitute another challenge for the Arab region. More than two-thirds of available surface water resources originate from outside the region and are managed unilaterally by the riparian countries. Almost all the shared river basins lack comprehensive international agreements.

Any disruption or pollution of these water resources in one country can damage adjacent countries' water quantity and quality. These transboundary effects may not be immediately apparent but may be very hard to reverse. Shared water resources thus play a significant role in the region's stability and development by creating hydrological, social and economic relations and interdependencies between countries, both Arab and non-Arab. Because many Arab countries depend on these water resources, water is a political issue that can strain relations with neighbours and lead to armed conflict. Cooperation and coordination across national borders and across the region to manage shared water resources sustainably is thus essential.[61]

Cooperation on shared water resources in the Arab region has been modest; the few agreements are bilateral rather than basin-wide.[62] Current cooperation modalities take many forms, from informal technical committees or expert meetings to more formal joint projects or interstate agreements (Table 2.2). But many shared water basins are still managed unilaterally, without legal agreements to ensure their proper and optimal utilization.[63] Given the mounting stress on the region's water supply, cooperation in managing shared water resources is imperative to ensure their sustainability in serving socio-economic development.

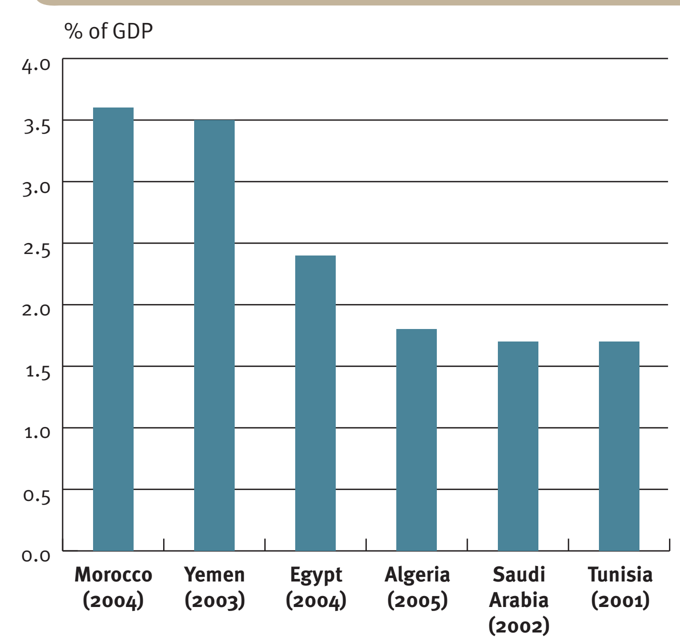
The Arab region has a striking absence of inclusive, comprehensive international water agreements on its most significant transboundary watercourses.[64] While some limited arrangements on transboundary waters exist for the Jordan, the Kebir, the Nile and the Tigris-Euphrates basins, they do not deal with optimization or planning, nor do they contain established principles of international water law such as "equitable and reasonable utilization" and the "obligation not to cause significant harm."[65] Most of these arrangements do not include all the riparian countries in the arrangement process—the Jordan River arrangement excludes Lebanon, the most upstream country. The lack of international agreement reflects the weak political and multilateral engagement between countries sharing the water. Without agreements to allocate water, countries race to establish infrastructure and claim the resulting acquired rights, but only countries with stronger economies and greater political and military power have had the financing to make these investments.[66]

As riparian countries intensify water development efforts to meet their growing demands, competition and conflict over shared water resources will increase, affecting the availability of shared water resources. Climate change—with its anticipated impacts on water resources in the mostly downstream Arab countries and the upstream non-Arab countries—will exacerbate the situation. These impacts will reduce renewable water resources, increase water resource variability and drought frequency and increase agricultural and domestic water consumption.

Uncontrolled development without joint agreements to manage shared groundwater sustainably has caused high depletion rates, increased pumping costs, deterioration of water quality due to mixing water among multi-layered aquifers, and the reversal of flow direction in some locations and across international boundaries. Groundwater development to meet increasing water demand will lead to further withdrawal of the shared aquifers reserve, potentially causing dispute among countries. Most of the reserves of these non-rechargeable basins are being used mainly for agricultural expansion and development and in an unplanned manner, and groundwater is being rapidly depleted.[67]

Because the overwhelming share of the region's water is devoted to agricultural production, the pressure on transboundary waters will not ease until the region reassesses the principles driving water allocation, not just between nations but also between sectors and users. Outdated or unrealistic food self-sufficiency policies, which continue to drive investments and often have severe implications for the countries sharing the water resource, must be reassessed. In making such a reassessment, planners, investors and decision-makers must see incentives in their political economy paradigms. For some countries, the incentive may be to align with international law and standards. Other countries may address the problem through water pricing and markets, while in others, economic diversification and growth may reduce the relative size of the agriculture sector, commensurately reducing the scale of its water allocations and meeting food requirements through trade. Most important, efforts to increase water efficiency and productivity in the agricultural sector must be enhanced to lower vulnerability to water scarcity. The Sudanese case provides further insight on how cooperative management and development of

Figure 2.14 **Public spending on water in selected Arab countries**



Source: World Bank 2007.

Box 2.10 Water governance in the State of Palestine

Water resources in the State of Palestine consist primarily of surface water and groundwater resources. The major, permanent surface water resource is the Jordan River, an international watercourse shared between Israel, Jordan, Lebanon, the State of Palestine and the Syria. But as the Palestinians were deprived by the Israelis of their rightful share of the Jordan River, groundwater resources have become the major source of fresh water. In the West Bank, groundwater is located in three major drainage aquifers: the Western Aquifer, the Northeastern Aquifer and the Eastern Aquifer. Although no water quality database exists, individual studies and monitoring projects indicate severe contamination and water quality problems in all major aquifers.

Under the Oslo II Agreement, Israel and the State of Palestine agreed to coordinate the management of water and sewage resources and systems in the West Bank through the Joint Water Committee (JWC), a bilateral committee established by the Oslo Accords to manage water resources in the West Bank and Gaza during the interim period. The JWC process disrupts sound planning of West Bank water resources, as water resource management plans cannot effectively be implemented because of restrictions imposed by Israel on accessing critical well fields.

After the 1967 War Israel took control of water resources and developed wells throughout the West Bank and a water supply network linked to the national Israeli water companies' (Mekorot and Tahal) network. In 1995 the Oslo II agreement (Article 40) contained provisions on water and sewage that recognized undefined Palestinian water rights and returned some West Bank water resource and service responsibility to the PA.

Israel has violated Palestinian water rights in the Jordan River since 1967. In the early 1950s the Jordan River had an annual water flow of 1.25 billion cubic metres a year. But as a result of the river water's diversion from Lake Tiberias to the Negev desert through the Israeli National Water Carrier, as well as other regional projects, the river is currently running with high salinity and deteriorated quality at a flow of 200 million cubic metres. The Israelis have also been discharging wastewater and diverting brackish spring water into the river, contaminating the river water along the West Bank. The Israelis are currently using about 82 per cent of the annual safe yield of the groundwater basins to meet 25 per cent of their water needs, whereas the water consumption of Palestinians residing in the West Bank constitutes around 17 per cent of the annual safe yield.

Israel has also actively prevented the construction and maintenance of water and sanitation infrastructure in the West Bank by exercising its veto through the Joint Water Committee, which is mandated to approve all water and sanitation projects in the West Bank.

In the West Bank, Mekerot distributes 110 million cubic metres a year to 1.5 million Palestinians and 30 million cubic metres to 140,000 Israeli colonists, whereas 460 million cubic metres are deviated to Israel. Typically poor, utility performance is deteriorating, with unaccounted-for water averaging 34 per cent and bill collection rates averaging only 50 per cent. Water service providers are not doing their best to collect water bills. The prevailing social, economic and political conditions in the State of Palestine have also resulted in many public groups either refusing or being unable to pay their water bills to the service providers.

The performance of the Jerusalem Water Undertaking, a district utility serving Ramallah-El Bireh area and belt communities east of Jerusalem, shows that under the right conditions, Palestinian operators can be efficient. For most other utilities, water scarcity, run-down infrastructure, security problems and lack of institutional autonomy and capacity, combined with an impoverished and resentful customer base, have led to very poor services and financial difficulties. Increasing dependence on Mekorot by the water supply utilities makes them vulnerable to Israeli decisions and interventions and may increase commercial risks and costs. There is a strong need for integrated planning for water resources and services at the local level.

The policies and practices outlined above have restricted the Palestinian authorities' ability to provide adequate service to the Palestinian population and in some cases prevented humanitarian organizations from providing aid and assistance to vulnerable communities. As an occupying power, Israel is primarily responsible for the welfare of the Palestinian population in the West Bank and obligated to facilitate the work of the Palestinian authorities in areas they are responsible for, including water and sanitation provision.

The Palestinian Water Authority (PWA) cannot conduct any integrated management for water resources in the West Bank within the current governance framework. The governance system established by Article 40 (Oslo II) requires approval by Israeli authorities of any proposed project within the West Bank. This arrangement and its implementation give Israeli authorities control over allocating and managing West Bank water resources. Israeli territorial jurisdiction in Area C (60 per cent of the West Bank) consolidates this control, which makes integrated planning and management of water resources virtually impossible for the Palestinian Authority. Despite growing demand from Palestinian consumers, the Israeli Water Authority has used its regulatory role to prevent Palestinian drilling in the Western Aquifer, while increasing its own extraction from the aquifer above agreed levels.

The JWC has not fulfilled its role in providing an effective collaborative governance framework for joint resource management and investment. Unfortunately, it does not function as a joint water resource governance institution because of fundamental asymmetries of power, capacity, information and interests. These asymmetries prevent a consensual approach to resolving water management conflicts and have reduced the development of water resources and services for Palestinian people below the levels expected at Oslo.

Water law provides for sector governance, including separation of resource management and regulation from resource use. But this vision is not reflected in present organizational arrangements. The National Water Council has never functioned as intended; PWA operates both as regulator and implementer, and water supply service remains in the hands of several hundred separate municipal water departments and local councils. PWA, not performing to expectations, has lost capacity because of governance and management problems. One yardstick of institutional capability is PWA's weak ability to negotiate effectively in the JWC.

Integrated water resources management is impossible under current conditions. The solution for all these problems will require political movement. Reforming the way the JWC and Civil Administration address Palestinian development needs is a priority until the political issues are finally resolved.

Source: Mimi and Samhan 2011, background paper for the report; ADA and ADC 2007; Isaac 2004; PWA 2009; World Bank 2009b.

shared water resources could create a win-win situation for riparian countries (Box 2.8).

Inadequate governance of shared water resources continues to threaten the region's stability and food security and impose high levels of uncertainty on water resource planning in the downstream countries. Despite the existence of several operational agreements governing Arab shared water resources, the increasing pressures on water and the deterioration of its quality require a basinwide water management framework ensuring an integrated and sustainable development of those resources (Box 2.9).[68]

Occupation and water governance

Deprivation of water resources in occupied territories is a major issue. The State of Palestine provides an example (Box 2.10). International conventions state that it is illegitimate for military occupiers to exploit and invest in natural resources within occupied territories while denying the state owning these resources the right to such investment. However, Israeli practices in occupied Palestine and the Syrian Golan heights violate these international conventions. Israel's military chief declared after the 1967 war that all West Bank water resources belonged to Israel. Palestinian waters were placed under the direct control of Tsahal (the Israeli Army) and the management of the Israeli government through the Water Delegation Office. In 1967–1968, several military orders were issued establishing the occupation's authority over all water exploration and well-drilling works. Military decision number 158 forbids Palestinians from owning a hydraulic system or drilling a well without a permit from Tsahal. Even with a permit, they cannot exceed 60 metres in depth, whereas settlers can reach depths ranging between 500 and 600 metres.[69] Israel now illegally exploits almost 85 per cent of West Bank water resources and continues to prohibit the Arab population from drilling new wells.

Funding

The Arab region's chronic water problems entail high investment needs and growing costs to maintain, develop and expand water and sanitation coverage to achieve the water-related MDGs. The water sector, predominantly publicly owned with little private sector involvement, has a funding gap. Water investments absorb large amounts of public funds that could be used more efficiently elsewhere, without generating optimum economic returns.

The Arab region has a fairly large public sector and a major share of central government budget in public funds. Across the region, significant public resources are invested in the water sector. Government spending on the water sector in the Arab countries varies between 1.7 per cent and 3.6 per cent of GDP (Figure 2.14). During the last decade, water represented between 20 per cent and 30 per cent of government expenditures in Algeria, Egypt and Yemen.[71] But these values are lower than the optimal annual investment needed between 2005 and 2010, estimated at about 4.5 per cent of GDP for the MENA region.[72] The Islamic

Box 2.11 Reducing water losses by combining a management contract with rehabilitation work in Amman, Jordan

The management contract in Amman illustrates the difficulty of assessing a private operator's contribution. The public-private partnership was one element of a major investment project (valued at about $200 million) to rehabilitate Amman's water distribution network. The plan was to move from a poorly designed hydraulic system to one with well-delineated zones gravity-fed through reservoirs. The management contract was supposed to ensure that an experienced operator would handle this structural change smoothly, reducing service disruptions and maximizing operational benefits from the new infrastructure.

Because of acute water rationing in the city, customers received water for less than four hours a day on average. Reducing water loss was a top priority, but it depended both on the government's rehabilitation programme and on the private operator's improvements. The original drafting of the contract did not clearly acknowledge these dual responsibilities. In addition, ambitious targets were imposed on the operator, backed by swift financial penalties: the nonrevenue water level was to be reduced by 10 per cent in the first year of operation, up to 25 per cent (halving the nonrevenue water level) by the end of the fourth.

Difficulties developed early on, as the government agency in charge of implementing the civil works experienced major contract delays. Further delays arose during execution because of the complexity of coordinating many contractors. After tense discussions in the first two years, it was recognized that the private operator could not be held liable for failing to meet the contractual nonrevenue water targets and that the targets had been overestimated. A special project monitoring unit was also set up to help the government better play its role as counterpart in the partnership.

As the programme proceeded, another problem arose: with the gradual reduction in water rationing, the increase in average network pressure caused a spike in the number of water leaks. The operator had to repair 55,000 leaks in 2004. By the end of the contract, it had replaced about 600 kilometres of pipe, close to 10 per cent of the network. The management contract was extended twice to keep the private operator in place until the end of the capital expenditure programme in 2006. By the end of the contract, nonrevenue water had been reduced from 51 to 42 per cent—a notable improvement, though far below the original target. At the same time, the average number of hours of service was doubled.

This case holds important lessons. Though the parties finally agreed that the original nonrevenue water target of 25 per cent was unrealistic, their protracted negotiations on this subject distracted them from focusing on more productive tasks. Tracking the operator's performance was made difficult by the operator's dependence on the government's timely execution of the investment programme. Finally, the network's hydraulics were being profoundly altered, so the reference point for measuring leaks was constantly changing. Using the nonrevenue water percentage as the sole contractual indicator of the operator's performance to track water losses and impose stiff financial penalties was thus a mistake.

Source: Marin 2009; El-Nasser 2007.

Development Bank (IDB) estimates that Arab countries may need to invest up to $200 billion in water-related infrastructure over the next ten years to satisfy the growing demand.[73] For these large amounts of required water investment funds, issues of accountability, transparency, democracy in decision-making and other governance factors must be tackled.

In Saudi Arabia the capital expenditure for infrastructure development projects in the water sector is about $40 billion for the next 20 years. Water distribution will represent 38 per cent of spending, while sewage collection and water treatment will account for the remaining 62 per cent. More than $20 billion has been earmarked as investments to be spent mainly on water and wastewater projects in six major cities—Dammam, Jeddah, Madinah, Makkah, Riyadh and Taif—over the next 10 years.[74] The Saudi National Water Company (NWC) is planning to invest $23 billion in Saudi Arabia's sewage collection and treatment infrastructure over the two coming decades. This investment aims to increase wastewater network coverage to 100 per cent, up from the current coverage level of 45 per cent (and lower in some cities/towns).[75]

Planned investments in water desalination are huge, particularly in the Gulf Cooperation Council countries. In 2003 the construction cost of desalination plants installed in those countries was about $21 billion.[76] Between 2011 and 2020, Saudi Arabia is expected to invest around $53 billion to increase production from desalinated sources by 3.92 billion cubic metres. The United Arab Emirates may invest $10 billion during the same period. Egypt, the Gulf Cooperation Council, Iraq, Jordan, Lebanon, the State of Palestine, Syria and Yemen may need more than $30 billion in investments in water supply and sanitation facilities up to 2015.[77] In Kuwait investments in desalination facilities are estimated at $7 billion up to 2025.

While most oil-producing countries in the Gulf Cooperation Council can afford water source solutions such as desalination, many other Arab countries suffer from these solutions' heavy financial burden. Jordan's water strategy for 2009–2022 was to invest Jordanian Dinars 5.86 billion ($8.24 billion) over 15 years, corresponding to more than 160 per cent of Jordan's GDP.[202]

In the Gulf countries, all investment for water and sanitation, including desalination, is funded directly by the central government. The eighth Saudi development plans covering 2006–2010 allocated for water (including irrigation) Saudi Riyal 41.6 billion ($11.1 billion), equivalent to around $2 billion per year. Many Arab countries depend, however, on external public donors for water supply and sanitation. The main external donors to the region are the European Union, Germany, Japan and the United States. Other donors include the United Nations (UN), the World Bank, the Islamic Development Bank (IDB), the Kuwait Fund for Arab Economic Development, the Saudi Fund for Development, the Abu Dhabi Fund and the Arab Fund for Economic and Social Development.[79] The size and share of external funding vary among the region's countries—some depend on external funding completely. Most investments in the Jordanian and Lebanese water and sanitation sector, for example, are financed through grants and loans from external public donors. Other funding mechanisms involve private sources through Build-Operate Transfer (BOT) projects. The BOT for the Disi-Amman carrier will be partially financed with around $190 million of private equity security. The government will secure a grant of $300 million, and loans totalling $475 million will be provided.[80]

Financial considerations, including revenue from the sale of assets and reductions in the direct cost of providing water services, may also motivate governments to introduce private sector participation. In countries where water technically belongs to the government, private interests may often access the water or lease rights for various purposes. Barriers and risk factors to private sector participation include low returns; asymmetry of information; technology-specific, inelastic demand; and capital-intensive, high fixed-cost, long-term investments.[81] Water and sanitation responsibilities are also split between ministries and among national and local authorities.

Privatization: positives and negatives

To achieve full cost recovery and improve economic efficiency, and under pressure from international donors, many Arab states have endorsed privatization through direct sales of assets, such as water supply and distribution systems and wastewater treatment plants, to private sector entities. But privatization is controversial. It allows the government to secure money and enhance the efficiency of local water service markets by reducing prices and satisfying customers with better service. According to privatization proponents, water pricing according to market forces will determine water's real price and force water users to adjust their consumption and constrain wastefulness. Private corporations can also better manage and distribute water because of their efficient management structure, access to cutting-edge technology, ability to recover the full cost of distribution and capacity to eliminate market distortion and subsidies.[82] Privatization thus prevents bureaucratic costs and limits political corruption.

On the other hand, many argue that water privatization will create new barriers to common resources and deprive vulnerable groups, especially poor people, of their basic water needs or rights, leading to inequitable distribution. A small group of capital owners will exploit a public good without regard for environmental consequences or concerns. Privatization can also reduce local control over natural resource management and negate years of positive development. Considering water private property creates the possibility of "excluding others from access" to a life-sustaining element.[83] Moral and social debates on water ownership and the negative implications of water commoditization are usually neglected. Empirical analysis results also show that demand-price and income-price are inelastic. So if a user-fee policy were adopted, tariff increases would affect disadvantaged groups' income but would not decrease their consumption. Large price increases would only be required in urgent situations to eliminate short-run shortages.[84] Non-price-based policies, such as technological change and improving water bills' informational content, could make price systems more effective and promote conservation, taking into consideration social and geographical features.

Water supply privatization contracts were implemented in Gaza, Jordan, Lebanon, Qatar and Yemen and seriously considered in Bahrain, Egypt, Kuwait and Saudi Arabia.[85] Water resource privatization is practiced in the region on a small-scale, individual level: private well owners sell water to private vendors and tankers for rural areas and parts of cities, either as a primary or supplementary water source. Without adequate infrastructure and regulatory frameworks, such off-network practices are often informal and characterized by hazardous source extraction.

Jordan, Lebanon and Yemen have implemented legislative and institutional reforms to pave the way for the privatization of water and sanitation services and counter the negative impacts of increasing water demand, such as overexploitation of groundwater resources. In the Emirate of Abu Dhabi, the first privatized project, Al-Taweelah A2 Desalination Plant, decreased the cost of desalinated water production by about 40 per cent, reducing the water tariff by the same amount and reducing government subsidies.[86]

However, water privatization problems persist. Non-transparent privatization plans and the lack of expertise in privatization planning and implementation have led to marginalization of local communities and the spread of public distrust and resistance. Governments are usually accused of selling off public assets at low prices and giving control of vital resources to the private sector.

Arab states could derive greater benefits from privatization by conducting dialogue with stakeholders, taking into consideration socio-economic needs and respecting water as a human right. In parallel, the preparatory privatization steps, including utility selection, contract negotiations, monitoring of the bidding process or the performance of private investors, need institutional and regulatory framework reform to ensure full coordination and consultation among various ministries and water institutions, as well as civil society structures.[87]

Public-private partnership

Public-private partnerships were introduced to the Arab region to enhance the performance of public water and wastewater utilities, expand and improve service coverage, provide alternative mechanisms to finance infrastructure investment and reduce the burden on government budgets. A wide range of approaches are available for involving the private sector, including service delivery (such as distribution, billing, monitoring and leak detection) and managing, operating and financing water and sanitation projects. Some options keep operations (and ownership) in public hands but involve the private sector in designing and building infrastructure.

The government's regulatory role in protecting the consumer from monopoly, overpricing and service quality degradation affects the success of such a partnership. Public control of water tariffs, along with sufficient capital investments, would make water affordable. On the other hand, a private entity will not achieve management efficiency if the government frequently intervenes in its operations. Also, it would not work for a loss or little profit. Thus, government regulations have to take into consideration the concerns of the investor, the contractor and the public. A regulatory framework is necessary but not sufficient for effective government regulation; effective implementation is required.[88]

In the Arab region, the urban population served by private operators is fairly small, with 7 million people in 2000 rising to 13 million people in 2007. Between 1990 and 2005 public-private partnerships in Morocco took the form of concessions in several cities and installed 270,000 new water connections, providing piped water access to about 1.3 million people and reducing nonrevenue water. The financial design of the Casablanca concession helped support access expansion. A special work fund, financed by a 0.5 per cent tariff surcharge, provided $140 million of the $500 million of civil works that the concessionaire carried out over a decade. Another major funding source has been a connection fee for all water utilities (public or private) well above the connection cost, although this fee did not meet targets for coverage expansion, mainly because of high connection fees and difficulties in dealing with illegal settlements.[89] An assessment of the public-private partnerships revealed, however, that water access and coverage grew only about 6 per cent in four Moroccan cities, while the publicly managed utilities registered growth of 9 per cent for the same period. Involving private operators in water utility management in Jordan and the West Bank and Gaza reduced nonrevenue water and improved bill collection through strict policies, education campaigns and close cooperation between public and private operators (Box 2.11).

The impact of public-private partnerships on expanding water coverage is not very significant. Whether public or private, water utility performance depends on more than funding mechanisms. Private sector participation should focus on improving operation efficiency and service quality through an inclusive partnership with the public sector, rather than just attracting private funding.

Improper water valuation

Comprehending water's value is vital for policy decision-making about water sector investments to ensure proper allocation and achieve economic efficiency. Social, cultural, environmental and religious issues of water as a human right must be kept in mind. The water sector tends to be capital-intensive, as service requires large infrastructure investments and fixed and sunk costs. Attributing investments, costs and benefits to water services helps manage these services economically, allowing all parties to charge the beneficiaries to cover the costs of their specific water service.

While most Arab countries are implementing water management strategies, they typically disregard or underestimate water's economic value, instead focusing on financial costs and feasibilities to recover the costs of providing water for various sectors. Many countries, such as Lebanon, subsidize agricultural, domestic and industrial water use. In the agriculture sector, water's economic value is often not considered and is set at a minimal cost despite overconsumption.[90]

Understanding, appreciating and properly establishing water's real value including environmental and social as well as operational and construction costs is essential to effective water governance.

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[31] At the United Nations Millennium Summit in September 2000, 189 heads of state adopted the MDGs, which set eight clear, time-bound goals and 18 underlying targets to be achieved by 2015. Target 10 of goal 7 (G7) focuses on freshwater: it aims to cut by half the proportion of the world's population without access to clean drinking water and adequate sanitation. Freshwater is not only one of the 18 targets embedded in the MDGs, but also a critical factor for meeting all the goals stated in the Millennium Declaration. At the Johannesburg World Summit for Sustainable Development in August 2002, the overall MDGs were reaffirmed with emphasis on the water and sanitation target. In 2013, the right to safe water and adequate sanitation for almost all of the world's poorest citizens remains an unfulfilled promise (WHO and UNICEF 2010).

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Chapter 3

Concepts and approaches for effective water governance in the Arab region

This chapter discusses three main issues: water security, the ultimate goal in efforts to achieve sustainable development; effective water governance, the way forward in achieving water security; and cost-effectiveness, an appropriate tool for guiding effective water governance.

Because water affects all human activities, water security has a wide-ranging definition. Water security is inseparable from social, economic, environmental and health security.

Water security refers to the "availability of an acceptable quantity and quality of water for health, livelihoods, ecosystems and production, coupled with an acceptable level of water-related risks to people, environments and economies."[1] Water insecurity "can arise from physical scarcity, resulting either from climatic or geographical factors, or from economic water scarcity, or from unsustainable consumption or overexploitation. It can also have economic origins, with poor infrastructure or capacity preventing access to the water resources available, or occur where pollution or natural contamination renders water resources inaccessible."[2]

Some argue that the definition of water security varies depending on water use and water user status. We will follow the definition established by the Food and Agriculture Organization (FAO) and the United States Department of Agriculture, but expand it to include socioeconomic, environmental and political requirements, following Janabi (2009; Box 3.1).[3]

Water security, poverty alleviation and sustainable human development

Sustainable human development, according to the Human Development Reports of the United Nations Development Programme, includes knowledge, health and income, as well as equity, freedom, equal opportunity, gender equality, access to resources and ability to choose. Water security, essential for livelihood, underpins all of these dimensions.

The need for water security is particularly acute in rural and poor communities. Water is critical for economic growth and social well-being, so improved water governance requires understanding the social, economic and institutional links between reducing poverty and ensuring access to safe water.[4] The Organisation for Economic Co-operation and Development states that "poverty encompasses different dimensions of deprivation that relate to human capabilities, including consumption and food security, health, education, rights, voice, security, dignity and decent work."[5] Unlike privileged people, for whom water is never scarce, poor people and marginalized groups have limited

Box 3.1 **Water security in Iraq**

Water security in Iraq comprises:

- Accessibility of water resources. Irrigated agriculture requires water for seasonal crops.
- Use of water resources for economic development. Water security is essential for economic growth.
- Ability to manage water resources sustainably and ensure quality and quantity. Water security requires sustainable management.
- Ability to balance and satisfy competing water demands. Integrated water resources management principles will help meet competing domestic, industrial and agricultural water demands through fair allocation, pricing and governance.
- Long-term water-sharing agreement with stakeholder participation. The Euphrates River and the Tigris and most of its tributaries cross the borders of more than one country. Iraq, the most downstream country, is vulnerable to upstream countries' water resource management practices. Lack of a long-term water-sharing agreement presents a direct threat to water security.
- Environmental protection from pollution and degradation. Iraq must protect its environment and restore the southern marshlands drained by the former regime. Maintaining Iraq's wetlands and protecting its biodiversity are preconditions for sound water management.

Source: Janabi 2009.

access to water, often because rich people can buy their way out of shortage. Lack of access to adequate, sustainable water is thus a cause, a result and an indicator of poverty. As water receives more recognition as a fundamental human right, the need to ensure equitable access and participation in decision-making is driving change in water governance.[6]

Poverty is also linked to food insecurity, malnutrition and hunger. The World Food Summit of Rome held by FAO in 1996 considered four dimensions of food security: (1) availability of sufficient food of appropriate quality, (2) access to sufficient resources to acquire nutritious food, (3) proper conditions—such as adequate diet, clean water, sanitation and health care—to use food for nutritional well-being that meets all physiological needs, (4) stable access to adequate food at all times. Several conditions are necessary to ensure food security. The first key condition is to better protect and manage water resources for irrigated and rain-fed agriculture. The second key condition is to raise public awareness of rural challenges and empower stakeholders with the means to ensure food security.[7]

Most Arab countries pronounced their commitment to sustainable development at the 1992 Earth Summit and confirmed this commitment in the 2012 Earth Summit—Rio+20.[8] In its original formulation, sustainable development was defined as "meeting the needs of the present without compromising the ability of future generations to meet their own needs."[9] The new paradigm of sustainable development implies a multigenerational vision that seeks to harmonize socio-economic and environmental goals. A prerequisite is to recognize that sustainability is a common problem and that all parties must sacrifice some needs for the common good (Box 3.2).

More than half of the Arab population is urban; by 2050 almost three-quarters will be. Rapid urbanization has contributed to the growth of large cities such as Algiers, Alexandria, Amman, Baghdad, Cairo, Damascus, Jeddah and Riyadh, and governments have expressed concern about how to provide services to mounting populations.[10]

The water situation in the Arab region is precarious. Water demand rises as populations grow, threatening sustainability. Demand management will become more important where scarcity and sector competition are increasing. Supply management will remain a priority where populations are more vulnerable. Calls for sustainable use of resources are gaining momentum, but water sustainability requires better water governance, more capacity and greater public awareness.

Water scarcity: a major determinant for water security

Scarcity can be expressed in various degrees: absolute, life-threatening, seasonal, temporary or cyclical. Water scarcity exists when water is not available in proper quantities and quality at the proper place, time and cost. Populations with normally high levels of consumption may experience temporary scarcity more keenly than other societies accustomed to using much less water. So it may be more useful to define water scarcity as a point where imbalance between availability and demand triggers water stress. Determining scarcity would thus be more qualitative than quantitative: the point where water scarcity occurs may vary widely from one situation to another.[11]

The UN defines scarcity as "the point at which the aggregate impact of all users impinges on the supply or quality of water under prevailing institutional arrangements to the extent that the demand by all sectors, including the environment, cannot be satisfied fully," whereas the European Commission defines water scarcity more simply as "a situation where there is insufficient water to satisfy basic needs."[12]

The causes of water scarcity can be physical or socio-economic. Physical scarcity—that is, limited access to water can arise from climate conditions (water shortage) or unsustainable management (overabstraction). With sufficient financial and technical resources, physical scarcity can be addressed through structural measures, such as water transfers, storage reservoirs and desalination. Physical scarcity is often followed or aggravated by socio-economic scarcity, a society's economic inability to develop additional water resources or social inability to adapt to the conditions imposed by physical scarcity.[13] Water sectors must tackle both types of scarcity to reduce water management problems. In addition, a third type of scarcity characteristic of the region is forced scarcity due to occupation and political conflict (for example, Darfur and the Jordan River basin).

Water scarcity poses dramatic threats to the livelihoods of countless people, particularly in rural and poor communities. Remote areas where food production is at the mercy of climate variability and where water and sanitation are inadequate are especially vulnerable. But water scarcity also affects urban dwellers, particularly in less developed countries.

Physical scarcity will present massive challenges for developing countries in semi-arid regions with rapidly growing populations and expectations for improved quality of life and poverty eradication. This is the case in many Arab countries, where agriculture is a major activity and water the main element of development. To what degree will water scarcity hinder socio-economic development? A country's economic diversification and social adaptive capacity can be more important than water availability.[14] And while physical availability is largely the

Box 3.2 Water sustainability

Sustainability has biophysical and socio-economic dimensions.

Biophysical sustainability seeks to maintain ecosystems and natural resources for human development. Socio-economic sustainability, a moral imperative, seeks to achieve basic social goals.

Socio-economic and environmental sustainability are highly interdependent. If a society allows excessive environmental deterioration, it undermines its citizens' economic welfare, its political systems' legitimacy and its institutions' endurance. If a society suffers from social tension and instability, it will neither prioritize the environment nor be able to implement sustainable development. Sustainability's socio-economic and biophysical dimensions must accordingly be addressed together.

Water sustainability presents one of society's major challenges. Fresh water is critical for human needs, economic activity and ecosystem preservation. The natural hydrological unit for water assessment is the river basin, but national water stress indicators can illuminate the global situation. A widely used measure of water stress is the use-to-resource ratio: national annual withdrawals/annual renewable resources. There is no firm relationship between values of this measure and degree of water stress, but a use-to-resource ratio exceeding 0.4 indicates a high water stress level. Signs of imminent competition between user groups, or between human and environmental requirements, can begin when the ratio is as low as 0.1.

In principle, a valid sustainability goal would be decreasing water pressure in all areas where water scarcity threatens development. In practice, water demand growth is unstoppable and nonlinear. While population in the 20th century tripled from 1.8 billion to 6 billion, water withdrawal increased sixfold. The continuing momentum of expanding populations and food requirements implies continuing growth in water demand.

Source: World Bank 2009b; Daly 1996; Raskin and others 1997.

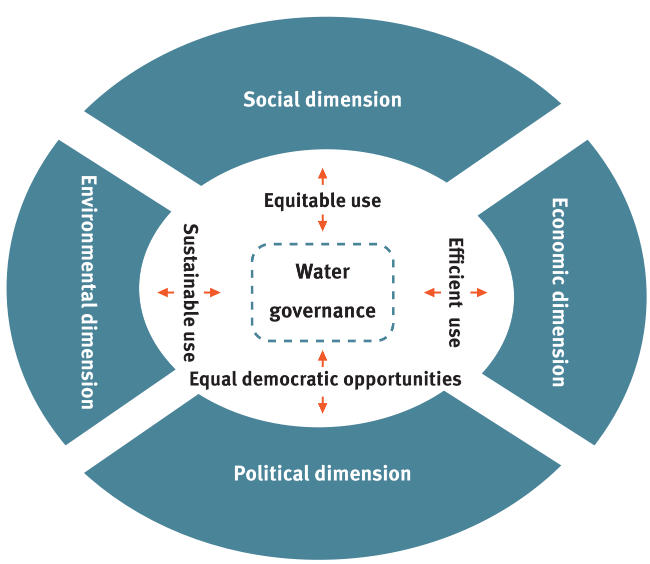
product of climate, demand is the product of a water-dependent population, competing sectors and water productivity. Water scarcity requires an integrated, multidisciplinary, multidimensional approach. An issue not solely for water technicians and specialists, it should be integrated within national social and economic planning.

Effective water governance: the vehicle for achieving water security

The so-called water crisis is a crisis of governance practices.[15] Water governance deficiencies include failure to provide sufficient water for poor and marginalized areas, lack of attention to water legislation and infrastructure, and inability to balance competing demands between socio-economic needs and the environment (Box 3.3).

Water governance refers to political, social, economic and administrative systems to develop and manage water resources and water services delivery.[16] The United Nations Development Programme stressed that water governance comprises the mechanisms, processes and institutions that allow all stakeholders, including citizens and interest groups, to articulate priorities, exercise legal rights, meet obligations and mediate differences.[17] Decisions in broader development areas also affect water governance.

Figure 3.1 Water governance dimensions



Source: Adapted from Tropp 2005.

Social, economic, environmental and political dimensions are the four pillars of water governance (Figure 3.1).[18] The social dimension refers to equitable water use. The economic dimension refers to efficient water use and water's role in economic growth.[19] The political dimension involves granting water stakeholders and citizens equal democratic opportunities to influence and monitor political processes and outcomes. It aims to ensure water equity for women and other socially, economically and politically weak groups. The environmental dimension involves sustainable water use and ecosystem services.[20]

Water governance depends not only on specific institutions but also on governance context. Key elements of good governance include transparency, accountability, participatory approaches, gender equity and access to information. Civil society and the private and public sectors must interact to ensure development in reforming and implementing water governance systems that allocate water. Governance needs continuous refinement and flexibility as new challenges arise. Even with general guidelines, one cannot set unique models. An IWRM approach would provide a framework of principles and good practices ensuring effective water governance (Box 3.4).

A recent review suggests a new definition of good water governance that addresses water management:

- Water governance consists of the decision-making processes and institutions that affect water. Water governance does not include outcomes or practical, technical and routine management functions such as modelling, forecasting, staffing and building infrastructure.
- Good water governance principles include predictability (rule of law); ethics (control of corruption); and open, transparent and broad participation.[21]
- Good governance requires appropriate conditions and an enabling environment.[22] A supportive context should include

collective decision-making; effective institutions; and suitable policy, legal and political frameworks.[23]

Improving water governance: An urgent task

Improving water governance involves a wide range of skills, institutions and actors. In almost all Arab countries, the distribution of roles and responsibilities is often unclear. Although several government agencies provide water, none manages or governs it. Governance structures are undergoing reform to improve efficiency in water use and human resources.[24] This is becoming more necessary with rapid population growth.

After the supply management approach failed, most governments shifted to demand management.[25] But demand management requires many institutional and technological interventions, such as water tariffs, water metring, recycling approaches, regulation policies, improvements in water distribution networks, and water-saving and energy-saving irrigation technologies. All these interventions relate to the human dimension, where attitudes are shifting due to urbanization; rising educational levels; and social, economic and political transformations. The success of any long-term vision on water governance will depend on understanding the challenges and changes modernization presents.[26]

As water affects livelihood, water governance reforms can catalyse larger social change.[27] The ongoing political transitions in several countries in the Arab region could further water governance reform through increasing participation and accountability. But shifts in attitudes and behaviours take time and effort to yield the desired impact.

To meet water governance challenges, some Arab countries have initiated institutional reforms. In Morocco the government decentralized the water management system and tasked local authorities with ensuring service provision. In some countries, such as Jordan, governments have turned to privatization by empowering water user associations to use contractor skills and resources. But in several countries many factors impede reliable progress, including corruption, ineffective regulations, unclear responsibilities and weak local capacity. The most important factors, however, are weak institutions, limited public awareness, decision-makers' lack of political will and the absence of leaders and skilled managers.

Many argue that effective water governance is anchored in five foundations: efficiency, environmental and economic sustainability,

Box 3.3 Water decisions and governance systems

Water decisions are anchored in governance systems across three levels: government, civil society and the private sector. Facilitating dialogues and partnerships among these levels is critical for water governance reform and implementation. Water governance includes:

- Allocating and distributing water equitably and efficiently, and integrating water management approaches.
- Formulating, establishing and implementing water policies, legislation and institutions.
- Clarifying the roles of government, civil society and the private sector and their responsibilities for owning, managing and administering water.

Source: UNESCO 2006.

Box 3.4 Integrated Water Resources Management

IWRM goals include:

- Improve institutional settings, boost reforms and enhance inter- and cross-sector coordination and coherence.
- Establish and enforce appropriate legal and regulatory instruments. Establish settings for water rights and permits and introduce environmental standards, including the "polluter pays principle." Establish inspection, monitoring and enforcement mechanisms and independent assessment, such as the "water police."
- Introduce and/or improve transparency and accountability.
- Enhance cooperation of riparian states on sustainable use and protection of transboundary water resources in harmony with the UN Convention on the Law of the Non-Navigational Uses of International Watercourses.
- Protect and safeguard natural ecosystems to ensure good water quality. Ensure and enhance the necessary biological and ecological goods and services they provide in accordance with the Convention on Biological Diversity.
- Align IWRM and integrated coastal zone management policies to tackle challenges in rapid coastal development and marine pollution.

Source: Union for the Mediterranean 2010.

Box 3.5 **Iraq: water governance in a post-conflict country**

The Iraq war and post-war insecurity, along with growing water scarcity, left a large part of the population vulnerable to health and hygiene problems and without safe access to water. Irrigation and drainage systems (canals and pumping stations) were also affected. As agriculture in Iraq depends mostly on irrigation, over-irrigation and drainage problems (silted canals, nonoperational drainage pumping stations, among others) have caused salinity and water logging in almost all irrigation schemes built between the Tigris and Euphrates rivers. The yields of major crops have fallen significantly, leaving large uncultivated areas and affecting farmers' income. Because of this, a large segment of the rural population has migrated to cities in search of employment.

Shortly after the U.S. invasion, renovating water infrastructure became a vital strategy. To reduce water loss, make irrigation more efficient and limit water logging and salinity, closed irrigation systems and pumping stations were used instead of lining and flumes for irrigation canals. According to the FAO Water Development and Management Unit in Rome, a 10 per cent increase in agricultural water efficiency could free up enough water to serve Iraq's urban population, and a 20 per cent increase could serve Iraq's industrial sector. But the electricity needed to operate these pumps made this alterative not cost-effective.

Costs greatly exceed the economic benefits of the current cropping system, largely dominated by low-profit cereals such as barley and wheat. Unless Iraqi agriculture shifts to added-value crops, water infrastructure cannot be rehabilitated.

Another alternative, under FAO's support, was to promote water user associations, involving farmers in water management and raising their awareness of high-tech, water-saving irrigation systems. But legislation in southern and central Iraq prohibits water user associations, unlike in northern governorates under the Kurdistan Regional Government. In the mountainous north, much smaller irrigation schemes are usually built by farmers themselves, facilitating the creation of such organizations.

Capacity building for water user associations was not well developed in the irrigation schemes rehabilitated by FAO in central and southern Iraq. This reflects a lack of interest in participatory governance. Schemes located in northern Iraq, however, had well-functioning water user associations, contributing to equitable and efficient water management.

Poor water governance, inexperienced water institutions, the absence of solid national water management policies and lingering corruption from previous dysfunctional regimes contribute to weak governance in a chaotic, post-conflict environment. Water management can be optimized by adopting appropriate legislation, facilitating water user associations and increasing agricultural productivity and water use efficiency.

Source: FAO-Iraq 2008; Romzek 2009.

responsiveness to socio-economic development needs, accountability before stakeholders and the public, and adherence to ethics and moral values. Openness, transparency, stakeholder inclusiveness and a participatory approach will lead to implementable policies and more flexible decision-making. It is critical to create an open forum with all stakeholders, including decision-makers, to discuss water issues. In Multi-Stakeholder Platforms—co-governance round tables where stakeholders of a watershed or region sit together—governance shifts from vertical command to horizontal coordination, easing problem-solving. This type of participatory, co-management organization forms the basis of Participatory Irrigation Management.

In the last twenty years many Arab countries have moved away from the state-led paradigm dominant from the 1950s to the 1970s. Today, governance entails decision-making and implementation processes involving levels of actors. Water governance is recognized as a political process whose changes reflect broader changes in governance structure.

Effective water governance in the Arab region confronts several challenges: lack of accountability, transparency, regulation and adequate stakeholder participation. The Arab region also suffers from inequity in water provision, a highly centralized decision-making process and inefficient responsiveness to escalating socio-economic development needs. Indeed, effective water governance is an urgent development requirement. The top-down approach to water governance has failed; the bottom-up approach, ensuring participation of all stakeholders, is the right one. The situation is more challenging in post-conflict countries facing severe water scarcity and potential water conflict. For countries in shambles emerging from a conflict, such as Iraq, it is critical to rebuild water institutions and destroyed infrastructure to support efficient provision of sustainable water services (Box 3.5).

There is no single model of effective water governance. To be effective, governance systems must fit the social, economic and cultural particularities of each country. But some basic principles are considered essential. Building on these definitions, the Global Water Partnership identified ten criteria for effective water governance.[28] These ten principles were further refined by the World Water Assessment Programme to produce eight features of good governance (Box 3.6).

Water governance guides, directs, enables and enhances effective and sustainable water management and provision. Effective water governance becomes more important as water becomes scarcer; it must ensure that all sectors of society have equitable, reliable and sustainable access to water and are using water efficiently (Figure 3.2).

Effective water governance entails legislative, organizational and administrative action, including practicing IWRM (Box 3.7). Responding to escalating challenges, many Arab countries are implementing IWRM plans and strategies with different approaches and varying degrees of success. Most attempts include water rights, multistakeholder participation, public-private partnership of water services, and decentralization reform.[29]

The water governance system must establish robust indicators to guide, monitor and assess reform. With information on reform's effectiveness and contribution to water security and sustainable development, stakeholders can contribute meaningfully to setting priorities and strengthen the responsiveness of institutions and processes to water needs. A Public Engagement in Water Management project initiated by the World Bank and the Arab Water Council in 2012 on public monitoring of water management in Egypt, Jordan, Lebanon and Tunisia established a series of such governance indicators.

With adequate indicators, water governance schemes can influence policy interventions by the government and the development community (Box 3.8). This is a challenging task because indicators can vary widely among countries. Each country must develop its own indicators and evaluate progress and drawbacks in water governance programmes.

Box 3.6 **The World Water Assessment Programme principles of good governance**

- **Participation:** All citizens, both men and women, should have a voice—directly or through intermediate organizations—representing their interests in policy- and decision-making. Broad participation hinges on national and local governments following an inclusive approach.
- **Transparency:** Information should flow freely within a society; processes and decisions should be transparent and open for public scrutiny. Right to access this information should be clearly stated.
- **Equity:** All groups in society, both men and women, should have equal opportunities to improve their wellbeing.
- **Accountability:** Governments, the private sector and civil society organizations should be accountable to the public or the interests they are representing.
- **Coherence:** Because of the increasing complexity of water issues, policies and actions must be coherent, consistent and easily understood.
- Responsiveness: Institutions and processes should serve all stakeholders and respond properly to preferences, changes in demand or other new circumstances.
- **Integration:** Water governance should enhance and promote integrated and holistic approaches.
- **Ethics:** Water governance must be based on the ethical principles of the society where it functions—for example, by respecting traditional water rights.

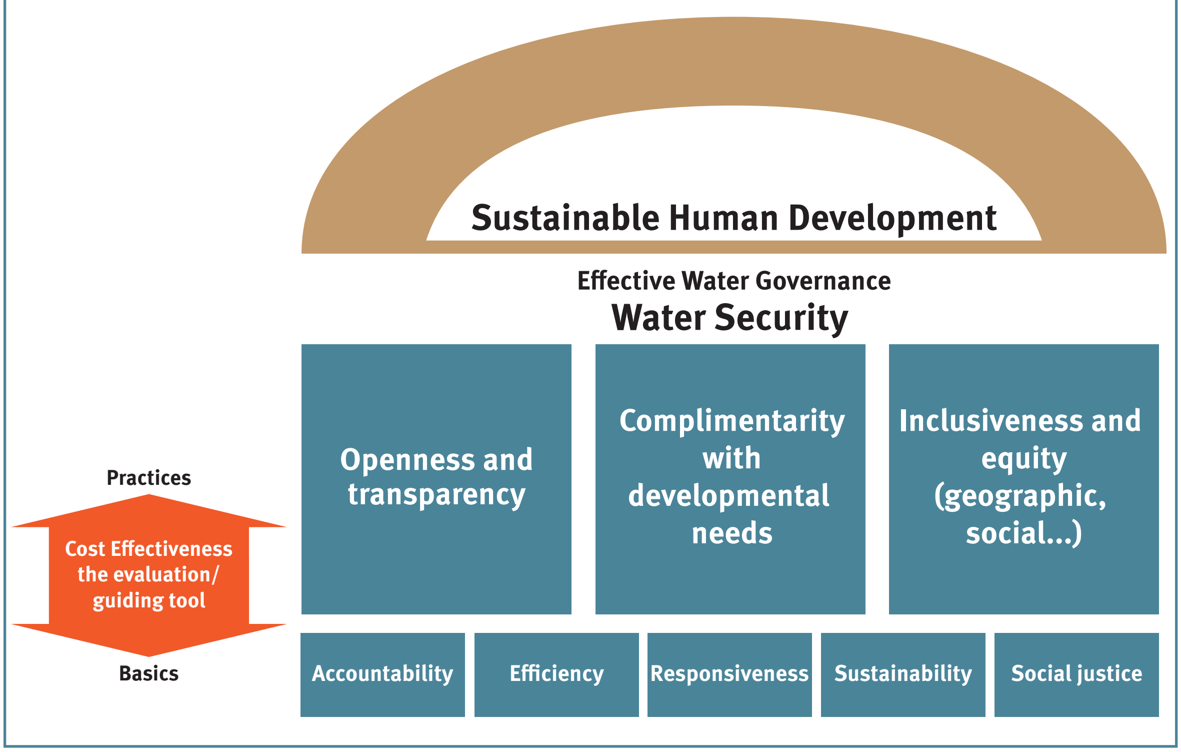
Source: Rogers and Hall 2003; IRG 2009.

Cost-effectiveness analysis: an important tool for guiding effective water governance

Decision-makers in the Arab region's water sector continuously face water scarcity. Often they base decisions on ways to increase water quantity and quality, using financial assessment as the major determinant. Unfortunately, these financial assessments often neglect economic and environmental costs, particularly in efficiency and effectiveness.[30] Cost-effectiveness analysis — as long as it considers economic, social and environmental perspectives—can help planners and decision-makers identify the most effective strategies to address water governance problems.

Another major dimension in water governance is water's proper valuation. Efficiency can be achieved when an economic activity's social net benefits (social benefits minus social costs)

Figure 3.2 Effective water governance scheme



Source: The Report team.

are at their maximum, but identifying the social cost is not easy. The real value might not be calculated properly, so one might end by overvaluing or undervaluing components. This is particularly true for the water sector. Economists and environmentalists believe that water misuse and overexploitation and inadequate governance are due mainly to ignoring water's real value. Economic efficiency that takes water's real value into account would prevent excessive water use and quality deterioration.[31]

Assessing water governance options: Cost-benefit versus cost-effectiveness analysis

Cost-benefit analysis

This approach assesses costs and benefits of investing in a particular action, reflecting its overall social impact. The cost-benefit analysis methodology can be employed either to decide if an activity is economically feasible or to select alternatives with the highest net benefits. Rather than focusing only on financial implications, the analysis incorporates all tangible and intangible costs and benefits. The most common use of cost-benefit analysis in the water sector is to justify investment needs and water quality improvements.[32]

Cost-benefit analysis is among the most powerful tools available for policy-makers deciding between alternative project structures the "with and without" scenario. The usefulness of cost-benefit analysis is limited, however, by the ease and reliability of identifying, quantifying and assigning a monetary value. These limitations are magnified in water governance. In addition to the traditional difficulties related to externalities and social costs, severe water shortages leave decision-makers with few alternatives. Choosing the most cost-effective way to address the major problems of water governance might be the only choice.[33]

Cost-effectiveness analysis

Cost-effectiveness analysis can be used to compare alternatives (Box 3.9). Unlike cost-benefit analysis, cost-effectiveness analysis does not depend on an absolute standard for accepting or rejecting any action, policy or programme.[34] Rather, it selects the least-cost alternative that can attain the intended objective. Considering the cost and consequences of alternatives, cost-effectiveness analysis can be used as a decision-orienting tool for water management, especially in urban areas. Cost-effectiveness analysis evaluates not only different alternatives and policies but also the least-cost and marginal (incremental) alternatives. For example, it can assess drinking water or sewerage systems to provide services in phases, giving the opportunity to choose the least-cost alternatives in each phase.[35]

Assessing alternatives through cost-benefit analysis or cost-effectiveness analysis requires knowledge of direct and indirect costs and benefits. The difficulty, as with many water-related variables, is that some of these costs and benefits are not related to goods or services traded in the markets and thus have no prices. Markets also sometimes fail to determine the real prices of some goods and services. Cost-effectiveness analysis can provide a viable alternative to cost-benefit analysis because it can save money, effort and time. Cost-effectiveness analysis can also reduce the chances of relying on estimates marred by bad information and data prejudices.

Box 3.7 Elements of sustainable water governance

For sustainable water governance, Arab countries could:

- Integrate policies in all water categories, including groundwater, coastal water and transboundary waters.
- Establish management organizations at appropriate levels.
- Enhance and facilitate stakeholder participation, emphasizing gender balance.
- Increase citizen awareness of water's value and culture.
- Support the media to play a more systematic and constructive communication role on water issues.
- Build capacity of water management and environmental protection administrations—address training needs (including training trainers) and facilitate knowledge and expertise exchange at the local, national and transboundary levels.
- Collect and monitor water data, using indicators that adhere to international standards.
- Support water research.
- Link research outcomes with policy development, application and monitoring.
- Establish and support fair and socially sensitive valuation and cost recovery.

Source: Lannon 2010.

Cost-effectiveness analysis and achieving effective water governance in the Arab region

Despite continuous efforts, the gap between water supply and demand has been widening continuously. Approaches to this problem have varied from enhancing supply to controlling demand by using pricing tools, raising awareness and enforcing water-rationing measures. In several cases, community-based, participatory approaches to demand management proved to be critical in achieving sustainability. Incentives, institutional reforms, awareness campaigns, appropriate technology transfer, public health and hygiene training, and cost recovery schemes based on a more appropriate valuation of water have demonstrated effectiveness. But no Arab country has achieved the desired balance, not only because of rising demand and scarcity, but also because of governance obstacles such as weak institutional arrangements, unequal water access and allocation, and inefficient and discriminatory enforcement of rules and regulations.

Securing and managing funding for the water sector is another major issue. Due to water and sanitation sector characteristics, such as natural monopolies; network infrastructure; large-scale delivery; large sunk investments; high technological needs and expertise; and high abstraction, distribution and transportation costs, effective water governance involves tremendous financial resources that very often exceed government capacity. Cost recovery is a major related issue, mainly because tariffs do not cover the total costs (investment and operational cost) of delivery, treatment and infrastructure maintenance. Over the last two decades private sector participation has emerged as a strategy to fill the funding and capacity gaps. Decisions are traditionally based on financial feasibility. The willingness to pay by end-users is frequently used as a guiding determinant, but this option is highly inadvisable for poor people. Despite

Box 3.8 Water governance benchmarking

In 2010 the United States Agency for International Development (USAID) conducted a water governance benchmarking initiative to evaluate water governance capacity and performance in Egypt, Jordan, Morocco and Oman. These countries have organized their water sectors well in setting policy goals and assigning responsibilities. Egypt and Morocco were more effective in applying good governance and decision-making practices. The water sector is highly centralized in Egypt, Jordan and Oman, where the government is playing a dominant role. Morocco succeeded in decentralizing water governance by involving agricultural water user associations and creating hydrological river basin agencies.

But accountability, integrity and transparency need substantial improvement. The water sector lacks strategic legal planning due to the absence of comprehensive water laws. A systematic, in-depth assessment of water governance in these countries would help monitor their evolution.

Water governance benchmarking can assess the state of water resources and the effectiveness of water policies or plans through performance indicators. These indicators can be formulated to measure and evaluate:

- Modifications in legislation and regulations.
- New, sustainable organizations and institutions.
- Diagnosis of water bodies: pressure-impact analyses.
- Cost recovery analyses by sector and/or river basin district.
- Environmental objectives for watersheds.
- River basin and groundwater management plans.
- National water plans.
- New water pricing policies
- Involvement of local communities and stakeholders in decision-making.
- Dialogue forums between stakeholders.
- Coordination between water agencies.

Source: Adapted from USAID 2010.

their limited financial capacities, poor people usually end up paying tariffs that go beyond their willingness and ability to pay. They are also charged for less effective water systems.

Cost-effectiveness analysis can help decision-makers achieve a balance between demand and supply (Figure 3.3) by presenting options in a clear and comprehensive manner that encompasses social and environmental as well as financial issues. Cost-effectiveness analysis can bring together supply, demand and effective water governance using a "unified lens and yardstick." It can evaluate the least-cost options for enhancing water quantity and quality, while taking social and legal dimensions into account. It can also apply to demand management, with attention to equity and justice. For effective governance, cost-effectiveness analysis can weigh participatory approaches and responsiveness to development needs. The positive impacts of this "unified lens and yardstick" extend beyond unifying economic and financial approaches to establishing consensus, a determining factor for success.

Major prerequisites for applying cost-effectiveness analysis in water governance

Applying cost-effectiveness analysis in water supply and sanitation projects requires specific conditions, including an estimation of social benefits based on the cost of the most probable alternative, and ability of water authorities, agencies or companies to provide similar output in the absence of alternatives.[36] Also, cost-effectiveness analysis cannot yield the required water governance results by itself. Decision-making mechanisms should incorporate water governance principles in designing, appraising, building, executing and implementing water and sanitation projects to achieve optimal use of resources, sustainable development and ecological sustainability.

Guaranteeing transparency, integrity and accountability is fundamental to successful and peaceful implementation. Water and sanitation projects should be made transparent to all stakeholders through stakeholder dialogue, access to information and environmental impact assessments. They must involve stakeholders from the beginning and ensure a system in the project management structure whereby individuals, NGOs, civil society and the private sector can ask questions and gain information that explains actions and decisions. They must also secure participation of all stakeholders, including vulnerable and marginalized groups, from conception to execution and allow input in deciding how water is used, protected, managed and allocated. Involving stakeholders can enable a deeper understanding of water governance.

Another criterion in comparing alternative actions is equity in allocating and using water.

All project areas have an equal right to water, so legal frameworks must provide solutions that enable users to demand their rights. This requires not only an effective legal framework, but also well-functioning institutions. Drinking water and sanitation are basic rights for all citizens. Irrigation is one water subsector where projects take social and economic criteria into account.

Water governance and cost-effectiveness analysis in the Arab region are complicated by international boundaries. Many countries must manage transboundary water—some of which carry run-off from other countries—and often rely on fragile, sometimes non-renewable aquifers, as in Jordan, Libya, Saudi Arabia and Yemen. Current groundwater management practices often neglect environmental considerations.

Water allocation between municipal and other water sectors is another challenge facing Arab countries. International pressure to reallocate from agriculture, with low value-added per cubic metre, to other, high value-added sectors such as industry, tourism and service fail to consider sovereignty for strategic crops, the fragile water trade balance and social and economic dimensions such as rural poverty and internal migration.

Cost-effectiveness in the water sector is becoming vital for Arab countries because of rapid population growth, increasing urbanization, rising food demand and a steady increase in the standard of living. Population growth is faster than the increase in water resources: per capita renewable internal freshwater resources fell from 573 cubic metres in 1992 to 374 in 2009.[37]

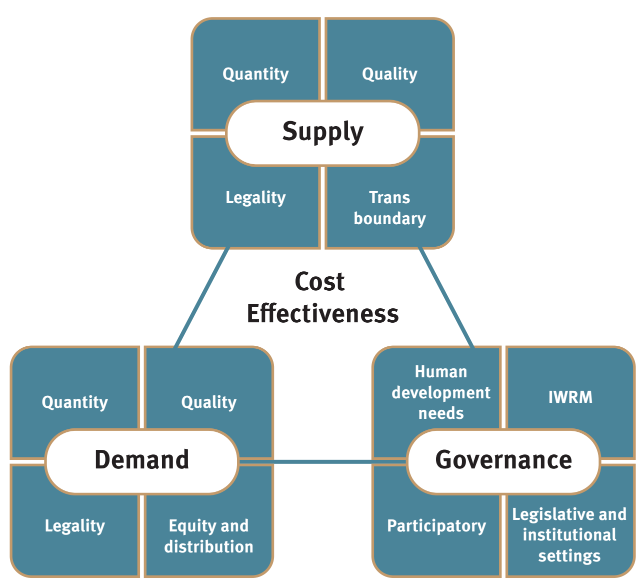
Cost-effectiveness analysis can help decision-makers and planners identify the most effective water governance options in administration, environment and demand management policies. In Arab countries that depend on desalination, for example, cost-effectiveness analysis can assess the efficiency of allocating quantities of desalinated water to domestic users. It can also identify the most effective desalination technologies, implementation modalities, funding and cost recovery strategies and other relevant approaches.

Box 3.9 Cost-effectiveness analysis

Cost-effectiveness analysis (also known as least-cost analysis) is used to identify the most cost-effective way to achieve an objective. The most cost-effective option meets the same objective at the lowest cost. "Cost-effectiveness analysis is a tool that can help to ensure efficient use of investment resources in sectors where benefits are difficult to value, or when the information required is difficult to determine or, in any other cases, when any attempt to make a precise monetary measurement of benefits that would be tricky or open to considerable dispute. It is a tool for the selection of alternative projects with the same objectives quantified in physical terms. It can identify the alternative that, for a given output level, minimizes the actual value of costs, or, alternatively, for a given cost, it maximizes the output level."

Source: EC 2009.

Figure 3.3 The cost-effectiveness analysis and effective governance triangle



Source: The report team.

Endnotes

[1] Grey and Sadoff 2007.
[2] Mileham 2010.
[3] As defined by the Food and Agriculture Organization (FAO), food security is achieved at "the individual, household, national, regional and global levels when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life" (FAO 1996). The United States Department of Agriculture defines food security at the household level as "food access by all members at all times to enough food for an active, healthy life. Food security includes at a minimum (1) the ready availability of nutritionally adequate and safe foods, and (2) an assured ability to acquire acceptable foods in socially acceptable ways (that is, without resorting to emergency food supplies, scavenging, stealing or other coping strategies" (USDA 2009).
[4] UNDP 1996.
[5] OECD 2001.
[6] Moriarty and others 2007.
[7] ICID 2012.
[8] UN 2012.
[9] WCED 1987.
[10] Mirkin 2010.
[11] Winpenny 2006.
[12] UN 2006; EC Water Scarcity Drafting Group 2006.
[13] Turton and Ohlsson 1999.
[14] Allan 2001.
[15] UNDP 2004.
[16] GWP SAS 2002.
[17] UNDP 2004.
[18] Tropp 2005.
[19] World Bank 2003.
[20] Miranda, Hordjik, and Torres Molina 2011.
[21] Lautze and others 2011.
[22] Tiihonen 2004.
[23] Kooiman 2003; Rhodes 1996; Tiihonen 2004.
[24] Varis 2007.
[25] UNEP 2010a.
[26] Varis and Tortajada 2009.
[27] Vairs 2007.
[28] Rogers and Hall 2003.
[29] GWP SAS 2003; CEDARE and AWC 2007.
[30] Gerasidi and others 2003.
[31] Birol, Karousakis, and Koundouri 2006.
[32] Mitchell and others 2007.
[33] Chong, Kazaglis, and Giurco 2008.
[34] COAG 2007.
[35] NWRI 2003.
[36] Aulong and others 2008.
[37] World Bank n.d.

Chapter 4

Effective water governance: water's value and cost effectiveness

Water's real value should guide water governance and management to the most economically, socially and environmentally efficient options.

Despite water's necessity for human life, it is among the world's most undervalued resources. What is water's true economic value? The water sector typically focuses on the financial costs of ensuring water quantity and quality. Economic value reflects preferences that depend on services and benefits affected by scarcity. Water's economic value is usually higher in arid areas because water resources are scarcer and thus trigger more competition between users.[1] A more difficult question: Who is using the water and for what purpose? The difficulty of this question is that water's value is closely associated with water value-added or productivity.[2]

Water's economic value

The economic value of consumer goods or assets—that is, the satisfaction they provide or their ability to generate income—is indicated by price. Price signals guide resource allocation and use.

Understanding and capturing water's value is necessary to compare the costs and benefits of policies, programmes and projects. But this is not an easy task.

Establishing water's economic value is one of the most discussed and debated issues in water use and allocation efficiency.[3] Young (2005) stated that "water valuation presents the economic analyst with a wide range of challenging issues and problems. Because water values tend to be quite site-specific, spatial and temporal, each case confronts its own unique issues and typically requires its own original valuations. Effective measurement of water values demands skill and rigueur in application of all the tools of the applied economist's trade. These tools include data collection, statistical analysis, optimization models and research reporting."

As measured by price, water's value is what users are willing to pay for it.[4] Consumers will use water as long as the benefits exceed the costs. Municipal and industrial water provide direct benefits to users and indirect benefits to society. Direct benefits are easy to identify but may be difficult to measure accurately. Indirect benefits, such as impacts on public health and well-being, are very difficult to identify and measure. One approach to estimating the benefits of municipal and industrial water is the contingent valuation method, which uses surveys assessing willingness to pay for improved water. Another is the conjoint analysis, which asks users to select among alternatives. To date, willingness to pay is the most successful application of economic

Box 4.1 **Costs of low-quality drinking water: a case from Amman, Jordan**

In the summer of 1998 a major drinking water pollution outbreak occurred in Amman due to a malfunction of the capital's water treatment plant. So the government advised people "to take more precautionary measures and boil water for at least one minute before drinking it."

In November 2007 thousands of Jordanians were sickened by water contamination. Experts fear the worst is yet to come unless a lasting solution is found to the kingdom's water shortages. The latest incident involved a refugee camp near Irbid, 120 kilometres north of Amman. People reported that their taps had turned yellow and feared their health was at risk. The government immediately shut down the water supply after experts realized the water had been contaminated by sewage. In July 2009 nearly 1,000 people from a village near the northern city of Mafraq developed diarrhoea and high fever from Cryptosporidium, a parasite that had made its way into the local water system. Investigations revealed that the disease had spread because of the town's worn-out water network.

Because of these and similar water crises, small and medium reverse osmosis units have spread in the market. Vendors currently sell and/or distribute treated water on demand. In Amman City alone, more than 120 small businesses are in operation. Many households have installed small reverse osmosis units to ensure adequate drinking water quality. These units' capacities are in the range of 1–5 m^3/d. The annual average value of machinery and apparatus for filtering or purifying water, most of them 1.5 m^3/d, jumped from $2.08 million between 1995 and 1998 to $10.5 million between 2007 and 2011. People are losing trust in drinking water provided by the public network.

Source: IRIN 2007.

valuation techniques for water and sanitation in developing countries.[5]

Resource allocation and use rely on market mechanisms, centralized or decentralized planning systems, or both. Market mechanisms cannot function properly alone for managing and allocating water. In the market, water's price should reflect its economic value. Because public agencies price water at its average delivery cost rather than its value to producers, water is rarely priced at its economic value.[6] Water can be valued by supply (cost of provision) or demand (value-added from productive use). When water is an intermediate good, such as in irrigated agriculture or industry, water demand is derived from the demand for the final output and from water's role in producing this output. In this case, water demand is a function of water's price and the price of the final product. Estimating water's economic value is equivalent to isolating water's marginal contribution from the total output value.[7] The market system thus fails to reach efficient levels; better situations exist where a market participant (producer or consumer) may be made better off without making someone else worse off, as Pareto optimality conditions in allocation.[8] Water rates set by the market and/or planning systems are also not usually at their optimum level, leading to misuse.[9] Market failure to achieve optimal water allocation and price can be attributed to several factors, including ignoring environmental or social benefits or costs.[10] Surface water and groundwater, for example, are often used without paying their "real economic value" in quality and quantity. Rather, policy- and decision-makers focus on covering at least part of the financial costs of provision, leading to misuse, abuse and pollution.[11]

Vague property rights can also contribute to market failure. Absence of specific rules governing groundwater exploitation, for example, can lead to overuse. The water sector is also a natural monopoly; accordingly, governments have usually created public authorities to monitor and control water.

Water and sanitation

Investment in water and sanitation typically generates many financial, economic, environmental and social benefits. Access to clean drinking water and sanitation reduces health risks and frees up time for education and other productive activities in rural areas, improving social capital as well as increasing labour productivity. Proper disposal of wastewater helps improve quality of life, reduce the child mortality rate and protect surface water bodies, benefiting the environment and other economic sectors. But these benefits, usually considered intangible, are not well presented in technical and feasibility studies, so they remain invisible to key decision-makers.[12] Because the benefits of water and sanitation in Arab countries remain insufficiently documented, water and sanitation receive lower priority than other public expenditure sectors.

Health, environmental and political costs

Water and sanitation deficiencies carry high health, environmental and political costs. Waterborne disease outbreaks and the time and cost of treatment reveal the negative health impact. The problem lies not only in absence of water but in lack of access to it, a problem compounded by mismanagement and unfair distribution. Water governance policies and structures must address these issues together.

Affordable, safe and sustainable sanitation can provide:

- Better health from safe disposal of pathogenic domestic waste.
- Better crops from applying decomposed, nutrient-rich domestic waste on fields.
- Better nutritional status of family members from better harvests.
- More income from excess harvest used for food and well-being.
- Better harvest because of fewer sick days.
- Less expenditure on hospital/doctor visits and medicine.
- Better education and career prospects because of fewer sick days at school.

Poor water and sanitation pose considerable public health risks. In 2003 waterborne diseases, notably diarrhoea, accounted for about 4 per cent (60.7 million disability—adjusted life years, or DALYs) of the global disease burden; 1.6 million deaths a year were attributable to unsafe water and sanitation, including lack of hygiene.[13] In 2008 the WHO and the United Nations Environment Programme reported that about 94 per cent of the 1.8 million annual deaths from diarrhoeal disease are attributable to environmental causes—particularly, unsafe drinking water and inadequate sanitation.[14]

Policy interventions can reduce mortality and morbidity-related health costs of water-related diseases. But the health benefits of water and sanitation policy interventions are sometimes underestimated when prioritizing, planning and budgeting. Economic valuation studies demonstrate that the health benefits of drinking water and sanitation interventions can be significant. Cost-benefit analyses have also shown that the benefits of drinking water quality and sewage treatment improvements are frequently greater than the corresponding investment and operating costs. Economic studies of water and sanitation interventions reviewed in Organisation for Economic Co-operation and Development countries have found benefit-cost ratios varying from 1 to 2.3, suggesting significant cost savings in health care.[15]

The health impacts of water-related diseases such as diarrhoea have a significant economic cost. Ample evidence accumulated over years confirms the link between improved health and water and sanitation quality. This link derives from the many waterborne organisms that can infect humans, causing diseases such as cholera, typhoid, trachoma, schistosomiasis, malaria, filariasis and dengue fever.[16] In the Eastern Mediterranean region diarrhoeal diseases cause 16 per cent of deaths in children under five. Providing safe water could reduce diarrhoeal disease incidence by about 21 per cent; improving sanitation, could reduce incidence by 37.5 per cent.[17] The economic value of these health benefits must be assessed to determine whether interventions are economically efficient.[18]

Table 4.1 displays the economic benefits of water and sanitation improvements. Providing water and sanitation infrastructure can improve livelihoods and life conditions. Direct support refers to sanitation infrastructure that will produce an income, such as treated wastewater in agriculture. Indirect support can consist of training to help poor people choose the sanitation infrastructure they need, eventually bringing higher health and hygiene levels.

To improve domestic water and sanitation on a large scale, investment must increase. With poverty reduction strategies dominating the international development agenda and infrastructure development improving productivity and raising income level, there is ample justification to allocate more investment in safe drinking water and sanitation. Costs of low-quality drinking water are high (Box 4.1), and cost-benefit analyses have predicted high returns on investments in domestic water and sanitation.[19] Safe sanitation enables poor people to undertake initiatives and mobilize their working assets. Without minimal safe sanitation, and the resulting health and environmental improvements, poor people might lack sufficient energy and productivity to initiate and sustain relevant action.

Water and sanitation projects provide important environmental benefits. The negative impact of untreated water on surrounding ecosystems is evident. The unregulated dumping of effluent waters has polluted many Arab shores and rivers. Untreated wastewater is also a major cause of underground water pollution. Because several Arab countries depend heavily on underground water, the negative health and environmental impact of this pollution is enormous. Treated wastewater is also becoming an important water source for agriculture and industry (see Chapter 2). The environmental benefits of a tightly built and managed sewer network that reduces or even eliminates soil and underground water pollution are clear. The positive environmental impacts of adequate sanitation on the environment also include reduced air pollution.

Allocating water among sectors has been seen as a macroeconomic decision and policy choice. But the implications of such contested decisions go far beyond economics, especially where strong advocacy groups represent sectors.[20] The political costs of water mismanagement can be very high: mass migration, economic recession, collapse of social order, and civil unrest and complaints.

Costs of lack of water and sanitation: an estimate for 2010

The cost-effectiveness approach can help identify the economic, social, environmental and political costs associated with lack of domestic water.[21] The cost-effectiveness ratio is used to cross-check and categorize water and sanitation projects based on the required costs to achieve the established objectives. Cost-effectiveness analysis is used instead of cost-benefit analysis particularly where output can be quantified but not monetized. The ex-ante appraisal assesses expected impacts, while the ex-post evaluation measures achieved impacts. Stakeholder consultations, focus groups and expert panels could provide a wider understanding of the key socio-economic issues for economic value. But cost-effectiveness analysis can only compare options that are simple to implement and have the same type of impact, a situation that rarely exists, so a combination of approaches should be used to reach the best "value for money" assessment. A quick and easy execution depends on the measures considered and the information available to quantify costs and effects. Calculating the cost-effectiveness analysis is fairly straightforward with reliable data.[22]

The costs of inadequate water and sanitation include health care costs, mortality and morbidity, and consumer willingness or ability to pay other sources, such as vendors.[23] Questionable water quality may also lead people to buy bottled water to avoid illness. Including externalities not typically caught in micro-economic cost-benefit studies may help capture projects' social rate of return.

We estimate each of the above-mentioned costs for 2010 to demonstrate the magnitude of economic damage caused by inadequate water and sanitation in Arab countries. The values of these costs are then extrapolated for 2010–2020, giving the cost of inaction.[24] We then estimate the required investment over the same period. This analysis can provide some insight into the magnitude of return on such investment and show how beneficial improving water and sanitation would be.

Costs of buying water from vendors in 2010

In 2010 approximately 63 million people in the Arab region did not have access to safe drinking water.[25] Because most of these people are poor and/or live in lower income countries, their willingness to pay is expected to be higher than that of people connected to the water network.[26] They would therefore rely on private vendors, springs, water harvesting and so forth to secure their water needs. A

Table 4.1 Economic benefits arising from water and sanitation improvements

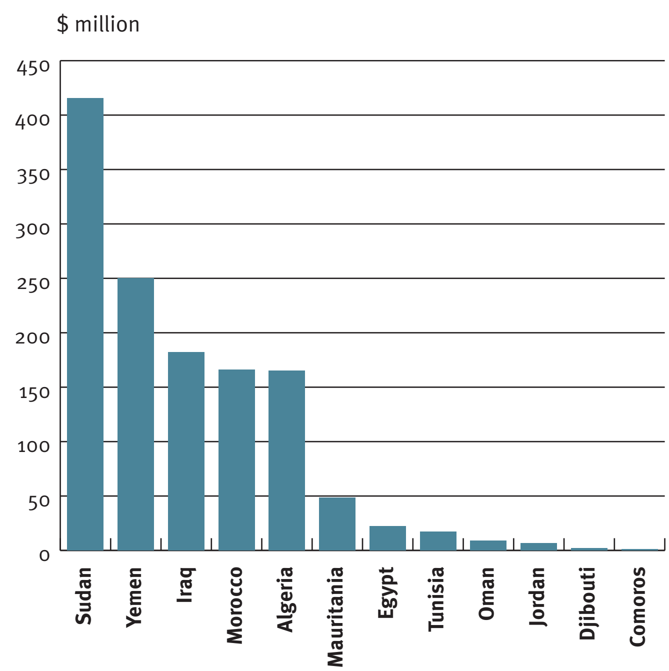
Beneficiary	Direct economic benefits of avoiding diarrhoeal disease	Indirect economic benefits related to health improvement	Non-health benefits related to water and sanitation improvement
Health sector	Less expenditure on treatment	Fewer health workers falling sick	More efficiently managed water resources and effects on vector bionomics
Patients	Less expenditure on treatment and less related costs Less expenditure on transport in seeking treatment Less time lost due to treatment seeking	Fewer days lost at work or at school Less time lost for parent/caretaker of sick children Loss to death avoided	More efficiently managed water resources and effects on vector bionomics
Consumers	Better socio-economic conditions and better job opportunities		Time savings related to water collection or accessing sanitary facilities Labour-saving devices in household Move away from more expensive water sources Property value rise Leisure activities and non-use value
Agricultural and industrial sectors	Less expenditure on treatment of employees	Less impact on productivity of ill- health of workers	Benefits to agriculture and industry of improved water supply, more efficient management of water resources—timesaving or income-generating technologies and land use changes and more labour productivity.

Source: Hutton and Haller 2004.

basic need of 50 litres per capita per day may be met from water vendors at about $1.5 per cubic metre.[27] We estimate the cost of buying water from vendors in selected Arab countries for 2010 at $1,285.56 million (Figure 4.1).

We found that Sudan and Yemen had the highest water shortage costs, at $415.42 and $250.21 million, respectively. This can be attributed to the high proportion of people lacking improved water and sanitation services.

Figure 4.1 Estimated cost of water purchase from vendors in selected Arab countries, 2010



Source: Authors' estimates.

Avertive costs on bottled water in 2010

Individuals or households offset some health risks through avertive expenditure. Consumption of bottled water is rising due to lifestyle and taste preferences as well as low municipal water quality.

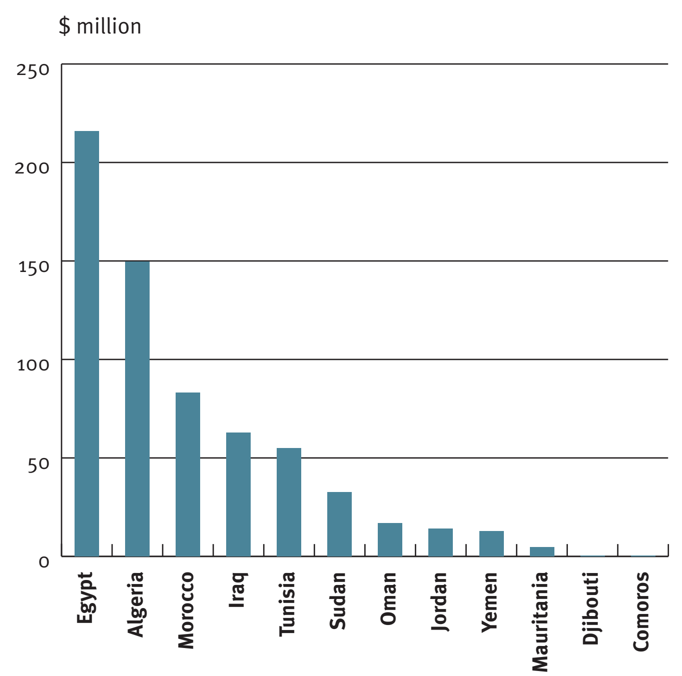
According to the Lebanese Ministry of Environment Report (2001), about 0.5 per cent of per capita expenditures in Lebanon are on bottled water, implying a per capita bottled water consumption of 115 litres a year.[28] The report estimated bottled water consumption associated with perceptions of low municipal

Table 4.2 Estimated total costs attributable to none or lack of provision of improved water and sanitation in selected Arab countries, 2010

Country	Cost of diarrhoeal death	Cost of diarrhoeal illness	Cost of diarrhoeal treatment	Cost of water purchase from vendors	Avertive costs on bottled water	Total cost attributed to none or lack of provision of improved water and sanitation	GDP current	% of GDP
Algeria	837.9	111.8	109.7	165.1	149.6	1374.0	161979.4	0.85
Comoros	7.7	0.7	3.9	1.0	0.3	13.6	541.1	2.52
Djibouti	14.0	1.1	3.6	2.0	0.5	21.1	1049.1	2.01
Egypt	192.2	177.3	286.6	22.2	216.0	894.2	218894.3	0.41
Iraq	655.7	96.5	165.0	182.1	62.7	1162.1	81112.4	1.43
Jordan	24.6	25.0	26.0	6.8	14.1	96.5	26425.4	0.37
Mauritania	57.1	3.9	16.3	48.3	4.7	130.3	3613.9	3.6
Morocco	356.5	61.1	96.1	166.2	83.1	763.0	90802.9	0.84
Oman	45.8	39.7	9.0	9.1	17.0	120.6	57849.2	0.21
Sudan	668.2	73.2	203.3	415.4	32.7	1392.9	66996.5	2.08
Tunisia	56.8	25.9	27.6	17.2	54.9	182.4	44238.2	0.41
Yemen	319.4	36.6	129.1	250.2	12.9	748.2	31042.7	2.41
Arab countries	3235.8	652.8	1076.1	1285.6	648.5	6898.8	784545.1	0.88

Source: Authors' estimates.

Figure 4.2 Estimated avertive costs on bottled water in selected Arab countries, 2010



Source: Authors' estimates.

water quality at an average of 86 litres per capita a year. At an average cost of $0.23 a litre, this represents about $86 million a year in avertive expenditures.[29]

Parker (2010) estimated the world outlook for bottled water across more than 200 countries. For each year, he reported estimates for potential demand, or potential industry earnings from bottled water sales. The estimated demand for bottled water for Arab countries rose from $1,429 million in 2001 to $2,229 million in 2011. The estimates of latent demand for bottled water in 2010 are about $2,090 million.

If one assumes that 50 per cent of bottled water consumption comes from efforts to avoid the health risks of low-quality water, this represents about $648.5 million a year in avertive expenditures in selected Arab countries. Other estimates go much higher.

The Arab countries with the largest populations were burdened with the highest avertive bottled water costs. Egypt and Algeria had the highest, at $216.0 and $149.6 million, respectively (Figure 4.2).[30]

Costs of diarrhoeal death in 2010

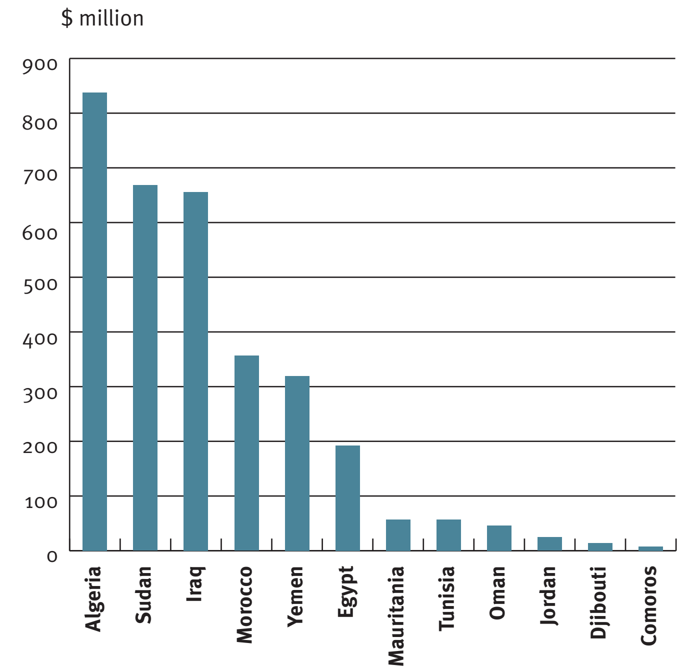
Waterborne disease outbreaks are the most obvious manifestation of the impacts of contaminated water on human health. The Arab region is severely affected. The number of recorded cases of waterborne disease in recent years shows that access to safe drinking water remains a problem. "Diarrhoeal diseases are estimated to be the largest contributor to the burden of water-related disease. Infectious diarrhoea can be caused by bacteria (for example, cholera, E. coli, shigellosis, typhoid fever and so forth); viruses (for example, norovirus, rotavirus and so forth); and protozoan parasites (for example, amoebiasis, cryptosporidiosis, giardiasis)."[31]

WHO and UNEP (2008) estimated that 94 per cent of the 1.8 million annual global deaths from diarrhoeal disease may be attributed to environmental causes—particularly, unsafe drinking water and inadequate sanitation. Not all of these deaths are water-related, but providing adequate drinking water and improved sanitation and hygiene would reduce the frequency of children diarrhoeal deaths by 88 per cent.[32]

Using the most recent data on death/DALYs and age-standardized death rate per 100,000, and assuming that 80 per cent of diarrhoeal cases were due to inadequate drinking water, sanitation and hygiene, we estimated the number of deaths caused by diarrhoea in 2010 in selected Arab countries at 97,583 (1,386,675 DALYs).[33] Applying the human capital approach, and assuming that the value of 1 DALY corresponds to per capita gross domestic product (GDP) in dollars, the annual cost of diarrhoeal death was about $3,235.84 million in selected Arab countries in 2010 (Figure 4.3).

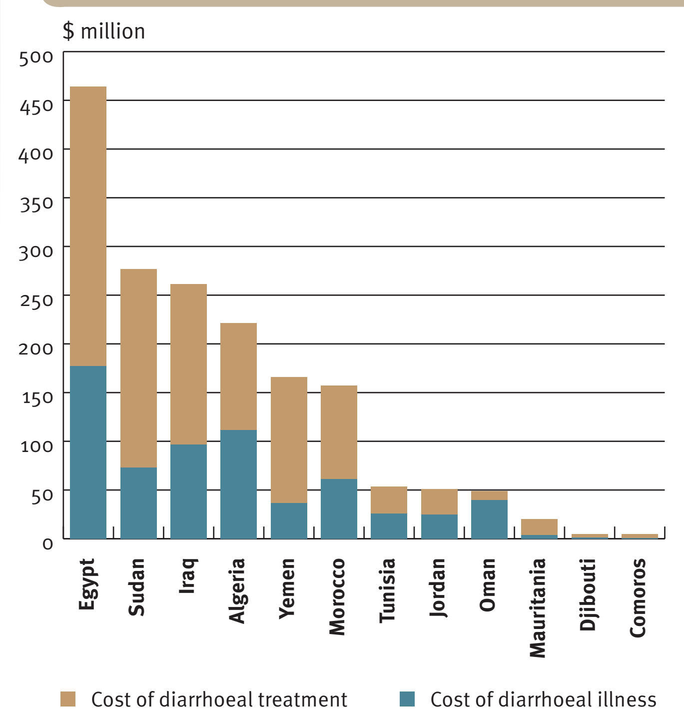
The magnitude of costs due to diarrhoeal deaths in each of these countries may be attributed to the number of diarrhoeal deaths, the number of DALYs per death at country level, as well as prevailing GDP per capita. Costs may thus not always reflect death incidence. Rather, DALYs per death and/or GDP,

Figure 4.3 Estimated cost of diarrhoeal death in selected Arab countries, 2010



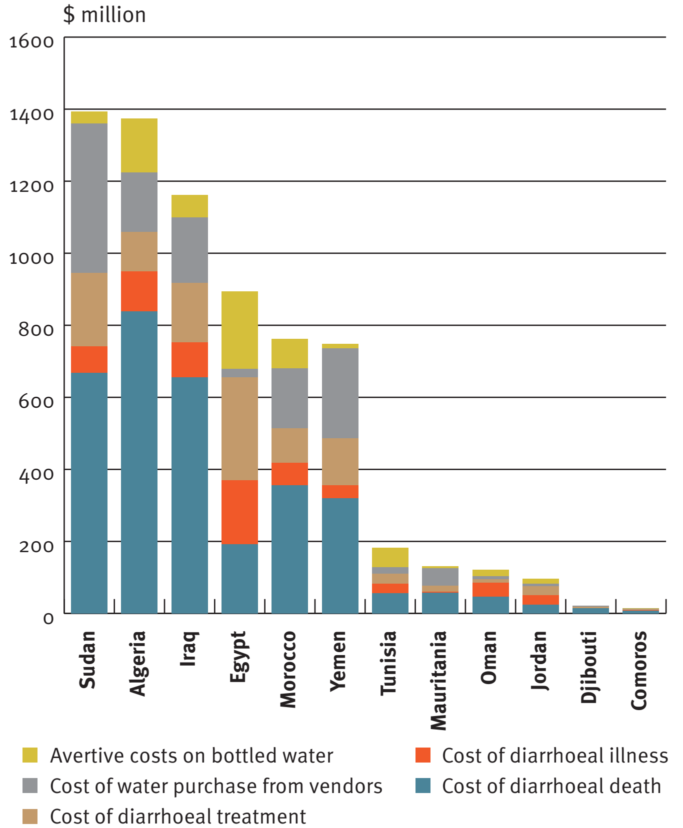
Source: Authors' estimates.

Figure 4.4 Estimated costs of diarrhoeal morbidity (illness and treatment) in selected Arab countries, 2010



Source: Authors' estimates.

Figure 4.5 Estimated costs attributable to lack of provision of improved water and sanitation in selected Arab countries, 2010



Source: Authors' estimates.

even in countries experiencing the same level of diarrhoeal deaths, may also contribute to high death costs.

The highest cost of diarrhoeal death was found in Algeria, Iraq and Sudan, where it exceeded $500 million. Comoros and Djibouti experienced the lowest. This low cost can be attributed to these countries' very low per capita income.

Costs of diarrhoeal morbidity in 2010

Costs of diarrhoeal illness in 2010

To estimate the costs of morbidity (cost of illness and cost of treatment), we calculated the prevalence of diarrhoea in children under five using 2008 WHO data, the most recent available, and 2010 UNDESA population estimates.[34] We assumed that 80 per cent of diarrhoeal cases were due to lack of improved water and sanitation.[35] The cost of illness is represented by the total days lost due to diarrhoea, which were estimated assuming that the average episode of diarrhoea would last five days.[36] The welfare losses due to parents' days lost from work were estimated as the opportunity cost of time equivalent to 15 per cent of daily monetary income, using GDP per capita proxy time value. The number of diarrhoeal morbidity cases among children under five attributed to lack of improved water and sanitation involved DALYs of 239,864 for the selected Arab countries.[37] We estimate the annual cost of diarrhoeal illness at $652.83 million in selected Arab countries in 2010.

Costs of diarrhoeal treatment in 2010

Diarrhoea's complexity and the rising cost of treatment put additional burden on the health sector. To estimate the cost of diarrhoeal treatment in Arab countries, we calculated the annual number of episodes (all children under five) using WHO statistics.[38]

We used per capita public and private health expenditures to estimate the treatment cost of diarrhoeal diseases attributed to unsafe water and sanitation. We assumed the cost of a doctor visit ($8), medicines ($8.5), oral rehydration therapy and caregiver time ($7). As above, the treatment cost for diarrhoea attributed to lack of improved water and sanitation services is 80 per cent of diarrhoeal treatment cost for children under five. The estimated annual cost of diarrhoeal treatment was $1,076.08 million in selected Arab countries in 2010 (Table 4.2). Accordingly, the cost of diarrhoeal morbidity (illness and treatment) was $1,728.91 million in the selected Arab countries in 2010 (Figure 4.4).

The cost of lack of domestic water and sanitation in selected Arab countries is thus about $6,898.81 million for 2010, representing 0.88 per cent of GDP (Table 4.2).

The absolute figures indicate that Algeria, Iraq and Sudan experience the highest cost of inadequate water and sanitation, exceeding $1,000 million (Figure 4.5). The cost in these countries together accounted for $3,928.93 million, about 57 per cent of the cost in Arab countries studied.

Relatively, Comoros, Djibouti, Iraq, Mauritania, Sudan and Yemen experience the highest cost as a proportion of GDP due to inadequate water and sanitation, exceeding 2 per cent.

Projection of water-associated costs for 2010–2020: cost of action versus cost of inaction

To demonstrate the benefit of improving water and sanitation, we extrapolated the costs of lack of these services for 2010–2020 and estimated the required investment for universal provision over the same period. These estimates should show the magnitude of investment return. All calculations are undiscounted and estimated using 2010 prices.

Cost-effectiveness analysis can help assess and select the most economically efficient measure to meet escalating water demand. Several measures can be taken to achieve the goal of universal water and sanitation provision involving different technologies, approaches and funding mechanisms. By considering the costs of inaction, one can evaluate the costs of various actions to select the optimal one.

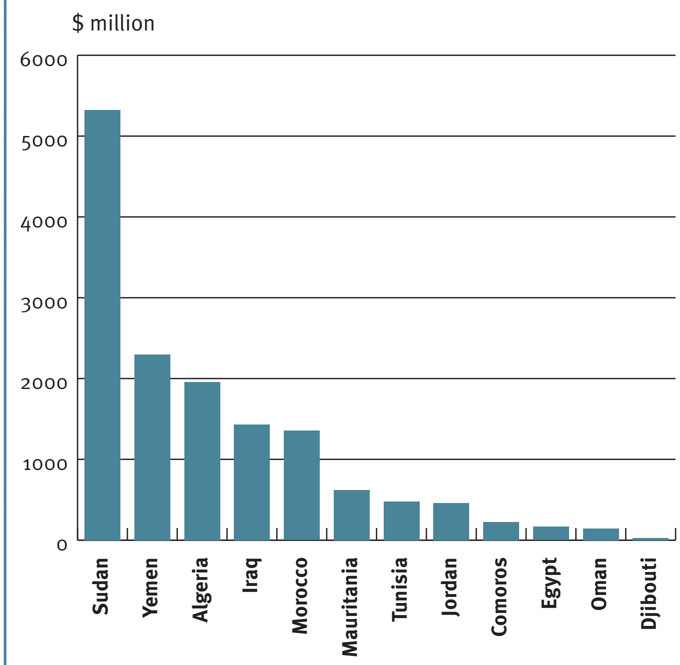
If no action is taken to improve domestic water and sanitation, the number of people lacking these services in the Arab region is expected to reach at least 76 million and 103 million, respectively, by 2020.[39] This lack of improved water and/or sanitation, typically associated with waterborne illnesses and mortality, will incur social costs.[40]

The values in tables 4.3 and 4.4, calculated using the same methods as for Table 4.2, relate to the cost of inaction. All these costs can be converted to benefits if and when drinking water and sanitation are improved and extended. This conversion will require effective water governance.

Costs of buying water from vendors for 2010–2020

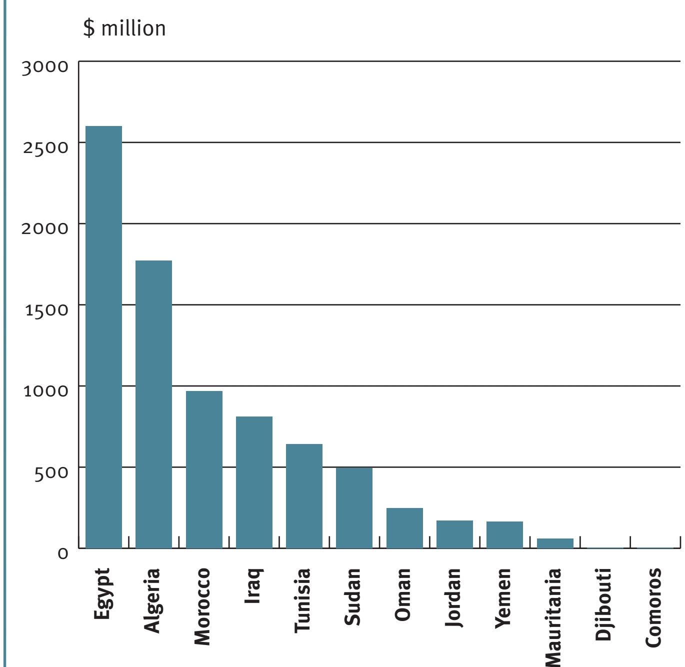
By 2020, 76 million people in the Arab region are expected to lack access to safe drinking water. They will therefore rely on private vendors, springs, water harvesting and so forth to secure

Figure 4.6 Projected costs of water purchase from vendors in selected Arab countries, 2010–2020



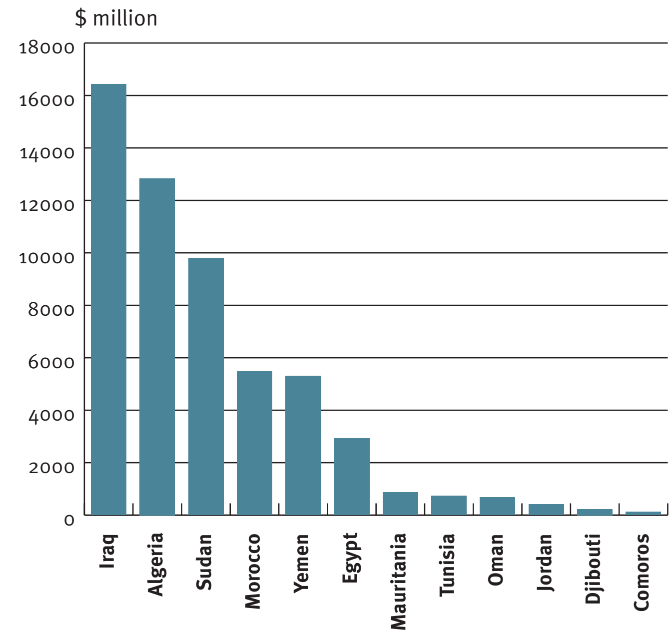
Source: Authors' estimates.

Figure 4.7 Projected avertive costs on bottled water in selected Arab countries, 2010–2020



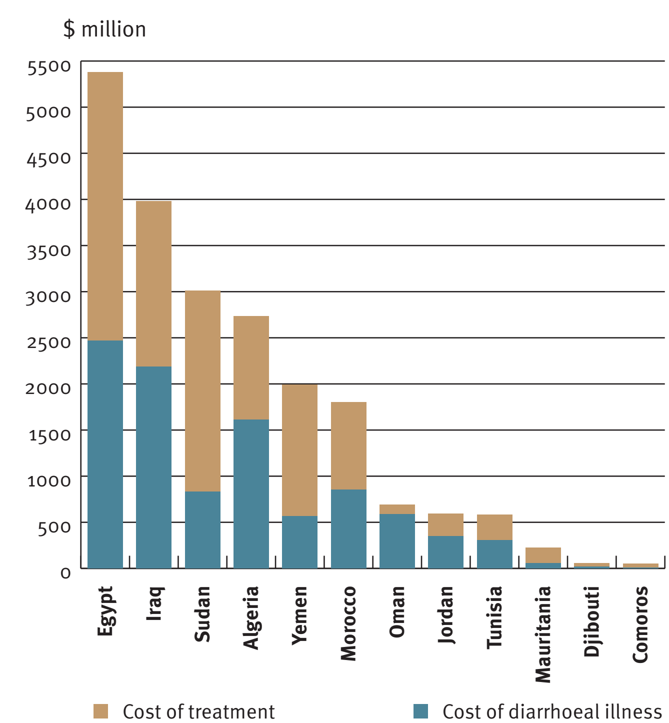
Source: Authors' estimates.

Figure 4.8 Projected costs of diarrhoeal death in selected Arab countries, 2010–2020



Source: Authors' estimates.

Figure 4.9 Projected costs of diarrhoeal morbidity (illness and treatment) in selected Arab countries, 2010–2020



Source: Authors' estimates.

their water needs. The cost of water purchase from vendors for 2010–2020 in selected Arab countries will be about $14,481.11 million (Figure 4.6, Table 4.3).

Arab countries with the highest spending on water vendors from 2010 to 2020 include Algeria, Iraq, Morocco, Sudan and Yemen, with $1,955.6; $1,430.62; $1,353.37; $5,322.10; $2,298.53 million, respectively.

Avertive costs on bottled water for 2010–2020

Assuming that current trends of bottled water consumption prevail, the average latent demand for bottled water from 2010 to 2020 is estimated at $15,882.72 million.[41] Assuming that 50 per cent of bottled water consumption is related to the health risks of low-quality drinking water, this represents a cumulative avertive cost from bottled water of about $7,941.36 million in selected Arab countries (Figure 4.7, Table 4.3).

Costs of diarrhoeal death for 2010–2020

The number of deaths attributed to lack of water and sanitation is about 992,363 for 2010–2020 for the selected Arab countries. This amounts to 18,339,459 DALYs over the same period. Applying the human capital approach, and assuming that the value of 1 DALY corresponds to the per capita GDP in dollars, the estimated annual cost of diarrhoeal death in the selected Arab countries is $55,839.63 million for 2010–2020 (Figure 4.8, Table 4.3).

Costs of diarrhoeal morbidity (illness and treatment) for 2010–2020

Costs of diarrhoeal illness for 2010–2020

The number of diarrhoeal cases among children under five attributed to lack of water and sanitation is expected to lead to a loss of DALYs of 2.734 million for the selected Arab countries for 2010–2020. The cumulative cost of diarrhoeal illness is accordingly about $9,847.82 million in selected Arab countries over the same period (Table 4.3).

Treatment is estimated at $11,254.54 million for 2010–2020.

If one adds illness and treatment costs, the cost of diarrhoeal morbidity cases related to inadequate drinking water and sanitation in

Table 4.3 Estimated costs attributable to none or lack of provision of improved water and sanitation in selected Arab countries, 2010–2020 ($ million)

	Cost of diarrhoeal death	Cost of diarrhoeal illness	Cost of diarrhoeal treatment	Cost of water purchase from vendors	Avertive costs of buying bottled water	Total cost attributed to none or lack of provision of improved water and sanitation
Algeria	12,839.6	1,610.0	1,126.2	1,955.6	1,771.9	19,303.3
Comoros	119.8	10.0	40.8	226.1	4.1	400.9
Djibouti	232.0	17.4	38.3	27.5	5.7	320.9
Egypt	2,926.0	2,468.1	2,914.1	165.7	2,599.8	11,073.6
Iraq	16,433.4	2,189.1	1,789.6	1,430.6	810.6	22,653.3
Jordan	409.3	347.5	246.6	461.0	171.2	1,635.5
Mauritania	867.0	55.0	173.4	619.0	58.5	1,772.9
Morocco	5,484.8	855.4	946.4	1,353.4	968.3	9,608.4
Oman	673.7	589.9	100.6	145.2	246.8	1,756.0
Sudan	9,807.5	830.0	2,179.1	5,322.1	495.6	18,634.3
Tunisia	736.8	307.6	274.0	476.6	643.0	2,438.0
Yemen	5,309.7	567.9	1,425.5	2,298.5	165.9	9,767.5
Total	55,839.6	9,847.8	11,254.5	14,481.1	7,941.4	99,364.5

Source: Authors' estimates.

selected Arab countries is about $21,102.36 million for 2010–2020 (Figure 4.9, Table 4.3).

The cost of lack of domestic water and sanitation in selected Arab countries is thus about $99,364.46 million for 2010–2020 (Table 4.3).

Figure 4.10 presents the cost of inaction—that is, maintaining the current trends and percentages of water and sanitation provision. These costs, no matter who covers them, are social costs. This estimate is extremely conservative: we considered only avertive and direct health costs. Including environmental, social and political costs would make these estimates much higher.

The cost of action: direct investment in water and sanitation for 2010–2020

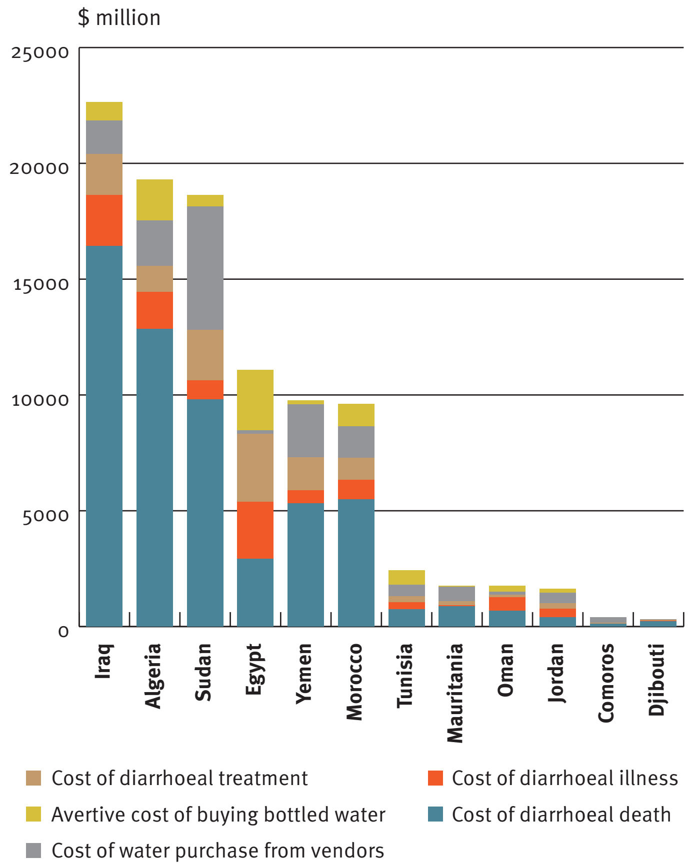
Upgrading water and sanitation, an established international goal, is vital to livelihoods and social well-being in Arab countries. MDG 7, which all Arab countries have committed to, calls for substantive increase in providing water and sanitation.

Many countries have made major progress. UNICEF (2008) indicated that about 84 per cent of the Arab population had access to improved water in 2006. This means about 50 million out of 324 million Arabs, mostly in Algeria, Iraq, Morocco, Somalia, Sudan, Syria and Yemen did not have a secure water supply.[42] Achieving 100 per cent provision of clean water is required. But other issues are also necessary, such as equity; accountability and transparency; efficient distribution; affordability for consumers; and water quality, reliability and sustainability. All these issues relate to efficient water governance.

To estimate the cost of action to achieve universal water and sanitation provision, we calculated the number of people who would lack access to improved water and sanitation for 2010–2020, based on population projections and current provision levels. Using the WHO cost estimate averages for water and sanitation provision per household, we then calculated capital and recurrent costs.[43]

We carried out an incremental cost analysis, estimating the costs of extending access to water

Figure 4.10 Projected costs of low-quality water and sanitation provision in selected Arab countries, 2010–2020



Source: Authors' estimates.

and taking population growth into account. The main data source for initial investment costs of water and sanitation interventions was the WHO global water and sanitation assessment 2012 report.[44] The WHO report provided annual capital and recurrent costs for a typical water and sanitation project, assuming a project lifespan of twenty years. These annual figures provided by the WHO were multiplied by the number of remaining years to 2020. Provision in 2010 and 2011, for instance, would involve annual capital and recurrent costs for 11 and 10 years, respectively.

We estimated that 100,406 million and 209,676 million households in selected Arab countries need improved water and sanitation, respectively, for 2010–2020 (Figures 4.11 and 4.12).[45] The cumulative costs of providing improved water for 2010–2020 were estimated at $19,692.35 million. The cumulative costs of providing sanitation over the same period were found, as expected, to be higher, at $52,531.64 million. This brings the capital and recurrent costs of providing improved water and sanitation in selected Arab countries for 2010–2020 to $72,223.99 million (Table 4.4).

Rate of return on investment in water and sanitation for 2010–2020: action vs. inaction

To assess the economic viability of potential actions to improve domestic water and sanitation provision, we made undiscounted estimates of the required investment for 2010–2020. If these actions are undertaken (Table 4.4), the costs of inaction (Table 4.3) will represent the benefits for each country.

The investment required for universal provision of improved water and sanitation varied considerably among countries. They reached as high as $8,217.06 million, $8,484.21 million, $30,187.13 million and $12,722.43 million in Iraq, Morocco, Sudan and Yemen, respectively (Table 4.5).

The returns on investment in improved water and sanitation are huge (Figure 4.13). And the above estimates do not capture all the social and environmental costs of inaction, such as time wasted by household members to obtain water or get rid of wastewater. Estimating and incorporating such costs would significantly increase these estimates and, accordingly, the rate of return.

But the rate of return on such provision varies considerably, with countries such as Algeria, Egypt, Iraq and Oman reaching 39.35 per cent, 13.36 per cent, 15.97 per cent and 52.37 per cent, respectively (Figure 4.14). Such high rates of return are associated with the limited amount of investment needed for universal provision of improved water and sanitation, relative to potential benefits in avoided health costs. On the other hand, rates of return were negative for poorer Arab countries with lower GDPs per capita and much lower water and sanitation coverage, such as Sudan and Yemen, mainly because all

Table 4.4 Estimated required investment in water and sanitation services provision, 2010–2020 ($ million)

Country	Total capital cost for water provision	Total recurrent cost for water provision	Overall total cost of water provision	Total capital cost for sanitation provision	Total recurrent cost for sanitation provision	Overall total cost of sanitation provision	Overall cost of water and sanitation services provision
Algeria	1,485.6	830.5	2,316.1	700.2	606.0	1,306.2	3,622.3
Comoros	12.5	7.0	19.5	146.4	52.8	199.2	218.7
Djibouti	39.9	22.3	62.2	170.3	51.9	222.2	284.4
Egypt	326.8	182.6	509.4	2,130.7	1,844.3	3,975.0	4,484.4
Iraq	1,502.6	839.7	2,342.3	3,149.0	2,725.8	5,874.8	8,217.1
Jordan	36.1	20.2	56.3	42.4	36.7	79.0	135.3
Mauritania	332.7	185.9	518.6	872.5	755.2	1,627.7	2,146.3
Morocco	1,245.0	696.0	1,941.0	3,507.3	3,035.9	6,543.2	8,484.2
Oman	86.8	48.5	135.3	66.7	57.7	124.4	259.7
Sudan	4,564.5	2,551.0	7,115.5	12,367.0	10,704.7	23,071.7	30,187.1
Tunisia	173.4	97.0	270.4	638.7	552.9	1,191.6	1,461.9
Yemen	2,826.4	1,579.4	4,405.7	4,458.0	3,858.8	8,316.7	12,722.4
Total	12,632.4	7,060.0	19,692.4	28,249.0	24,282.6	52,531.6	72,224.0

Source: Authors' estimates.

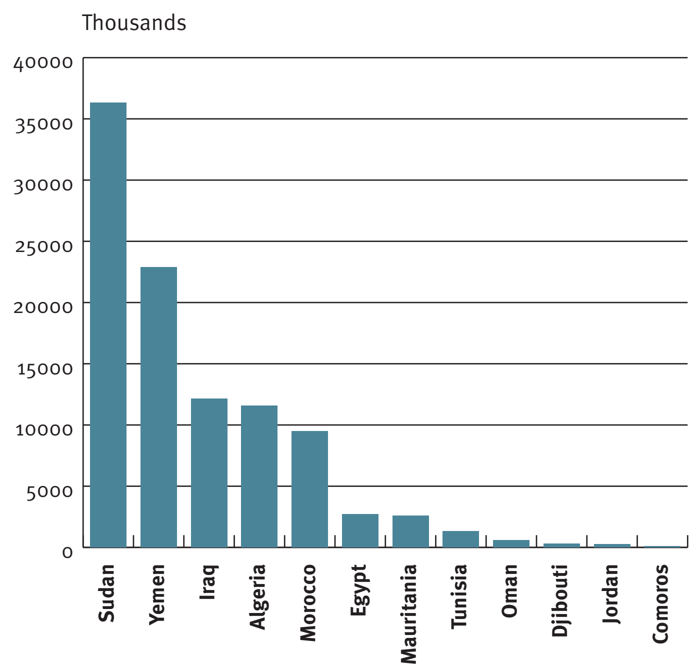
investment figures calculated in this report are based on average house connection costs. Also, when the rate of return is negative, provision options other than house connections must be explored. Options may vary in technologies, approaches and execution modalities. In Yemen, for example, using wells and septic tanks for water and sanitation provision would decrease costs enough to make the rate of return 54.22 per cent.

The goal should be to identify the optimal intervention with the highest rates of return to achieve universal water and sanitation coverage—a goal that cost-effectiveness analysis can help achieve.

Proper valuation of water and cost-effectiveness analysis: tools for establishing effective water governance

Improper valuation of water has marred management and governance approaches, with negative socio-economic and environmental repercussions. Water's value can and should be

Figure 4.11 Projected cumulative number of households without access to improved water in selected Arab countries, 2010–2020



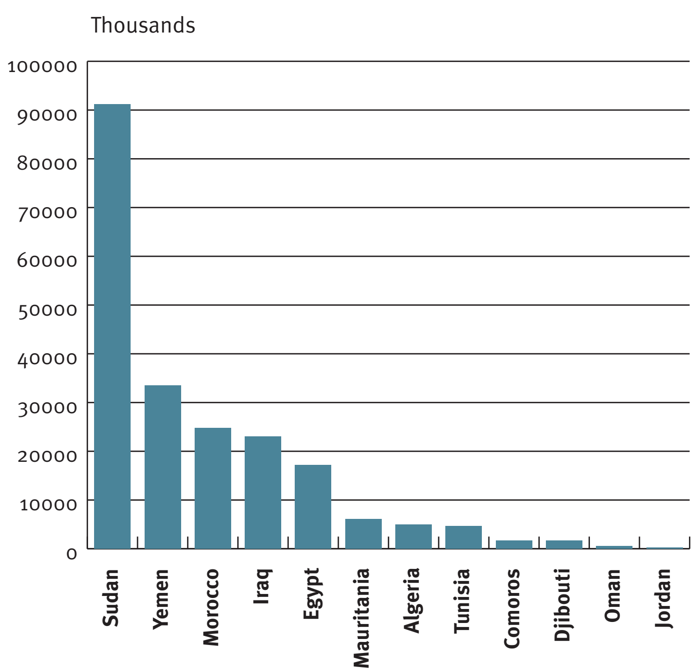
Source: Authors' estimates.

Table 4.5 The expected cost and benefit of action and expected rate of return on investment in improved water and sanitation provision for 2010–2020

Country	Required investments in provision of water and sanitation services ($ million)	Potential benefit (avoided total cost attributed to none or lack of provision of improved water and sanitation; ($ million)	Rate of return (%)	Average annual rate of return (%)
Algeria	3,622.3	19,303.3	432.9	39.4
Comoros	218.7	400.9	83.3	7.6
Djibouti	284.4	320.9	12.8	1.2
Egypt	4,484.4	11,073.6	146.9	13.4
Iraq	8,217.1	22,653.3	175.7	16.0
Jordan	135.3	1,635.5	1108.7	100.8
Mauritania	2,146.3	1,772.9	–17.4	–1.6
Morocco	8,484.2	9,608.4	13.3	1.2
Oman	259.7	1,756.0	576.1	52.4
Sudan	30,187.1	18,634.3	–38.3	–3.5
Tunisia	1,461.9	2,438.0	66.8	6.1
Yemen	12,722.4	9,767.5	–23.2	–2.1
Total	72,224.0	99,364.5	37.6	3.4

Source: Authors' estimates.

Figure 4.12 Projected cumulative number of households without access to sanitation services in selected Arab countries, 2010–2020



Source: Authors' estimates.

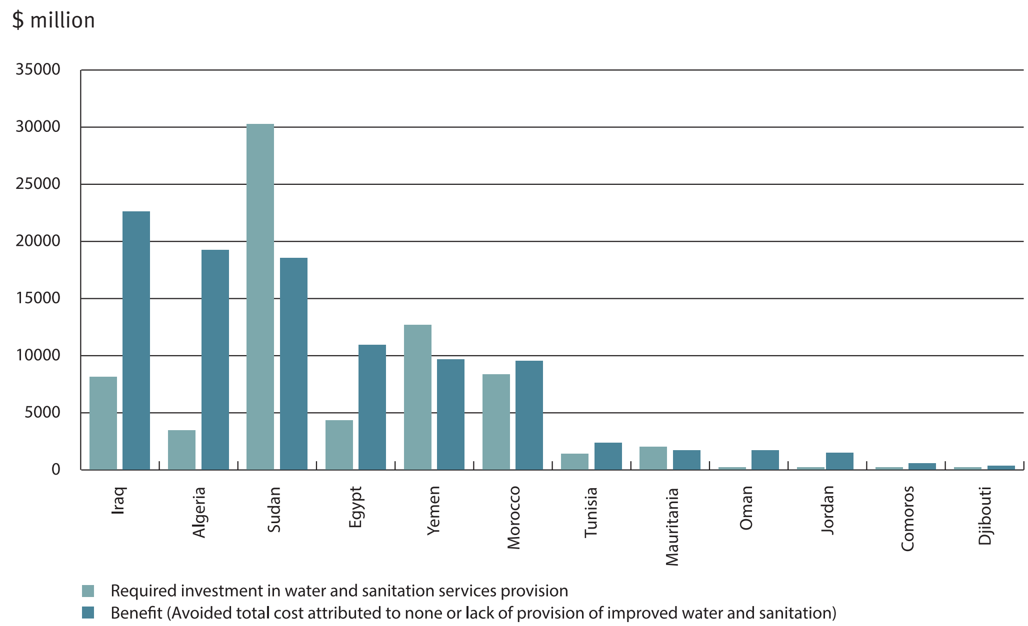
calculated with attention to social, economic and environmental dimensions.

Action (achieving universal water and sanitation coverage) is clearly feasible and has a higher rate of return than inaction (continuing prevailing water governance structures and practices). Several potential approaches to this goal can be identified, all with different costs. Cost-effectiveness analysis thus comes in handy. The approach presented above for calculating the costs of action and inaction can be replicated for each option; the expected return and benefit of each option will help identify the most cost-effective option.

Cost-effectiveness analysis can help decision-makers limit the gap between demand and supply as they work to achieve effective water governance. By assessing policy options with attention to all the economic, social and environmental variables, cost-effectiveness analysis helps establish consensus among stakeholders. It reveals the health, political and environmental benefits of improved water and sanitation. The proper valuation of water, through cost-effectiveness analysis, guides decision-makers in assessing the efficiency and costs of alternative water management strategies.

Figure 4.13

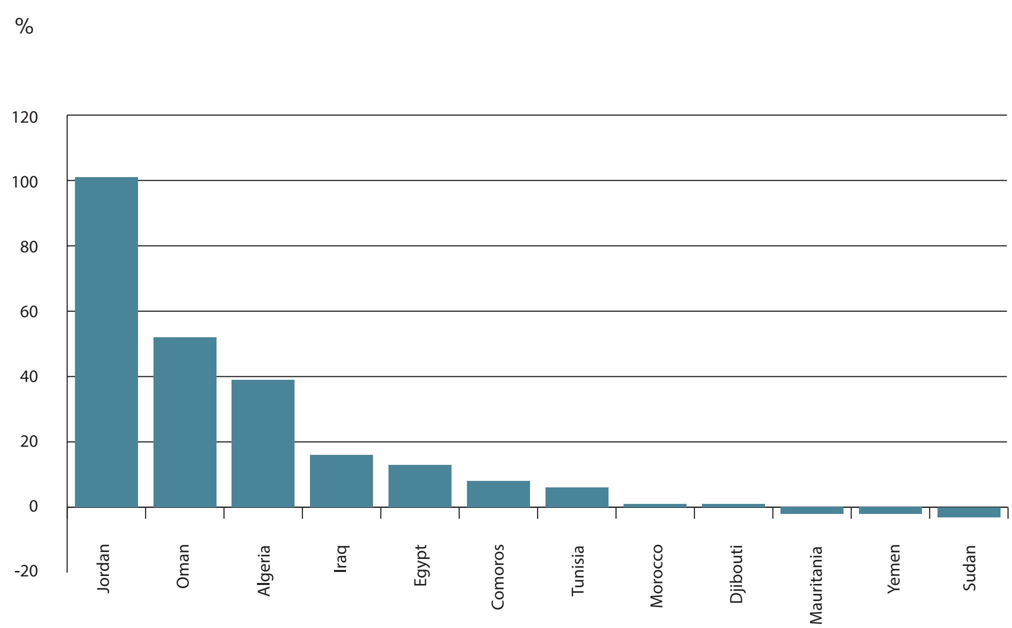
Water and sanitation in selected Arab countries: projected cost of action versus cost of inaction



Source: Authors' estimates.

Figure 4.14

Estimated average annual rate of return on investments in water and sanitation provision in selected Arab countries, 2010–2020



Source: Authors' estimates.

Endnotes

[1] NWRI 2003.

[2] For example, hydroelectric power generation companies estimate water's value by the quantity of electricity it can produce. Fishermen assess the value of water and water quality by the number and size of the fish they can catch (Ramachandra, Rajanikanth, and Ranjini 2005).

[3] Gibbons 1986.

[4] Willingness to pay is the price ($/amount) that a buyer is willing to give up (opportunity cost) to acquire a good or service.

[5] Mitchell and Carson 1989.

[6] Young 2005.

[7] Young 2005; Turner and others 2004.

[8] Market failure, in economic theory, is the market's inability to allocate goods and services optimally among sectors and/or uses within sectors.

[9] Abdrabo 2003.

[10] Taylor 2003; Young 2005. In economics, external costs or benefits, or negative and positive externalities, are borne/obtained by a third party not directly involved in market transactions—that is, not a producer or consumer. Third parties are thus not taken into account by the market system.

[11] Koundouri 2000.

[12] OECD 2011.

[13] Hutton, Haller, and Bartram 2006. DALYs (disability-adjusted life years) for a disease or health condition are calculated as the sum of the years of life lost (YLL) and years lost due to disability (YLD).

[14] WHO and UNEP 2008.

[15] OECD 2007.

[16] Hutton and Haller 2004.

[17] WHO 2011.

[18] OECD 2007.

[19] Hutton and Haller 2004.

[20] Molle and Berkhoff 2005.

[21] Assumptions and calculations presented in this section are based on the work of two core Arab Water Report team members, Dr. Mohamed Abdrabo and Dr. Emad Karablieh.

[22] EC 2009.

[23] Willingness to pay represents the maximum amount of money a person or a household would be willing to pay for water, taking benefits into account. Such willingness to pay would depend on household income, water use efficiency and frequency (toilets, appliances, among others) and the relative prices of other goods and services purchased by the household.

[24] The estimated costs represent only part of the economic costs associated with lack of water and sanitation in Arab countries. Most of the environmental, social and political costs are not included due to inadequate data and information. Costs, and consequently benefits, will rise once all costs are included.

[25] WHO and UNICEF 2010.

[26] Whittington, Lauria, and Mu 1991.

[27] Gleick 1996. Willingness to pay augments water supply by private vendors in Jordan in rural areas and during network supply failure and interrupt pumping in urban areas at about $6 per cubic metre; in Yemen this figure is about $3–$4. An average of $1.5 per cubic metre is used here as a very conservative estimate to take variations in living standards into account.

[28] Sarraf, Larsen, and Owaygen 2004.

[29] Sarraf, Larsen, and Owaygen 2004.

[30] Due to lack of data and information on municipal water quality, these estimates are based mainly on population size.

[31] OECD 2007.

[32] WHO 2011.

[33] WHO 2004, 2008a.

[34] WHO 2008a; UNDESA 2011.

[35] This age group is considered to be the most vulnerable to diarrhoeal disease.

[36] WHO 2012.

[37] Many more cases of nonfatal diarrhoeal diseases occur each year, not only causing illness but also incurring treatment costs, caregiver time and earning losses of parents. The cost-of-illness approach estimates these cost components. DALYs lost to morbidity have also been valued to account for the cost of pain and suffering not included in the cost-of-illness approach (World Bank 2003).

[38] WHO 2008b.

[39] These estimates are conservative; other estimates are higher (WHO and UNICEF 2010).

[40] World Bank 2004b.

[41] Parker 2010.

[42] UNICEF 2008.

[43] WHO 2011.

[44] WHO 2012.

[45] We used the national average household size prevailing in 2010 to estimate the number of households up to 2020.

Chapter 5

Building blocks of effective water governance in the Arab region

This chapter provides an in-depth description of the major building blocks of effective water governance. These building blocks include reorienting water policy, enforcing legislations and regulations, financing the water sector, developing organizational capacities, monitoring and evaluating, managing data and information, coordinating regional and international cooperation, educating and raising awareness, promoting stakeholder participation and empowerment, ensuring water rights and social equity, increasing water use efficiency and improving links between research and management.

Effective water governance in the Arab region consists of several mutually reinforcing blocks, including policy reorientation, institutional reform, stakeholder empowerment, and R&D. The ultimate goal is to establish efficient water management practices that align with socio-economic and environmental conditions. Overall local, regional and global governance affect water governance, as do socio-economic realities and aspirations. Other influencing factors include food security, climate change and the water-energy nexus.

Reorienting policy

Formulating water policy involves many decisions, actors and processes. There are two policy-making models. In the first—the linear, idealized, input-output model—the typical stages are inputs (the policy's basis), content, implementation and a feedback loop. In the second, nonlinear model, actors with different interests, stakes and powers try to influence the outcome. The actors and process depend on the challenges the policy is intended to address. The nonlinear model reveals some of the critical factors that now shape policy. Because policy must be implemented at local levels, local organizations and regulations greatly affect water management and the potential for effective water governance.[1] Interventions and priorities may change depending on the situation or place.

Shifting from crisis management to sustainable effective governance

The region's natural water scarcity puts continual pressure on water systems and institutions. Water management has functioned mostly in crisis mode to meet rapidly escalating demands. The objective has been simply to provide water to as many people as possible. Unfortunately, principles and practices of effective water governance have been ignored and social, economic and environmental dimensions disregarded. Effective governance practices, including engaging stakeholders and addressing equity issues, have rarely been implemented. Short-term solutions to "put out fires" have prevailed over long-term planning. In many cases, institutions responsible for formulating policy have had conflicting and/or ambiguous mandates and little effective coordination.

Several countries, such as Bahrain, Djibouti, Egypt, Jordan, Lebanon, Libya, the State of Palestine, Saudi Arabia, Syria, Tunisia and Yemen, have national water policies, plans or strategies that incorporate many IWRM elements, and thus effective water governance. Several have striven to improve accountability and stakeholder involvement in water decisions. But these efforts are not yet reaching their intended goals. Transformation to a more flexible, adaptive water management system must go hand-in-hand with growth and economic diversification. People must better understand the forces that lead to policy development and ensure that policies are implemented. Improved accountability and other governance mechanisms inside and outside the water sector will be crucial for this transformation.

Despite progress, the Arab region still faces water scarcity due to inadequate physical resources, organizational capacities and accountability.[2] Governments have invested heavily in engineering-based, supply-driven programmes and projects. Wells have been dug, water channels extended and dams erected to enhance supply and storage. But the challenge of meeting escalating water demands persists.

A new approach to water governance is urgent. To address the widening gap between supply and demand, one should encourage practices and policies that can sustainably manage demand. The top priority for adaptation in the water sector should be reducing the vulnerabilities of poor and disadvantaged people.

The political will to provide effective water governance

Strong political will is a fundamental requirement for good water governance. It is a prerequisite for economic, legal and institutional implementation of plans for effective water governance.

The Global Water Partnership Framework for Action stated that the "water crisis is often a crisis of governance" and identified effectiveness as one of the highest priorities for action.[3] Effective water governance has been reinforced and built upon in many declarations and conference statements at the global level by ministers and heads of states (for example, the 2000 Hague Ministerial Declaration, the Bonn 2001 Freshwater Conference, the UN 2000 Millennium Assembly and the 2002 World Summit on Sustainable Development). At the Bonn Freshwater Conference in 2001 ministers recommended action in three areas, with water governance being the most important. They proposed that each country make applicable arrangements for water governance at all levels and accelerate water sector reforms where needed.

But despite these commitments, there seems to be only limited success. The most important impediment is the dominance of hierarchical and market-led—rather than distributed—governance systems (Box 5.1).[4] We must raise the political will to overcome obstacles to change; we must develop and reform our water institutions and establish an enabling environment for IWRM principles and policies. Examples of good, though limited, water management practices in the Arab region include:

Consolidating fragmented water institutions under one authority and separating the water authority from agriculture (the main water consumers) (for example, Saudi Arabia, Yemen).

Establishing higher water councils for setting water policies and coordinating water institutions (for example, Algeria, Bahrain, Egypt, the State of Palestine and Qatar).

Implementing demand management in agriculture based on community actions and cumulative knowledge (for example, Tunisia)

Developing water policies and strategies based on consultations with stakeholders, including government officials, politicians, water user associations, local communities and the private sector (for example, Egypt, Jordan, Morocco, Tunisia and the State of Palestine).

Box 5.1 **Governance systems: hierarchical, market-led and distributed**

Hierarchical governance: Part of modernization is the evolution of governance from top-down, hierarchical systems with centralized institutions to more decentralized administrative settings. There is no evidence that decentralized systems are more effective than centralized ones. But what works in particular settings? There is an ever-widening gap between countries that have moved towards subsidiarity—performing functions at the lowest effective level—and countries that remain centralized and stagnant. The above-mentioned forces for change will have an even greater impact in poorer countries, as expectations rise for a better quality of life. There is a growing dissatisfaction with ineffective but costly state machinery, lack of vision or leadership, weak financial discipline and political dictates that cripple administrative functions. In distributed governance, rich and poor countries are growing apart; more mechanisms exist in developed countries to establish the required new governance systems. Less developed countries must establish their own governance systems by learning from, but not imitating, models from richer countries with different historical and cultural backgrounds.

Market-led governance: With the end of the cold war, many proposed the market as the solution to economic growth, social equity and environmental problems. This led to deregulation, greater private sector involvement and a changed role for the civil service and civil society. This restructuring reduced government control and promoted private enterprise, with the market as the superior resource allocation mechanism.

Today the laissez-faire market-led model is often considered simplistic (hierarchies may not work well, but markets do not necessarily work well either in all situations) and not representative of wider societal values. More people are examining new instruments and forms of exchange between state and society to ensure political control and societal support, such as partnership, co-management, co-governance and distributed governance.

Distributed governance: Local networks (civil society, private sector) and global networks (international organizations and NGOs), even as they support the state's development goals, are challenging the state's role of "directing" or "steering" society. Many politicians (mainly in the West) now see the state as part of the problem rather than the solution. Reversing the post–Second World War ideology of a hierarchical central state caring for its citizens, they are calling for a return to smaller government. Neither the state nor the private sector can solve societal—especially socio-environmental—problems alone.

Source: Rogers and Hall 2003.

Decision-making processes: Centralization versus decentralization

Community organizations and non-governmental organizations (NGOs) in the Arab region are becoming more involved in planning processes.[5] Consulting with stakeholders and, if necessary, revising investment programmes will strengthen accountability in water governance and management. Decentralization could improve relations between central agencies and local communities in water production and distribution. Democratic decentralization would promote cooperation with central agencies and encourage poor people to express their demands and satisfy their needs.

Implementation and monitoring

Governments often fail to implement and monitor policy reforms. "There is a tendency to separate policy-making processes from implementation and monitoring. The problem is that policy-making is ascribed to decision-makers, while implementation is linked to administrative capacity. This way of thinking is too rigid and fails to acknowledge that policies are often modified as they move to local levels for ultimate enforcement. Policy-makers should not escape the responsibility of implementation and making sure that adequate capacities and funding is available for effective implementation."[6] Monitoring is the "interactive link" between formulating policy and implementing reform. With effective monitoring, policies can be fine-tuned, allowing for financial reallocation between reform priorities. Stakeholders must also be able to monitor the quality of decisions and how they are implemented. Noncompliance with and unenforceability of water reforms are due mainly to lack of inspection and monitoring capabilities; lack of procedures and rules for investigating violations and assessing penalties; and lack of empowerment and authority to compel compliance through court actions. Arab countries should develop monitoring indicators for water reform progress and impacts. Establishing a regional monitoring system—particularly for transboundary waters—could contribute to better understanding of problems and promoting solutions. Indicators should be structured to monitor and assess the enabling environment, institutional frameworks and management instruments.

Many Arab countries are changing their water governance practices through policies, legislation, regulations and monitoring systems. The Third International Forum on Water Governance in the MENA Region in Marrakech, Morocco, 9–13 June 2008, identified the main impediments and action mechanisms for policy implementation. The forum strongly recommended establishing effective water monitoring systems with clearly defined benchmarks and indicators.[7]

Reforming institutions

Institutions are more than organizational structures. They consist of three interactive components—law, policy and administration—that create norms, rules and legal systems affecting natural resource governance and management.[8] Institutions comprise systems of laws, regulations, decrees, organizational arrangements, customs, markets, and economic and financial instruments.[9] Institutional frameworks are influenced by the socio-economic, political and resources-related conditions they operate in, but can significantly affect incentive and disincentive structures. If appropriate, such structures can serve environmental protection and social needs.[10] Institutions involve not only formulating and enforcing policy, but also distributing decision-making among authority levels, both vertically and horizontally.

Arab countries are behind in reforming their water sectors.[11] Weak institutional frameworks are frequently to blame. Implementing new legislation proves to be rather slow because of lack of financial resources, insufficient technical equipment and human resources, lack of political will to enforce legal regimes that contradict local institutional regimes, and the vested interest of political and economic elites. The efficiency of existing institutions, the extent and effectiveness of enforcement capabilities and the potential net benefits of their enhancement affect the enforcement of laws and regulations.[12]

There is almost a consensus about a few basic principles. "A good framework for initiating and advancing water policies will not be achieved without an interaction of knowledge and politics within an institutional setting. However, the water policy environment in Arab countries is far more influenced by the politics of entrenched interests and asymmetric power relations than by a knowledge-based discourse. Water stakeholders do not have well-developed institutional mechanisms to get their voice heard."[13] Proper institutional arrangements can directly contribute to the success or failure of good water governance practices, including designing, executing and managing water projects.

Human resources cannot develop fully without adequate institutional capacity, including the resource base and management capacity. The resource base comprises the organization's personnel, facilities, technology, knowledge and funding; management capacity comprises procedures, programmes and external relationships.

Several Arab countries are improving water and sanitation institutions to address problems "such as unclear lines of responsibility for operations, low tariffs and political interference in staffing policies and other aspects of operations."[14] They are shifting to more client-oriented approaches and making governance more efficient, transparent, accountable and equitable. Successful examples from Egypt, Jordan, Morocco and Tunisia mostly involve private companies.

Capacity building and development

Deficiencies in human resources are key contributors to water scarcity. Capacity building, training and organizational development constitute a cornerstone for developing the water sector.

Capacity development requires enhancing human resources, strengthening institutional capacity and creating an enabling environment to end the current divides that hinder sustainable development. A successful organization should develop an efficient decision-making structure, an effective partnership with all stakeholders, "a spirit of transparency, sharing responsibility and delegation with accountability, a sense of ownership by all involved and attractive term of services for its employees."[15] The 2008 establishment of the Arab Water Academy of the Arab Water Council as well as the Arab Water Ministers Council may provide important opportunities for capacity development.

Coordinating institutions

Good governance requires good relationships between relevant organizations with separate mandates and responsibilities. Most of these organizations—whether community- or government-led—have little formal or practical authority and insufficient resources. Interagency competition for budgets and other resources impedes coordination. As competition for water from sectors (for example, hydropower and agribusiness) and users (for example, upstream and downstream) increases, major challenges remain, such as clarifying mandates, coordinating agencies, collaborating across sectors, managing disciplinary and administrative boundaries, and planning multisector/multi-stakeholder consultations. Governance must be both top-down and bottom-up and embedded into all spheres of water management.

Coordination between different water-related institutions in any Arab country is a major water governance issue (Box 5.2). Rivalries between water institutions are common, and the responsibilities of each body are not always clearly established. Inefficient water delivery is often the outcome. There is an urgent need for institutional reform in almost all water-related institutions.

Transparency and accountability

Dialogue and participation are not enough to achieve good governance. They must be targeted towards correct decisions based on clear consensus. Stakeholders must be able to monitor the quality of decisions and how they are implemented and compare performance with that of other regions or countries. This process will improve the likelihood of good decisions. Transparency is not an end in itself, but authorities should be held accountable. Accountability makes good governance much more likely.

Water allocations based on social priorities, not the needs of small special-interest groups, require strong mechanisms of external accountability. Increased education, urbanization,

Box 5.2 Polycentric governance

Polycentric governance systems disperse political authority to separate bodies with overlapping, non-hierarchically related jurisdictions. Adaptive management literature suggests that a management system should have multiple centres of power (polycentric) rather than one (monocentric). Skelcher (2005) suggests that even with state-centric models, governance was never completely monocentric. Today the "old-fashioned" mutual exclusivity between jurisdictions operating at the same level and the rational, hierarchical ordering of jurisdictions at different levels has been abandoned. Replacing it is a system with a more diffuse underlying order, a different division of authority and a more complicated set of hierarchical relationships and "political spaces."

The suggestion behind polycentric governance was that local communities all face their own problems and that their skills and local knowledge place them in the best position to address these problems. Polycentric governance systems are supposed to be more resilient and better able to cope with change and uncertainty. Issues with different geographical scopes can be managed at different scales, and polycentric systems have a high degree of overlap and redundancy, making them less vulnerable—if one unit fails, others may take over its function. Polycentric governance systems may also exhibit certain disadvantages. Economies of scale may be lost, for example, especially if the basic units in the system are very small. Collective decision-making is also difficult because of the need to accommodate spatial and functional patterns and complexities. Coordination becomes crucial. If coordination fails, unnecessary duplication of efforts and counterproductive actions may result.

All water management systems are polycentric in different degrees and ways. Tasks and competencies may be shared within the governmental sector, but also between the government and the non-governmental sector. There is little evidence that polycentric systems are more flexible and less vulnerable than monocentric systems, or that they reflect local conditions and preferences better or allow more experimentation and learning. But many case studies of individual polycentric water management systems suggest that this type of management is indispensable.

Source: Quoted with minor adaptation from Huitema and others 2009; McGinnis 2000; Hajer 2003.

open access to information and decentralized decision-making could help transform societies and allow them to be more critical of decision-makers. Traditional knowledge and customary practices should also be re-examined. To improve water management, the expertise of water professionals is not enough. Academia, the media, advocacy groups, water user associations and other parts of civil society should also be involved in a well-informed decision-making process. Arab countries must set up the kind of institution that ensures this role (for example, a national water council). It will also require accountability between users and governments, between governments and service providers and between users and service providers.[16]

Because opaque power structures can breed corruption, anti-corruption measures are central to equitable and sustainable water governance. Good water governance must combat corruption through awareness, decentralization, transparency and programmes on water integrity and accountability. Above all there must be political will.[17]

Data and information management and sharing

The Arab region continues to be affected by extreme weather events that are increasing in severity and frequency and putting great stress on water supplies. These conditions make reliable water data even more critical for sustainable water management. One of the biggest challenges to water management is lack of attention to the systems that collect and monitor water data. Without water data, it is nearly impossible to allocate water efficiently.

Better water data support decision-making at every scale. At the local level, access to better water data helps improve the reliability of irrigation flow. At the river or aquifer basin level, data support larger planning efforts such as balancing water demand from agricultural, municipal and industrial sectors or allocating water for environmental flows. Data can also improve the equity and transparency of decisions and support the establishment and monitoring of roles for water quality. Similarly, access to data can help farmers make better decisions about what and when to crop and how much fertilizer to add.

Options to better monitor, collect and process water data are increasing every day. Technological development can help water gauging and monitoring become cheaper, easier and less time-consuming. Once installed, many gauging stations can be monitored remotely by satellite or by mobile phone. Similarly, database and geographic information system technologies have made storage retrieval and spatial information display straightforward and easily accessible. Exciting new advances in remote sensing technologies have recently opened up the possibility of monitoring major changes in groundwater level using gravity data.[18]

Open, free access to water data can improve decision-making. Research centres must be the first beneficiaries of the database. Data collected has a cost and an economic value. The final objective is not to have data but to use it—most important, to determine the cost and impact of efforts to improve water management. The need for data from the watershed level is high because of the impact of climate change and of water harvesting infrastructures on the watershed and upstream dams. To develop prevision and management rules, one needs to review all data.

Collecting and monitoring high-quality data and information should be the goal of all water planning and management institutions. Modelling future water scenarios is only possible if there is access to reliable water data for essential information about responses to rainfall events, flood hazards, seasonal flow variations, groundwater level changes and the impact of major extractions on flow. Access to data is a prerequisite for understanding how water economies function and the various ways water is used, managed and shared. Access to appropriate data is also the best way to discuss transboundary water sharing, provide bases for water allocation and also provide a moving picture of the impact of climate change on water resources and the environment. Sharing accurate data can improve policy responses to climate change. It is therefore important to overcome institutional barriers to data sharing.

To ensure data quality, reliability and consistency, one authority should be responsible for data collection and standardization. To maximize data value, data should be freely available to all stakeholders, including government agencies, farmer and user associations and the public (Box 5.3).

Legislation and enforcement

Water legislation plays an important role in formulating water policies and strategies. It provides the legal framework for water governance, institutional reform, regulatory standards, management systems and enforcement of regulations.

Most Arab countries have made efforts to develop the institutional and legislative framework for good water governance. But although they have formally adopted IWRM, they still lack legislative instruments to support its implementation. New, exacerbated challenges, such as water tariffs and cost recovery, require innovative tools, such as decentralization, the participatory approach, building local authorities' technical and financial capacities, promoting dialogue and consensus, ensuring effective enforcement and compliance and strengthening water institution performance.[19] This does not negate the advancement in several Arab countries. Many new ministries or independent water management authorities have been founded at decentralized levels to support environmental protection. A series of capacity-building IWRM initiatives have been undertaken to help formulate and monitor water policy and evaluate the water system.

Other countries have focused on privatization by establishing new companies, such as the Water and Electricity Company in Saudi Arabia, or forming committees to study privatization of power generation and water in Bahrain. Several legislative steps have aimed to enhance the proposed institutional reform measures, promote decentralization and participatory water resources management and strengthen private sector involvement in water infrastructure projects (for example, Law 5/23 for power generation and water in Saudi Arabia and Sanitary Law/2002 in Qatar). In Jordan water laws have been implemented to support institutional reforms, such as Law 30/2001 to clarify the roles and responsibilities of the Jordan Valley Authority, Law 54/2002 on public health, Law 85/202 to regulate groundwater usage and Law 12/2003 on environmental protection.[20] In Tunisia the Ministry of Agriculture is updating water laws to better enforce participatory management and further preserve groundwater. Finally, in Lebanon, Laws 221 and 241, published in May and August 2000, respectively, and Law 337 issued in March 2002 established a new institutional policy for water management, setting new competences for the Water Establishments and the Ministry of Energy and Water. In 2012 the parliament promulgated a National Water Sector Strategy. Because institutional and legal frameworks vary among Arab countries, it is necessary to define roles and functions, time schedules, degree of responsibility, relations to stakeholders, communication channels and investment and monitoring plans. To ensure

Box 5.3 Data and information availability

The Arab region is continually threatened by natural disasters. Although most current predictions are based on outdated information, the situation is expected to worsen. In recent years many Arab countries have suffered severe floods that have claimed thousands of human lives, such as the Algeria flood in 2001, and billions in economic damage, such as the Saudi Arabia floods in 2010 and 2011 and Oman in 2007. But water scarcity remains the severest water dilemma facing the region. Given rapid urbanization, population growth and consequences of climate change, FAO projections show that many Arab countries are expected to experience severe water shortages by 2050. As reported in the 2008 Intergovernmental Panel on Climate Change report, the MENA region will suffer from high temperatures, decline in rainfall and reduced flows. Scientists and researchers in many Arab countries lack data that would allow them to help redress government policies. Arab countries must enhance institutional regulations, use advanced scientific models, promote capacity building of skilled professionals, ensure transparent stakeholder involvement and promote public-private partnership in services and decision-making. They must also ensure a knowledge hub for collecting data and disseminating and sharing information, in line with advanced technology.

Source: El-Ashry, Saab, and Zeitoon 2010; FAO 2002; IPCC 2008; Merabtene 2011, background paper for the report

Box 5.4 Steps forward for improving legislation compliance

Assess, update and/or amend water legislation and associated bylaws and requirements using a participatory approach involving all stakeholders to ensure public support for compliance through multistakeholder platforms.

Promote compliance by disseminating and communicating water legislation, publishing relevant information, encouraging compliance during the transitional grace period and providing technical advice, and incentives for compliance.

Enforce legislation by:

- Developing competent inspection capacities, credible monitoring, accredited and standardized measuring systems, a registered chain of custody and a certified reporting system.
- Preparing procedures for investigating violations and rules for assessing penalties.
- Identifying measures to compel compliance without resorting to formal court action using administrative actions.
- Developing measures to compel compliance through court action by engaging well-trained judiciaries.

Source: UNDP-WGP-AS 2011.

policy coherence and to enhance cooperation and coordination among stakeholders, it is vital to set up a national interministerial water council (NWC) at the highest political level. Several Arab countries have already done this (Annex II). Current water laws and regulations should also be modernized to implement IWRM policies and plans. Compliance with standards and regulations in the water laws in coordination with other enforcement channels would not be ensured without the empowerment of inspectors and officials in water, health and environmental institutions.[21]

Compliance with water regulation in the Arab region is weak. Overlooking enforcement has led to the spread of a "social value or a culture" that tolerates noncompliance and considers the cost of compliance avoidable. Relevant government bodies (local administration, police, legal, etc.) must work hand-in-hand to enforce water law, bylaws and decrees, especially in regulating groundwater abstraction and preventing illegal well drilling. Community-based water management is a critical component of overall water resource management and enforcement of laws and regulations, so water user organizations (for example, irrigation councils) should be an integral part of water resource management and decision-making and should be empowered to generate income from membership or other services to support their functions and assist in enforcing laws and implementing water management plans.[22]

Several measures are needed to promote compliance with Arab water legislation (Box 5.4) and its enforcement. These include information dissemination; technical assistance; economic incentives; involving NGOs; public support and partnerships; publicizing success stories; and education and awareness for all stakeholders, including journalists, reporters and judges of water conflicts. Several measures are also needed to improve capacity building among water users. These measures can include improving monitoring and inspection capacities, establishing self-monitoring, self-record keeping and self-reporting systems, enhancing area monitoring capacities, encouraging citizen complaints, developing criteria to ensure predictable responses to violations and developing capacities to produce credible evidence for indictment when water law violations occur.

The 2011 UNDP-WGP-AS report suggests three feasible approaches for enforcing water legislation in the Arab Region: a command and control approach, a market-based/economic incentive approach and a risk-based and participatory approach. The command and control approach advocates regulators as the centralized authority for spectrum allocation and usage decisions; the market-based/economic incentive approach relies on market forces to correct for producer and consumer behaviour; and the participatory approach involves stakeholders in management and aims to enable them to exchange views and opinions on problems. These approaches can vary among countries, but it is important to keep good governance in economic, environmental and social perspectives. Many experts argue that promoting compliance and enforcement is the most effective strategy to ensure equitable and sustainable sharing of water resources

Empowerment: exploring new levels

Stakeholder participation

Integrating all relevant stakeholders into the discussion around distributing water resources is a very important aspect of good water governance. It is essential to provide marginalized people with a voice in the discussion process—for example, to defend water requirements for preserving ecosystems and their values and functions.

Water governance in many Arab states has traditionally taken place at the local level. Oasis communities in many areas continue to allocate water among individuals, and quality is maintained through resource ownership responsibilities.[23] Informal irrigator councils around the springs in Mount Lebanon still govern the resource without government intervention. In the 20th-century drive towards developing supply and irrigation, new institutional structures emerged to manage the nation's water resources.

Until recently water management in the Arab region was highly centralized and managed mostly at the national level with little local stakeholder or civil society participation, resulting in ineffective, fragmented structures. Water responsibilities were scattered among government departments, bureaucracy and inefficiency influenced decision-making, and action was slow and non-transparent. Various actors had their own roles, rights and responsibilities, with often conflicting interests in managing water resources.[24]

Local community stakeholders and user associations are established in Egypt, Jordan, Lebanon, Libya, Morocco, Oman, Tunisia and Yemen. The Arab region's recent experience shows that some of the water user associations have been established through a bottom-up consultative approach, where authorities have conferred with ordinary water users (Box 5.5). This helps to bolster participation, improve farmer welfare and develop irrigation and drainage by providing an alternative to public utility monopolies.[25]

Interest groups ensure that policy-makers and service providers are subject to the consequences of good and bad performances. The more inclusive, transparent and accountable systems are, the more likely it is that the changing political circumstances will lead to opportunities for beneficial water reform. Stakeholder involvement is central to improved water management and governance, especially in decision-making. Water users, water service

Box 5.5 **Pioneering water user associations in Lebanon: the Association of the Friends of Ibrahim Abd El Al**

When the Lebanese government launched the "Conveyor 800 scheme" for irrigation and potable water in South Lebanon, it recognized water user associations' central role in implementation. The project, which will irrigate an area of 14,700 hectares and provide potable water for approximately 100 villages, is vital to an area that has suffered decades of Israeli occupation.

The Association of the Friends of Ibrahim Abd El Al (AFIAL) initiated a pilot project to establish a work methodology for the designated area. The pilot project was funded by the Lebanese Recovery Fund (LRF), under the management of the United Nations Development Programme and in partnership with the Litani River Authority. This project sets the infrastructure for the distribution network, shows the advantages and efficiency of modern irrigation techniques, proposes new cropping patterns in the region with their socio-economic impact and supports the establishment of water user associations, with a direct impact on the livelihoods of at least 1,250 households within 5 communities impacted by the July 2006 war in Lebanon, covering an area of 522 hectares and benefiting more than 1,259 farmers.

AFIAL is responsible for preparing the legislation and the creation and implementation of the pilot water user associations. It implemented communication campaigns with the farmers and conducted capacity-building workshops locally and in Italy.

Source: UNDP 2011.

Box 5.6 **Public participation in water management**

Public participation in water management should take full account of the rights and responsibilities of the public and public authorities. At the national level, states are encouraged to guarantee legal rights for the public on access to information, public participation in decision-making and justice in environmental matters. States should adapt their national legal systems as necessary.

Source: UNECE 2000b.

Box 5.7 **Jordan water conservation education**

In 1986 Jordan's Royal Society for the Conservation of Nature (RSCN) introduced environmental conservation clubs in single-gender primary and secondary schools throughout the country. The eco-clubs initiative aimed to protect the country's indigenous animals. In the face of increasing water scarcity and a rapidly growing population, RSCN introduced the water conservation focus in the mid-1990s. USAID/Jordan asked GreenCOM, an environmental education and communication project active in 28 countries, to provide technical assistance to this new programme in research, teacher training, evaluation and curriculum development and implementation.

In 1994 GreenCOM conducted formative qualitative research on a sample of RSCN eco-clubs representatives from 10 schools in different parts of the country. The themes included in the interviews and focus groups covered knowledge of Jordan's water situation; water shortage and pollution; attitudes towards water problems and roles and responsibilities in solving those problems; and water conservation practices at home, in school and in the community. Initial findings indicated high levels of awareness of water shortage and pollution among teachers and students. Nevertheless, respondents were not convinced that they could take effective action to ameliorate Jordan's water problems and felt that any solutions were the government's responsibility. The unavailability of technical materials on water conservation in the eco-clubs was also noted.

The project partners to develop a secondary school water conservation curriculum used these findings. The curriculum was divided into five units covering the natural water cycle and water sources in Jordan: irrigation, pollution, home gardens, household water consumption and groundwater and surface water. The curriculum emphasized the importance of engaging students in discussions and hands-on experiments to help them understand the topic's relevance and the need to change their water consumption habits. One activity required students to take some simple water-saving actions at home. They were asked to compare household water bills received before and after the experiment to observe the reduction in water use and expense.

GreenCOM introduced the new curriculum to eco-clubs by first training RSCN staff, which later held a series of two-day teacher training workshops with 163 leaders from 72 selected clubs. Trainees practiced using the manual and conducting some of the experiments. Many of the teachers reported that it was the first time they had encountered an interactive teaching methodology.

After the trained teachers had used the new materials in their clubs for four months, GreenCOM conducted post-implementation surveys to gauge the curriculum's impact. The curriculum had a strong positive influence on the number and kind of water activities teachers implemented in their clubs. Most teachers who received the curriculum training implemented almost all of the recommended activities with their students. An overwhelming majority (90 per cent) said they would use the curriculum again. Implementing the curriculum did little to change teachers' beliefs about the advantages of interactive teaching methods and their confidence in using those methods. Despite this finding, the research suggests that using interactive methods could change teachers' preferences over time. On the other hand, students from eco-clubs that used the curriculum had more positive scores on knowledge, attitudes and beliefs about water conservation than students from non-participating clubs. Students who were exposed to the new curriculum had more positive scores on an aggregate scale of social behaviours than students with no exposure.

GreenCOM's work on the water conservation curriculum for secondary school eco-clubs demonstrated several important results:

- ***Professional development:*** Skill building for staff members of RSCN's education department was a major component of this project.
- ***Dialogue about water conservation:*** The new curriculum helped to open a public dialogue on water conservation.
- ***Introduction of interactive teaching methods:*** The curriculum introduced Jordanian teachers to interactive teaching, which contrasted sharply with their traditional lecture-based methods.

Source: USAID/Jordan 1996.

providers, water resource managers and multistakeholder platforms have therefore come to the fore as logical companions to IWRM.[26]

Principle 10 of the Rio Declaration on Environment and Development emphasizes that "environmental issues are best handled with the participation of all concerned citizens, at the relevant level (Box 5.6)."[27] Other widely recognized international policy documents emphasize the need for an adequate role for the public, including NGOs, in environmental and water management. Examples are the Dublin Statement on Water and Sustainable Development, Agenda 21, the Noordwijk Political Statement and Action Plan (Ministerial Conference on

Box 5.8 **Heroes of the UAE**

The Heroes of the UAE is a national press campaign jointly developed by the Emirates Wildlife Society in association with the Worldwide Fund for Nature (EWS-WWF) and the Environment Agency-Abu Dhabi, and endorsed by the Ministry of Energy, the Ministry of Environment and Water, MASDAR and the Abu Dhabi Water and Electricity Authority. This campaign aims to raise awareness of the importance of rationing energy consumption to avoid shortages. The campaign involved the press and outdoor and radio advertising in early 2009, as well as a website (www.heroesoftheuae.ae). Information was made available to everybody to learn more about the problem's causes and also find out what they can do to help reduce energy consumption.

Principal features of the website include an animated sequence that explains the present energy and environment situation in simple, graphic terms, along with a long list of energy-saving tips, a calculator that enables households to establish exactly how and where they can make real savings on their consumption, and a unique pledge facility that enables households to positively state their intention to make a difference.

As part of the school Heroes campaign, EWS-WWF organized an Energy and Water Reduction Competition inviting all government and private schools in the United Arab Emirates to participate. The competition aimed to raise awareness among students of the urgent need to conserve energy and water to mitigate the impact of climate change.

More than 70 schools from all over the United Arab Emirates participated in the three-month competition. Participating teams were expected to come up with innovative methods for conserving energy and water in their schools using their utility bills for February, March and April 2010. Consumption units in these three months were then compared with the respective months in 2009 to identify how awareness and behavioural changes could have a positive impact on consumption habits.

The panel of judges had a tough time choosing the winners. The quality of entries indicated the keen interest among students to bring about positive changes in their environment through simple behaviour modifications and basic technological innovations. Students also commented on an increased sense of team spirit while carrying out these activities and their willingness to gently switch to a more sustainable lifestyle to ensure longevity of our planet's resources.

Source: Heroes of the UAE 2010.

Drinking-Water and Environmental Sanitation in Noordwijk, 1994) and the Guidelines on Access to Environmental Information and Public Participation in Environmental Decision-Making (Environment for Europe Conference, 1995).[28]

Awareness and education: the change factor

Public awareness is a major foundation for effective good water governance. It is the first step for meaningful participation and tangible action. By promoting behavioural changes and good practices, it can save water and thus enhance water security. Although various ministries and agencies, the private sector and nongovernmental organizations have launched innovative public awareness, training and education programmes on conserving water resources, most of these campaigns are ad hoc and not tailored to the needs of user groups. NGOs could be key actors in raising awareness, but they need further support in that role.

A long-term awareness programme needs to be instituted that takes into account local and regional socio-economic and ecological dimensions.[29] Inefficient water use in irrigation (around 40 per cent) and water loss in networks (over 50 per cent) indicate low water awareness.

NGOs and UN agencies can play a pivotal role in raising water awareness. A survey of farmers in Lebanon showed that 70 per cent thought their agriculture practices had no negative impacts on the environment, despite evidence. In southern Lebanon, where many NGOs are working, farmers demonstrated more awareness of environmental impacts was found in the south of Lebanon where there are many NGOs working (for example, AVSI, Mercy Corps, World Vision, AIDA. Bad agriculture practices in Lebanon include improperly disposing of unused agrochemicals and their containers, overusing pesticide applications, using counterfeit chemicals, and excessive irrigation. The best management practices promoted there include safely disposing of agrochemicals, improving terracing, accurately applying fertilizers and pesticides and planting trees as wind breaks.[30] Jordan introduced

Box 5.9 **Gender mainstreaming in water governance**

Good governance can help decrease gender inequalities through the following:

- "Ensuring that poor women's and men's human rights and fundamental freedoms are respected, allowing them to live with dignity.
- Introducing inclusive and fair rules, institutions and practices governing social interactions to improve outreach to the vulnerable, such as poor men and women, and the younger and older generations.
- Ensuring that women are equal partners with men in decision-making over development, use, technology choice, financing and other aspects of water management.
- Ensuring that the environmental and social needs of future generations are reflected in current policies and practices.
- Focusing water development policies toward eradicating poverty and improving the livelihoods of women and men."

The above principles also apply to effective water governance. To maximize and improve the efficiency of women's participation in all decision-making, the particular social, economic and cultural roles assigned to men and women should gain emphasis. Agriculture and the water sector must be made are gender aware, a process that should begin with training programmes for water professionals and the community on gender approaches and methodologies. Reforms must also be introduced at various levels of local communities for an effective integration of gender and participatory approaches into local and regional businesses, especially to empower women in conflict zones and agricultural and poor communities.

Source: UNDP 2003.

environmental conservation clubs to promote awareness (Box 5.7).

The role of media should be activated at national and local levels through well-tailored and easy-to-understand programmes, dialogue and frequent meetings (Box 5.8). The newly established Lebanese Centre for Water Management and Conservation is effectively raising public awareness on the importance of water and conservation through initiatives that target residential, touristic, industrial and agricultural water sectors.

Water rights and social equity

Arab countries widely recognize that water is a public good. Ambiguous water rights, frequently sparking local tension and conflict, lead to poor decision-making on efficient, equitable water use. In most Arab countries, water rights are placed within a legal, pluralistic context. Legal instruments to regulate water allocation are lagging behind in many Arab countries. Setting well-defined, coherent water rights is fundamental to deal with increasing competition among water users:

- It can promote equitable water use and improved access to water by groups previously denied water rights.
- It can improve the efficiency of water allocations.
- It can promote the willingness of farmers and urban water users to take economic risks to make necessary investments in improved water management and practices.
- It can render other governance measures, such as pricing mechanisms, more effective.[31]

Social equity, a declared goal of effective water governance, should anchor policy choices. Policies should rely primarily on approaches that allow for meaningful participation of all relevant stakeholders. Regardless of social status, power or gender (Box 5.9), social groups should be able to voice their claims and concerns in an open, transparent environment. To realize this, countries should go beyond legislative arrangements and staged participatory processes to include cultural changes and attitudes. Reflection on social equity concerns in policy formulation, plans and programmes is a key prerequisite for effective water governance.

Financing and economics

Properly comprehending water's value is vital for decision-making about water investments, allocation and pricing. One of the biggest faults in the Arab region's water governance system is neglecting and/or miscalculating real water values/costs, which include social and environmental costs as well as direct financial costs of extraction and delivery.

Funding: between availability and attractiveness

To ensure the financial sustainability and viability of effective water governance, a clear water financing scheme is needed. This includes identifying (a) financing sources and "who should pay and for what" (for example, the user pays principle, the polluter pays principle, full cost-recovery); and (b) economic and financing instruments that ensure an optimal and efficient allocation of financial resources.

Themes of effective water governance and financing for water resources management intersect at many levels. Good governance is a precondition for generating the financial and human resources necessary to sustainably develop and manage water resources. Unfortunately, some of the Arab countries most in need of additional resources lack the governance conditions that will either attract new financing sources or ensure that public and private resources are managed equitably or sustainably. Sound governance practices create enabling environments that can encourage both public and private sector water investment. Specific attention should be directed to efforts that reduce risk and facilitate healthy capital markets, especially at the domestic level. Some additional guidelines on using good governance to mobilize financial resources include:

- Water should be recognized as an economic, social and environmental good; the full costs of water management and water services should be acknowledged; and the costs should be allocated transparently, equitably and sufficiently throughout society (through tariffs, subsidies, taxes, cost recovery and the like).
- Access to capital should be available at all levels (for example, microcredit, revolving loan programmes and local bond issues).
- Accountable and transparent systems, full accounting of costs and benefits, a progressive policy and legal environment and a constructive relationship between civil society and government should be promoted.

Depending on the type of activity, different mechanisms can be proposed for financing water and sanitation projects. Some financial sources should stem from public budgets, fed by general taxes, especially when the project benefits cannot be easily quantified, as with awareness programmes for water saving or institutional reform. Some can come from users and beneficiaries of the water projects through instruments applied directly in the water sector or in other sectors (for example, reducing unaccounted-for water or increasing irrigation efficiency in agriculture). Both approaches correspond to the cost-recovery principle as well as to the user-pay and polluter-pay principle.

Public funds should be spent on services that bring pure public benefits. International best practices suggest that users should pay at least for the operation and maintenance of

Table 5.1 Possible allocation of public/private responsibilities across different water demand management options

Options	Setting performance standards	Asset ownership	Capital investment	Design and build	Operation	User fee collection	Oversight of performance and fees
Green code	Public	Public	Private	Private	Private	Private	Public
Admin loss	Public	Public	Shared	Private	Private	Public	Public
Reduction of physical loss	Public	Public	Shared	Private	Private	Public	Public
Wastewater irrigation projects	Public	Public	Shared	Private	Shared	Public	Public
Improve on farm efficiency	Public	Private	Private	Private	Private	Shared	Public
Awareness programme	Public	Public	Private	Private	Private	Not Applicable	Public
Institutions/policies	Public	Public	Public	Shared	Public	Not Applicable	Public

Source: Authors.

Box 5.10 **Financial analysis of Jordan's cost recovery programme**

Using the financial analyses carried out in the cost recovery programme of the Water Authority of Jordan from 2002 to 2004 for providing water and wastewater services, we assume that 85 per cent of operation and maintenance cost and 60 per cent of capital cost is attributed to water, while the remaining 15 per cent of operation and maintenance cost and 40 per cent of capital cost is attributed to wastewater service. Thus, the full cost of water service is estimated at 179 million Jordanian dinars. As the billed water in 2009 is 183 million cubic metres and water supply is 322 million cubic metres, the average cost of water service for all Jordan can be estimated at 0.89 Jordanian dinars per cubic metre of billed water and 0.51 Jordanian dinars per cubic metre of water supply.

The low level of water tariffs made it impossible for water agencies to come closer to the long-term objective of financing their operating expenses and capital investments from their own revenue stream. In fact, the Water Authority of Jordan operations have generated annual deficits of over $50 million from 1990 and reduced the authority's net worth from $177 million in 1990 to zero in 1995. The authority's inability to generate sufficient surplus to finance its investment programme resulted in large debt obligations.

Source: Haddadin 2006; ECO Consult 2004.

infrastructure that brings private benefits. But determining the share of public benefits is difficult, thus complicating the task of apportioning infrastructure costs to individual users. One of the most important reforms in Arab water provision in the last decade has been the increasing role of the private sector. Government inability to raise adequate capital to finance, operate and maintain necessary water and sanitation infrastructures has encouraged private sector participation. Private sector management and technical practices can lead to more efficient services. Governments in some Arab countries (Algeria, Egypt, Jordan, Morocco, United Arab Emirates) have thus moved from directly providing water and sanitation services to playing a more strategic and regulatory role. Water economics has drawn more attention to the importance of economic instruments in managing water demand. Economic incentives, when adjusted to local settings, can curb the tendency in demand management without affecting socio-economic benefits and livelihoods.

International donors and lenders have promoted privatization of water management and distribution to achieve full cost recovery and improve efficiency in distributing public utilities. Conflicting arguments about water sector privatization extend from feasibility to morality. Considering water a "gift from god, a public good and as a human basic right" creates conflicts within and between communities opposing its private ownership. Many argue that water privatization creates new barriers to the access of common resources and deprives vulnerable groups, especially poor people and women, of their basic water needs or rights.[32] Other debates relate to public-private partnerships and their limitations and potential.

All possible approaches to privatization should be weighed in effectiveness, efficiency, equity and other elements of effective water governance. Arab states could derive greater benefits from privatization by conducting dialogue with stakeholders and considering the social and ethical issues, the community's socio-economic needs and water's status as a human right. Preparatory privatization steps, including selecting utilities, negotiating contracts or monitoring the bidding process or the performance of private investors, need institutional and regulatory reform to ensure full coordination and consultation among ministries and water institutions, as well as civil society structures.[33]

The private sector could participate in capital investment, design, building and operation of green code (Table 5.1).

Among widely used approaches for funding and public-private partnerships are the BOO/BOT modalities.[34] For every water BOO/BOT project, four categories of stakeholders can be identified, including the public sector authority; the contract awarding agency; the grantor, who may also be the off-taker under a long-term commercial agreement; and the private operators and contractors who participate in the concessionaire's equity and provide the technology, construction and project development skills.

Although no single structure holds for all water and sanitation BOO/BOTs, some fundamental principles apply. The best contractual structures allocate activities and risks fairly among stakeholders.

One of the strengths of public-private partnerships is that market initiatives, combining creativity, profit motivation and entrepreneurship of the private sector with the strong knowledge base and national responsibility of the public sector, can achieve desired natural resource management goals. Public-private partnerships require a roadmap that charts shared goals, a patient policy that balances market economy principles and public interests, incentives for each sector and a shared understanding of each partner's strengths and weaknesses.

Since 1990 many Arab countries have adopted an economic restructuring programme leading to a new water and sanitation management policy. For municipal water and wastewater services and systems maintenance in Jordan, the government applied the management contracts strategy funded by loans from the World Bank and other donors. Private firms were contracted to manage the water and wastewater systems with the staff of the Water Authority.[35]

Some governments have also adopted the BOT approach to involve the private sector in financing water resource development. The government could thus expand and improve service coverage, generate resources to finance future investments, increase economic efficiency, reduce government fiscal burdens and introduce technological advances. In Jordan, for example, the government finances both planning activities and most of the new constructions, either directly or indirectly (for example, BOT system in Disi and Al-Samra wastewater treatment plant). Much of the cost associated with infrastructure construction (flood control, wastewater treatment and agricultural water supply) are subsidized by the government directly but implemented in most cases by the private sector.[36]

Many initial successes have resulted from relatively simple management improvements that did not require large investments or sophisticated technologies. Private firms have shown a remarkable capacity to improve the operation of existing infrastructure within a short time.

Box 5.11 Operation and maintenance requirements

Operation and maintenance for public systems would require the following actions:

- Adopting a water tariff mechanism to promote cost recovery of water projects.
- Setting municipal water and wastewater charges at a level that will cover at least the cost of operation and maintenance.
- Depending on concessionary loans, private borrowing and BOT arrangements in project financing.
- Making profitable undertakings in industry, tourism, commerce and agriculture to pay the fair water cost.
- Setting differential prices for water based on water quality, the end users and the social and economic impact of prices.
- Regularly reviewing and adjusting water tariffs based on the costs of supply and operations and the comprehensive analysis of economic data.
- Moving towards the recovery of all or part of the capital costs of water infrastructure.
- Using water tariffs to drive water consumption behaviour that leads to better conservation.
- Establishing the real cost of operation and maintenance and charging for irrigation water accordingly.

Source: Hellenic Aid 2010.

The privatization experience in Jordan was successful in the Greater Amman region. Performance efficiency of manpower has improved. Collection rates have increased. And unaccounted-for water has fallen from 54 per cent to 45 per cent. This could be the result of the superiority of private sector handling of water and wastewater operations, known to require prompt responses to maintenance requests, supply of needed inputs and mobility in staff and equipment.[37] A number of countries have started implementing this experiment, including Morocco, Tunisia and Jordan. Saudi Arabia is also considering involving the private sector in building water desalination units.

Public-private partnership is picking up momentum in the Arab region. Dubai, Lebanon and Saudi Arabia illustrate that public-private partnership is developing under many different provision models. In countries such as Jordan and Tunisia, a centralized, public sector–funded system has recently introduced moderate private sector participation

Box 5.12 **Arab Ministerial Water Council**

The League of Arab States established the Arab Ministerial Water Council in 2008, reflecting a unified regional political will to promote discussion on water issues from the technical to the political level. The council's aim was to boost cooperation efforts within a joint Arab strategy to combat water challenges and bolster water security. Its main objectives were managing water demand, developing and preserving water quality and quantity, managing water resources, protecting Arab water rights and improving regional governance under the League of Arab States.

Source: Cherfane 2009.

in sanitation through service contracts and a BOT contract.[38]

Arab countries must allow private sector participation in financing water projects under government supervision and regulation. Public-private partnerships, particularly with the national private sector in a BOT or BOO, can increase desalination capacity and municipal sectors by reducing public expenditure, managing large-scale projects and improving technical and managerial expertise.

Financial resources in most Arab countries are limited and unable to provide all the necessary funding to invest in water. Arab countries, especially nonoil countries, are encouraged to increase private sector participation in various water projects, such as desalination; irrigation systems; building, implementing, upgrading and managing drinking water networks and sewage systems; and building and operating wastewater treatment plants. Cooperation between the public and private sectors not only raises economic efficiency, but also accelerates various water projects, improving sanitary and environmental conditions in communities. In addition, effective methods of supporting private sector capacity have to be identified through public-private partnership ventures. Public utilities cannot continue to underprice water and introduce subsidies that encourage overexploitation of a scarce resource.[39]

Many public-private partnerships have encountered difficulties, however, due to insufficient attention to the social consequences of measures such as tariff increases. Another difficulty is the popular mistrust of institutions involved in public-private partnership projects. Unless continued access to water for the poorest sections of the population is ensured at a reasonable cost, and sufficient levels of transparency in decision-making are provided, major social resistance to public-private partnership is expected. Developing social protection schemes prior to or parallel with public-private partnerships is therefore a crucial success factor.

Economic and financial sustainability

Achieving economic and financial sustainability is important for ensuring continuation of water and sanitation provision. Responsible institutions cannot continue to function effectively and efficiently unless they are provided with the required means and finances. In most cases, throughout the Arab region, water services have been heavily subsidized to meet the escalating cost of providing water. But with rising economic pressures and demands for financial resources, calls for full cost recovery are gaining momentum.

Cost recovery in Arab countries is generally low and impacts water services' financial sustainability (Box 5.10). For example, the cost recovery in Saudi Arabia does not exceed 2 per cent. Regional water authorities do not have sufficient revenues to recover costs. The Riyadh branch, which is considered the best branch in cost recovery, had revenues of 370 million Riyals in 2004, while its operational expenses were 570 million Riyals. On average, the government is only recovering one or two percentage points of its costs. There is no recovery of the cost of wastewater collection and treatment. According to a 2000 World Bank estimate, the government paid annual subsidies of $3.2 billion, equivalent to 1.7 per cent of GDP and 7 per cent of oil revenues.[40] These figures are expected to be much higher today.

Arab decision-makers are thus torn between pressures to meet water authorities' demands for expansion and maintenance, and public pressure to restrict water prices, particularly for poor people. Pressures from donor communities to adopt full water cost recovery aggravate the situation. Water pricing is the most important measure in establishing effective demand management to use water efficiently and sustainably. Appropriate and adequate operation and maintenance of water systems is necessary to enable them to meet the current environmental standards for distributing safe drinking water (Box 5.11).

Water efficiency

Effective and environmentally sound use and management of available water resources are required for closing the ever-widening gap between water supply and demand. The Arab region needs realistic water management strategies to deal with the following issues: safeguarding water to meet basic needs; allocating scarce water for socio-economic development; minimizing water losses; and protecting the environment from degradation and loss of productive capacity.[41]

Efficiency in water use is an essential element of effective water governance as well as IWRM. The World Summit on Sustainable Development identified two main aspects of efficiency in water use: technical efficiency and allocation efficiency.[42] User efficiency, supply efficiency and recycling would help. Economic efficiency means using tools such as water pricing and tariffs, appropriate incentives and subsidies and realistic cost-benefit analyses. But water's social and environmental value must be taken into consideration.[43]

Research and development: a missing link

The Arab countries are lagging behind in R&D efforts. Arab Knowledge Report 2009 stated that innovation is the weakest point in the Arab knowledge scene. The Arab expenditure on R&D (as a percentage of GDP) has been usually below the world average, ranging from 0.1 per cent to 1 per cent, compared with 2.5 per cent in developed countries. Despite ambitious plans to raise R&D spending, many Arab countries have not achieved concrete advancements yet.[44] Tunisia is considered the leading country in R&D spending, reaching 1.1 per cent in 2009, followed by 0.64 per cent for Morocco and 0.34 per cent for Jordan.[45] A major issue is the weak linkage between R&D and production.[46]

This argument applies to all socio-economic issues and sectors in the Arab region. Unfortunately, the water sector, despite its importance, is no exception. Water research organizations in the Arab region are hampered by a lack of human and financial assets and an absence of national science and technology policies. Research agendas sometimes reflect the requirements of international funding organizations rather than local community needs and national goals.

The Arab region is facing a double challenge in linking water science to public policy. First, the capacity to generate innovative scientific research is lacking. Second, systematic institutional linkages to use knowledge in policy-making are not yet well-developed. Hence, the ability to formulate and implement effective water policies is severely constrained. As a result, demand for water research is not yet a systematic component of the water policy cycle, even among government agencies that fund research organizations. Underfunded, understaffed, poorly performing research organizations, in addition to poor quality and unavailability of data, continue to dominate regional water research.[47]

Research and innovation are critical to setting the stage for effective water policies that ensure sustainability, efficiency and equity in access and use of the Arab region's scarce water resources. Accordingly, Arab countries need to place high priority on research and policy analysis.

A key element in linking research to policy is the government's demand for, and systematic use of, research findings in formulating policy.[48] A survey conducted in Algeria, Egypt, Jordan, Lebanon, Morocco, the State of Palestine, Sudan, Tunisia and Yemen with case studies in four countries (Egypt, Jordan, Lebanon and Morocco) and encompassing 70 research organizations found that government demand for research appears to be extremely limited.[49] Any government interest is most likely represented through specific individuals' actions. This seems to reduce opportunities for research organizations to contribute to positive change at the national or even regional level.[50] There is thus little effort to link science to policy.

Governance research should be directed towards identifying and assessing anticipated new drivers and changes. Among emerging research topics are water quantity and quality requirements and the indirect water-related impacts on energy, agriculture, health, the environment and social behaviour.

Water research into institutional aspects should involve identifying arrangements that may contribute to a functional, coordinated approach to important water-linked sectors such as energy, agriculture and the environment. It should include how compatible policies in the interlinked sectors can be developed and implemented, and focus on enhancing accountability and transparency by establishing clear mandates, authorities and responsibilities.

Cooperation: at the regional and transboundary level

Because of the high dependency on shared water resources, regional cooperation in water governance is essential.

The Arab region lacks comprehensive agreements on the major international river basins. The second best alternative is an international binding legal instrument that sets the duties and responsibilities of riparian countries and establishes guiding principles for coordinating, managing and allocating shared water resources.[51] The international community widely recognizes the Convention on the Law of the Non-Navigational Uses of International Watercourses, published by the International Law Commission of the United Nations in 1997, as a candidate. Turkey, the upstream riparian country of the Euphrates and Tigris rivers, and Burundi, one of the upstream riparian countries of the Nile River, voted against the convention. Only nine Arab countries signed the convention (Jordan, Syria, Tunisia and Yemen with initial signatories and Iraq, Lebanon, Libya, Morocco and Qatar with accession), while three countries (Jordan, Tunisia and Syria) ratified it.[52]

Arab countries, in cooperation with neighbouring countries, must adopt a strategic approach to translate their sociocultural solidarity into a unified political position supporting the rights of all riparian countries to fair, just and equitable shares in international water resources. The 2008 establishment of the Arab Ministerial Water Council by the League of Arab States, an important step in this direction, reflects a regional political will to elevate water issues from the traditional technical level to the more influential political level (Box 5.12). There is a need to establish and improve high-level cooperation with neighbouring non-Arab countries to strengthen the joint management of water resources by setting priorities, building consensus, nurturing and strengthening institutions and supporting the implementation of action programmes. Mutual cooperation and coordination establishing effective water governance, and hence management of shared surface and groundwater basins, will help to achieve sustainable development.

One of the best examples of cooperation in managing shared water resources in the Arab region is the North Western Sahara Aquifer System, shared by Algeria, Libya and Tunisia. With support from UNESCO and other bi- and multi-lateral donors, scientists from two of these countries have been working together since the 1960s to develop a common database and agree on the impacts of use scenarios. Libyan experts joined the cooperation in 1998. This case illustrates the advantages of processes to agree on datasets and plans and build consensus before large-scale exploitation gets underway, since it is hard to reduce allocations once the resource has become overexploited.[53]

Improved regional cooperation on shared water development and management is vital.[54] This cooperation should take into consideration the rights of the region's peoples in an equitable and balanced manner and reform and empower relevant regional institutions and legal frameworks. Effective regional water governance can transform water issues from points of tension to points of progressive international cooperation.

Endnotes

[1] Gooch and Huitema 2004.
[2] World Bank 2007.
[3] GWP SAS 2000.
[4] Rogers and Hall 2003.
[5] AWC 2006.
[6] UNESCO 2006.
[7] Varis and Tortajada 2009.
[8] Saleth and Dinar 1999.
[9] UN-ESCWA 2004.
[10] Pugh 1996.
[11] Majzoub 2010.
[12] UN-ESCWA 2005a.
[13] El-Ashry, Saab, and Zeitoon 2010.
[14] El-Ashry, Saab, and Zeitoon 2010; World Bank 2007.
[15] AWC 2009.
[16] Bucknall and others 2007.
[17] Choukr-Allah, Ragab, and Rodriguez-Clemente 2012.
[18] Chartres and Varma 2010.
[19] GWP Med 2007.
[20] GWP Med 2007.
[21] GWP Med 2007.
[22] UNDP-WGP-AS 2011.
[23] Zekri and Al-Marshudi 2006.
[24] Laban 2008.
[25] Abou-Hadid 2010.
[26] Warner and others 2006.
[27] UNESCO 1992.
[28] UN 1992a,b; UNECE 2000b.
[29] Al-Mohannadi, Hunt, and Wood 2003.
[30] UN-ESCWA 2004.
[31] World Bank 2007.
[23] Sitaraman 2008.
[33] Hefny 2009.
[34] BOO stands for build, own, operate, while BOT stands for build, operate and transfer, the system employed in building projects under private sector finance whereby the builder undertakes to operate the project and collect revenues for an agreed number of years.
[35] Haddadin 2006.
[36] MWI 2009; Denny and others 2008.
[37] Haddadin 2006.
[38] AWC 2009.
[39] UNDP 2006; Sitaraman 2008.
[40] World Bank 2005.
[41] Mehmet and Biçak 2002.
[42] GWP 2005.
[43] Placht 2007.
[44] UNESCO 2010c.
[45] World Bank n.d.
[46] UNDP and Mohammed Bin Rashid Al Maktoum Foundation 2009, 2011.
[47] Taylor, Okail, and Achy 2008.
[48] Carden 2009.
[49] Taylor, Okail, and Achy 2008.
[50] Taylor, Okail, and Achy 2008.
[51] UN-ESCWA 2010.
[52] UNTreaty 1997.
[53] Benblidia 2005.
[54] UNESCO 2012.

Chapter 6

The way forward

Effective water governance is vital for sustainable development in the Arab region. Water security requires appreciating water's proper value—including social and environmental as well as financial costs—and adopting new approaches. Cost-effectiveness analysis can help identify the most effective strategies to address the escalating water crisis. Shifting from supply management to demand management is also necessary. Decision-making mechanisms should incorporate principles of good governance such as transparency, integrity, accountability and active stakeholder participation.

Effective water governance is anchored by five foundations: efficiency, economic and environmental sustainability, responsiveness to socio-economic development needs, accountability before stakeholders and the public, and adherence to ethics and moral values.

Towards effective and sustainable water governance

Sustainable and effective water governance looks at the water sector as part of a broader framework for social, political and economic development, and therefore as capable of affecting and being affected by other sectors and the overall context.

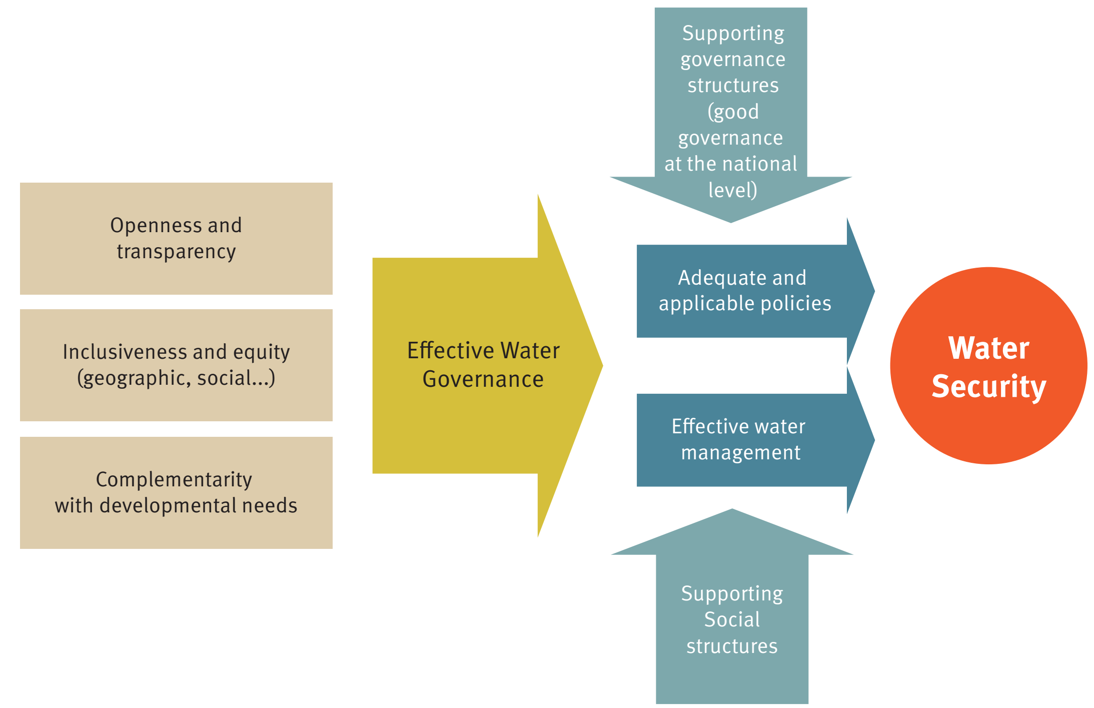
The water sector can act as an agent of change for prevailing governance systems. Because water is central to well-being, health, advancement and almost all socio-economic activities, water sector reforms can be easily promoted at government and popular levels. Mechanisms should be established to allow effective and meaningful participation of all relevant stakeholders (such as water user associations) in formulating, implementing and monitoring water governance policies and strategies. Several approaches can be introduced, such as decentralization and the transfer of responsibility and authority to local user groups, and legal frameworks can be formulated to expand public-private partnership capacity. The cost-effectiveness approach can help evaluate and guide policy towards water security so that the Arab region can guarantee the well-being of its citizens (Figure 6.1).

A major shift in water policies is required, emphasizing conservation and demand management to secure long-term water supplies while meeting strict criteria for socio-economic, financial and environmental sustainability and public health requirements. The following guiding principles and recommendations can help realize effective water governance in the Arab region.

Reorienting policies

Implementing a water management strategy based on securing supplies, without adequate

Figure 6.1 Comprehensive system of effective water governance



Source: Authors

attention to use and allocation efficiency, has led to unsustainable water use patterns. Also, lack of transparency, participation and political will has prevented policy implementation.

National and regional political institutions are now in flux, increasing the potential for change in water governance. Transformation to a more flexible, adaptive water management system must go hand-in-hand with growth and economic diversification. Improved accountability and other governance mechanisms inside and outside the water sector will be crucial for allowing the transformation to lead to improved water policy reforms. Main recommendations include:

- Developing water policies and strategies based on consultations with stakeholders, including government officials, politicians, water user associations, local communities and the private sector.
- Having strong political will and avoiding politicization of resource competition.
- Developing distributed governance systems, taking into consideration local context and moving away from more traditional hierarchical and market-led governance.
- Promoting democratic cultures of accountability, transparency and political will.
- Linking water economy and policies with other economic sectors.
- Arranging for cooperative management and governance of shared and transboundary water resources between all riparian countries.

Instituting reform

Water governance structures in the Arab countries are undergoing reform to improve the sector's efficiency in service delivery, coverage, client-orientation and equity of distribution. Egypt, Jordan, Morocco and Tunisia offer successful examples of public-private partnerships. Institutional reform—addressing laws, regulations, decrees, organizational arrangements, customs, markets and economic and financial instruments—should include capacity building, coordination efficiency, accountability and transparency, monitoring and evaluation, and reform in legislation and enforcement. Main recommendations include:

- Establishing higher water councils for setting water policies and coordination among water institutions.
- Addressing human resources and skill deficiencies through capacity building, training and organizational development.
- Developing and strengthening efficient and expedient decision-making and coordination in and across organizational structures.
- Instating the spirit of shared responsibility and a sense of ownership and accountability.
- Strengthening partnerships and networking between different stakeholders and water-related institutions, including research centres, private institutions, consumer associations, farmer and agricultural associations and organizations, and municipal and agricultural authorities.
- Addressing interagency competition, especially for budgets and other resources, through coordination and accurately set policies, roles and responsibilities.
- Establishing monitoring, feedback and assessment mechanisms for water policies and decision-making at all levels (forming and implementing). These mechanisms should involve the various stakeholders, researchers and media. This includes making water-related data and updated statistics available, developing performance indicators and monitoring them, and integrating incentives in performance and efficiency indicators.
- Policy-makers should not escape the responsibility of implementation and ensuring adequate capacities and funding for effective implementation. Policies should be modified as they move to local levels for ultimate enforcement.
- Each country should adapt indicators and data to its own priorities, but a regional monitoring system could contribute to better understanding common problems and promoting cooperative solutions.

Addressing inadequate and weakly enforced legislation

Although many Arab States have applied different legislation and approaches to manage and protect their scarce water resources, most efforts have been hindered by inadequate compliance and poor enforcement. The challenge remains in embedding the laws in the region's socio-economic, political and cultural contexts. Existing laws and legislations should be updated or modernized to strengthen institutional arrangements and water governance. Examples of the negative impact of weak legislative enforcement include illegal well drilling, resulting in overexploitation of already stressed groundwater resources. Other examples concern pollution and illegal dumping of chemicals.

Legislative enforcement in the water sector should be conducted through the judicial system and, more important, through building public support and stakeholder involvement; publicizing success stories and developing better economic incentives such as fees and subsidies; and education, information dissemination and technical assistance. This also includes developing competent inspection capacities, credible monitoring, accredited and standardized measuring systems and certified reporting systems.

Empowerment

Actors in the water sector have their own roles, rights and responsibilities, often with conflicting interests.[1] Today local community stakeholders and user associations are established in Egypt, Jordan, Libya, Morocco, Oman, Tunisia and Yemen. Integrating all relevant stakeholders into the discussion on distributing water resources is very important for good water governance. Main recommendations include:

- Supporting and facilitating the establishment of water user associations, water-related NGOs and civil society organizations.
- Establishing and supporting research centres and studies on the water sector, especially in finance, research priorities and connections with policy-making platforms.
- Establishing dialogue forums that raise water issues in current policy debates and national priority agendas.
- Guaranteeing legal rights to information access, public participation in decision-making and access to justice in environmental matters, and adapting legislations accordingly.
- Establishing an updated dataset and depository of key publications and statistics on the water sector and its various dimensions.

Reliable, accessible, high-quality water data supports effective governance at every scale.

- Raising public awareness through education, training programmes, interactive initiatives and media, among other means. Major themes can include sustainability, use efficiency and participation and common responsibility. Long-term awareness programmes should be tailored to specific local contexts.

Sustainability: the companion of success

Social, economic and environmental sustainability is a prerequisite. Social sustainability cannot be secured without equity and justice. Active and meaningful engagement of relevant stakeholders should be an established policy at all governance levels. Economic sustainability entails calculating benefits and costs of water governance policies. Other sustainability dimensions include institutional, financial and organizational levels. Environmental sustainability should first and foremost take into account the need for continued water availability. Special attention should be made to rationing renewable water resources. Water governance should also attend to ecological preservation and conservation of natural environments in the Arab region. Countering diversification and preserving wetland ecosystems and oases are among the most urgently needed steps.

Addressing water-related challenges and nexuses

Mitigating water scarcity and variability and ensuring that water of adequate quantity and quality is available when and where it is needed requires broad and sustained efforts of all involved stakeholders, including decision-makers, planners, engineers and the public. A top priority for adaptation in the water sector should be reducing the vulnerabilities of poor and disadvantaged people. Securing environmental and ecological sustainability is another major priority. Coping with water scarcity requires adaptive behaviours and actions. This will allow for better management of challenges such as climate change, water and food security and the water-energy nexus, among others.

Specific water governance challenges are highly contextual and depend on individual country priorities. Main recommendations include:

- Building partnerships with beneficiaries and the private sector, thus encouraging participation in modern, timely and well-monitored and metred water delivery services.
- Expanding water services to vulnerable communities and encouraging local initiatives in building and managing such services.
- Reforming agricultural policies and food crop productivity, taking into consideration the ecological system and water value.
- Increasing irrigation efficiency from its current average levels of about 50 per cent to 70–80 per cent to increase irrigated areas by about 50 per cent and significantly reduce the Arab region’s water deficit and food imports.
- Increasing Arab cooperation in areas of water, food and energy trade. Establishing a common Arab market could be one step in this direction.
- Reforming the energy sector, raising awareness of water’s importance in energy-related decisions and establishing coordination and cooperation schemes between the energy and water sectors.
- Establishing energy-water balance in desalination.
- Researching and developing efficient, reliable and scalable renewable energies, desalination and water treatment technologies that better meet the region’s demands.
- Studying climate change and investigating possible measures to limit its effects or adapt to them.
- Developing emergency and priority intervention plans, especially for more vulnerable, heavily populated areas.
- Setting legal instruments to identify and regulate water rights, regulate water allocation among and within sectors and regulate permit systems for drilling wells.
- Promoting and supporting the use of treated wastewater and drainage water after ensuring its quality treatment.
- Investing in transfer and localization of water-related technologies and knowledge.

This includes researching and testing non-conventional water resources, especially at low scales and for domestic uses.

Finally, the transitions in several Arab countries have resulted in major changes in the political environment through calls for improved democracy, accountability, participation and development. Although these changes are not directly associated with the water sector, they may provide an opportunity to advance overall water governance reforms. Meaningful public participation, good governance and cost effective use of resources require the utmost attention from decision-makers. Balancing evolving demands across sectors such as energy, food, agriculture and industry is critical and will vary according to national priorities and resource availability. While these political transitions increase people's expectations, putting more pressure on governance systems, they can also bring about awareness and increase people's readiness to shoulder more responsibility for scarce resources.

Endnotes

[1] Laban 2008.

Annex I: Cost-benefit analysis versus cost-effectiveness analysis

Cost-benefit analysis

Cost-benefit analysis involves translating all benefits and costs into monetary terms, including non-marketed environmental, social and other impacts.[1] The benefits from an action are compared with the costs (including the opportunity costs) within a common analytical framework. The direct benefits are usually measured physically in widely differing units—for instance, quantities of water generated by desalination plants. Other benefits are intangible and difficult to estimate in physical or monetary terms—for example, reduction in mortality rates due to improved water provision. The same concepts apply to the cost of water options (direct costs, indirect costs, or both). Comparison is enabled through the use of a common monetary term. Benefits and costs of each option should thus be converted into monetary values in a given time period and compared with the common scenario that would prevail if no action was taken. The net benefit of each alternative option is given by the difference between the costs and benefits. The most economically efficient option is that with the highest present value of net benefits (net present value). Economic efficiency requires selecting the option with maximum net present value, assuming that various options involve equal investments. Options are economically viable only where the net present value that they generate is positive or the present value of total benefits equals or exceeds the present values of total cost. (B/C => 1)

The key elements for cost-benefit analysis in the water sector include:

- Identifying possible alternatives for intervention, including maintaining the status quo (business-as-usual or no action).
- Determining the scope of the analysis, which involves identifying key stakeholders and the costs and benefits associated with each identified individual and group, compared with the status quo.[2]
- Systematically assessing the benefits and costs of various alternatives, based on a common unit of measurement (money).
- Identifying all benefits and costs associated with each alternative, including societal benefits and costs. This means incorporating both private and external costs and benefits, such as treatment costs borne by members of the community in case of sickness caused by drinking contaminated water.
- Measuring external benefits and costs, including environmental benefits and costs, using methods appropriate for them and the degree of uncertainty in available data. In this context, many methods are available to measure or estimate the monetary values of benefits and costs, but not all of them will lead to meaningful results.[3]
- Dealing with the benefits and costs associated with the activity over its life span, meaning future values of benefits and costs are included in present values.
- Applying fixed criteria or objectives to reach a decision and the most common standard criteria used in the cost-benefit analysis are the net present value and benefit-cost ratio.

Cost-effectiveness analysis

Cost-effectiveness analysis (also known as least-cost analysis) is used to identify the most cost-effective option for achieving a set of predefined objectives. The most cost-effective option is identified as that with the lowest present value to meet the same level of objective. "Cost-effectiveness analysis is a tool that can help to ensure efficient use of investment resources in sectors where benefits are difficult to value, or when the information required is difficult to determine or, in any other cases, when any attempt to make a precise monetary measurement of benefits that would be tricky or open to considerable dispute. It is a tool for the selection of alternative projects with the same objectives quantified in physical terms. It can identify the alternative that, for a given output level, minimizes the actual value of costs, or, alternatively, for a given cost, it maximizes the output level."[4]

Applying cost-effectiveness analysis involves the following steps:[5]

- Drafting alternatives that can achieve a set of objectives and determine the degree of compatibility between the alternatives, including the option of maintaining the status quo (business-as-usual or no action).
- Determining the scope of the analysis, which involves identifying key stakeholders and their associated costs.
- Estimating the costs of each alternative, not only in financial costs (capital, operation or maintenance costs) but also in economic costs from a social perspective, regardless of whether they are incurred by the government, donors or beneficiaries.
- Excluding alternatives that can neither meet the intended objectives nor attain them at a higher cost than other alternatives.
- Integrating the assessment of successive alternatives and incremental costs, if any, to determine the overall cost of the alternatives that can achieve the ultimate goal in phases.

The disadvantage of cost-effectiveness analysis is that it does not identify the benefits of actions or society's willingness to pay for improving the environment by implementing water and sanitation projects, which are important considerations in many decisions.[6]

The following underlines some of the limitations and drawbacks of cost-effectiveness analysis:

- Cost-effectiveness analysis points to the least-cost combination of measures to achieve an objective. Regarding water deficits, for example, uncertainties on costs and water yields are serious limits to the relevance of the results. These uncertainties can significantly bias the ranking of the measures.
- Cost-effectiveness analysis can be applied easily to quantitative and qualitative water issues, but applying it to ecological issues is more challenging. The effectiveness of actions is more difficult to assess when habitats and biodiversity are considered.
- Many options and measures are hard to quantify physically. Either they have to be omitted from the analysis or their effects have to be estimated very roughly. This will lead to bias in the result.
- Other biases in the formulation of actions or measures can result from the omission of time lags, synergy effects and transport coefficients from the calculations. Although these aspects can be taken into account in quantitative cost-effective analyses, they are often omitted for a practical convenience.
- Ranking biases can occur if the multiple effects of measures are neglected and a selection is made accounting for only a series of multiple objectives for a body of water.
- It is used to make comparisons between alternatives that have the same scope. It cannot be used for projects with different objectives or for a project with multiple objectives.[7]

Endnotes

[1] Turner and others 2004.
[2] Mitchell and others 2007.
[3] Chong, Kazaglis, and Giurco 2008.
[4] EC 2009.
[5] Gerasidi and others 2003.
[6] Turner and others 2004.
[7] Aulong and others 2008.

Annex II: Water institutions and legislation in Arab countries

Table A.2.1 Water institutional settings and legislation in Arab countries

Country and institution/setting	Authority/law name	Source
Algeria		Ministry of Water Resources of Algeria (www.mre.gov.dz/eau/organisation.html)
Legislation	Water Law 2005	
Main water resources management (WRM) administration	Ministry of Water Resources (MRE)	
Drinking water supply institution	Algérienne des Eaux ADE (Algerian of Waters), under MRE	
Sanitation institution	Office National de l'Assainissement (National Sanitation Office), under MRE	
Irrigation management institution	Office National de l'Irrigation et du Drainage (National Office of Irrigation and Drainage), under MRE	
Intersectoral coordination	Agences de bassins hydrographiques, comité de bassin (watershed agencies, basin committees)	
Territorial water management	Five basin organizations	
Water master plan	National Water Plan in progress (2010–2030)	Karracha (2010)
Bahrain		GWI (2010)
Legislation	No water law or legislation in place (only privately owned water use rights)	FAO (2008)
Main WRM administration	Ministry of Works, Ministry of Energy and Ministry of Municipalities Affairs and Urban Planning	
Drinking water supply institution	Electricity and Water Authority	
Sanitation institution	Ministry of Works	
Irrigation management institution	Ministry of Municipalities Affairs and Urban Affairs	FAO (2008)
Intersectoral coordination	High Council for Water Resources	FAO (1997)
Territorial water management	..	
Water master plan	None	FAO (2008)
Egypt		Egypt Ministry of Water Resources and Irrigation (www.mwri.gov.eg/En/)
Legislation	Many laws, including Law 48/1982 for the protection of the Nile River and water ways, Law 12/1984 on Irrigation and Drainage, and Law 4/1992 for the environment.	
Main WRM administration	Ministry of Water Resources & Irrigation (MWRI)	
Drinking water supply institution	Ministry of Drinking Water and Sanitation Facilities	GWI (2012)

Sanitation institution	Ministry of Drinking Water and Sanitation Facilities	GWI (2012)
Irrigation management institution	MWRI	
Intersectoral coordination	Ministerial committee at the Cabinet level	World Bank (2006)
Territorial water management	Nile Water Sector and Groundwater Sector	
Water master plan	National Water Resources Plan (issued in 2005 and valid until 2017)	
Jordan		Jordan Ministry of Water and Irrigation (www.mwi.gov.jo/sites/en-us/default.aspx)
Legislation	Several laws (Jordan Water Authority Law 18/1998; Law 30/2001 for Jordan Valley development; Law 85/2002 for the control of the use of groundwater; Provisional Law 1/2003 for the protection of the environment)	World Bank (2009)
Main WRM administration	Ministry of Water and Irrigation	
Drinking water supply institution	Water Authority of Jordan (national)	Water Authority of Jordan (www.waj.gov.jo/sites/en-us/default.aspx)
Sanitation institution	Water Authority of Jordan (national)	Water Authority of Jordan (www.waj.gov.jo/sites/en-us/default.aspx)
Irrigation management institution	Jordan Valley Authority/Ministry of Agriculture	Jordan Valley Authority (www.jva.gov.jo/sites/en-us/default.aspx)
Intersectoral coordination	Ministry of Water and Irrigation	
Territorial water management	Local	
Water master plan	National Water Master Plan (launched in 2004, currently in progress) and National Water Strategy 2009–2022	
Kuwait		World Bank (2005)
Legislation		
Main WRM administration	Ministry of Electricity and Water	
Drinking water supply institution	..	
Sanitation institution	Ministry of Public Works	
Irrigation management institution	Public Authority for Agricultural Affairs and Fish Resources Soil and Water Division	FAO (1997)
Intersectoral coordination	..	
Territorial water management	Informal	
Water master plan	In process	Dar Gulf Consult (n.d.)

Lebanon		Lebanon Ministry of Energy and Water (www.energyandwater.gov.lb/)
Legislation	Several laws (Water Law 221/2000 to organize and identify the roles of four water authorities; laws to establish water consumption tariffs in industrial and domestic sectors); National Water Sector Strategy (2012)	
Main WRM administration	Ministry of Energy and Water; four regional water establishments; Litani River Authority; Council for the South; Council for Development and Reconstruction; Ministry of Finance; High Commission for the Displaced	
Drinking water supply institution	Regional water establishments	
Sanitation institution	Regional water establishments	
Irrigation management institution	Regional water establishments and Litani River Authority	
Intersectoral coordination	National (interministerial)	
Territorial water management	Regional water establishments and Litani River Authority	
Water master plan	Ten-year plan issued in 2000 (extended until 2018)	
Morocco		INECO (2009a)
Legislation	Several laws, including Water Law 10 of 1995 (Grounds for the Law and Benefits of Water Legislation)	
Main WRM administration	Ministry of Energy, Mines, Water and Environment; Secrétariat d'Etat Chargé de l'Eau et de l'Environnment (Secretary of State for Water and Environment Ministry of Finance and Privatisation; Ministry of Health; Ministry of Agriculture, Rural Development and Sea Fisheries; Ministry of Interior; Ministry of Economic Affairs	
Drinking water supply institution	Office National de l'Eau Potable (National Water Utility); private concessionaries; and local public water utilities (régies)	
Sanitation institution	Office National de l'Eau Potable (National Water Utility); private concessionaries; and local public water utilities (régies)	
Irrigation management institution	Offices Régionaux de Mise en Valeur Agricole (Regional Offices for Agricultural Development); Ministry of Agriculture, Rural Development and Sea Fisheries	
Intersectoral coordination	Supreme Council for Water and Climate (Water Inter-Ministerial Committee)	
Territorial water management	Hydraulic basin agencies	
Water master plan	National Water Strategy 2009–2030	AfDB (2009)

Oman		Al-Habsi and Al-Hosnui (2009)
Legislation	Several decrees, including Water Wealth Protection Law (2000); Royal Decree 114 of 2001: Issuing the Law on Conservation of the Environment and Prevention from Pollution; Royal Decree 115 of 2001: Issuing Law on Protection of Sources of Potable Water from Pollution; Royal Decree 78 of 2004: Law for the Regulation and Privatisation of the Electricity and Related Water Sector	World Law Guide (2011); USAID (2010)
Main WRM administration	Ministry of Regional Municipalities and Water Resources; Ministry of Environment and Climate Affairs	World Bank (2005)
Drinking water supply institution	Public Authority for Water and Electricity	
Sanitation institution	Haya Water, originally operating as Oman Wastewater Services Company (Muscat Governorate)	AWC (2011)
	Salalah Sanitary Drainage Services Company (Salalah)	
	Sohar Development Office (Sohar)	
	Ministry of Regional Municipalities and Water Resources (rest of country)	
Irrigation management institution	Ministry of Agriculture and Fisheries	
Intersectoral coordination	Ministry of Regional Municipalities and Water Resources	
Territorial water management	Regional governorates	
Water master plan	National Water Resources Master Plan (2001–2020)	
Palestine		SEMIDE-EMWIS (2005)
Legislation	Water Law 2002; several decrees and by-laws	
Main WRM administration	Palestinian Water Authority	
Drinking water supply institution	Regional water utilities (the West Bank Water Department in the West Bank; the Coastal Municipal Water utility in the Gaza Strip); municipalities; village councils; joint service/subregional councils	
Sanitation institution	Regional water utilities (the West Bank Water Department in the West Bank; the Coastal Municipal Water Utility in the Gaza Strip); municipalities; village councils; joint service/subregional councils	
Irrigation management institution	Palestinian Water Authority; Ministry of Agriculture	
Intersectoral coordination	National Water Council	
Territorial water management	Regional water utilities; municipalities; village councils; joint service/subregional councils	

Water master plan	National Water Plan 2000–2020	
Qatar		GWI (2011)
Legislation	New water law by 2016 (water decrees are included in the Issuance Law of Environment Protection of 2002)	Qatar Embassy (2002)
Main WRM administration	Ministry of Energy and Industry	
Drinking water supply institution	Qatar Electricity and Water Corporation KahraMaa	
Sanitation institution	Public Works Authority Ashghal	
Irrigation management institution	Ministry of Municipal Affairs and Urban Planning	
Intersectoral coordination	Permanent Water Resources Committee	
Territorial water management	..	
Water master plan	30-year power and water master plan (completed in 2008 and in the process of being approved)	
Saudi Arabia		FAO (2008)
Legislation	Comprehensive Water Act and regulations	WWC (2012)
Main WRM administration	Ministry of Water and Electricity	
Drinking water supply institution	National Water Company and private companies (through management, operations and maintenance, build-operate-transfer projects, build-own-operate projects and concession agreements)	NWC (2011)
Sanitation institution	National Water Company and private companies (through management, operations and maintenance, build-operate-transfer projects, build-own-operate projects and concession agreements)	NWC (2011)
Irrigation management institution	General Administration of Irrigation Affairs (under Ministry of Agriculture)	
Intersectoral coordination	Ministry of Water and Electricity	
Territorial water management	Local water agencies and authorities	WWC (2012)
Water master plan	National Water Sector Plan under preparation; National Water Strategy under review	UNDP (2012)
Syria		INECO (2009b)
Legislation	Several laws, including Water Law (2005)	
Main WRM administration	Ministry of Water Resources (General Commission for Water Resources Management)[a]	
Drinking water supply institution	Ministry of Housing and Urban Development[b]	
Sanitation institution	Ministry of Housing and Urban Development	
Irrigation management institution	Ministry of Water Resources	
Intersectoral coordination	Higher Water Committee	
Territorial water management	Public drinking water and sewerage establishments	UNW-AIS (2012)

Water master plan	National Water Strategy 2003–2030 (includes provisions for the elaboration of an integrated water resources management plan)[c]	SWIM (2012)
Tunisia		INECO (2009c)
Legislation	Water Code of 1975 (Code des Eaux)	
Main WRM administration	Ministère de l'Agriculture, des Ressources Hydrauliques et de la Pêche (Ministry of Agriculture, Water Resources and Fisheries)	
Drinking water supply institution	Société Nationale d'Exploitation et de Distribution des Eaux (National Water Distribution Utility) in urban areas and agglomerated rural areas; associations of collective interest or Groupements d'Intérêt collectif in dispersed rural areas	UNDP-WGP-AS (2011)
Sanitation institution	Office National de l'Assainissement (National Sanitation Utility)	
Irrigation management institution	La Direction Générale du Génie Rural et de l'Exploitation des Eaux (General Directorate for Rural Engineering and Water Exploitation)	
Intersectoral coordination	Comité National de l'Eau (National Water Committee)	El Hedi Louati, Mellouli, and El Echi (2005)
Territorial water management	Commissariats Régionaux au Développement Agricole (Regional Departments for Agricultural Development)	
Water master plan	Ten-year Strategy of Water Resources (2001–2011); Long-term Water Strategy (2003–2030)	Hamza (2010)
United Arab Emirates		FAO (1997)
Legislation	No comprehensive water law (several federal laws as part of environment and aquatic resources federal laws); Law 17 of 2005 for wastewater; a new water resources law is under final review	
Main WRM administration	Ministry of Energy; Ministry of Environment and Water	
Drinking water supply institution	Federal Water and Electricity Authority; Abu Dhabi Water and Electricity Authority; Dubai Electricity and Water Authority; Sharjah Electricity and Water Authority	Italian Trade Promotion Agency (2012)
Sanitation institution	Ministry of Environment and Water	
Irrigation management institution	Ministry of Environment and Water	
Intersectoral coordination	Water and Electricity Council	United Arab Emirates Cabinet (n.d.)
Territorial water management	General Water Resources Authority	

Water master plan	National Water Conservation Strategy (2010–2021)	Al-Mulla (2011)
	Abu Dhabi Water Resources Master Plan	
	Environment Agency Abu Dhabi's Environment Vision 2030	EAD (2010)
	Environment Agency Abu Dhabi's 5-year Strategic Plan (2009–2013)	EAD (2009a; 2009b)
Yemen		GTZ, World Bank, and Republic of Yemen (2007)
Legislation	Framework Water Law 33 (passed in 2002 and amended in 2006; by-law passed in 2011)	GTZ, World Bank, and Republic of Yemen (2009); Yemeni-German Technical Cooperation (2011)
Main WRM administration	National Water Resources Authority	
Drinking water supply institution	National Water and Sanitation Authority, local corporations and autonomous public utilities affiliated with local corporations (urban areas)	
	General Authority for Rural Water Supply Projects (rural areas)	
Sanitation institution	National Water and Sanitation Authority, local corporations and autonomous public utilities affiliated with local corporations (urban areas)	
	General Authority for Rural Water Supply Projects (rural areas)	
Irrigation management institution	Ministry of Agriculture and Irrigation	
Intersectoral coordination	Ministry of Water and Environment	
Territorial water management	Ministry of Local Administration (local councils)	
Water master plan	National Water Sector Strategy and Investment Program (2009–2015)	GTZ, World Bank, and Republic of Yemen (2007)

a. Ministry of Water Resources assumed the tasks of the former Ministry of Irrigation after the issuance of presidential decree No.44 for 2012 (Day Press News, 23 June 2012: www.dp-news.com/en/detail.aspx?articleid=124241).

b. Ministry of Housing and Urban Development assumed the tasks of the former Ministry of Housing after the issuance of presidential decree No. 45 for 2012 (Day Press News, 23 June 2012: www.dp-news.com/en/detail.aspx?articleid=124241).

c. Project funded by the European Union.

Table A.2.2 List of major water-related NGOs in the Arab region

Institutions	Website	Type	Focus
Arab Healthy Water Association	www.mgwater.com/arabhwa.shtml	Local NGO	Water quality, health-related issues and water conservation
Arab Integrated Water Resources Management Network	http://waterwiki.net/index.php/AWARENET.org	Regional	Training and research on IWRM
Arab Urban Development Institute, Environment Centre for Arab Towns	www.araburban.com	NGO	Regional, non-governmental, nonprofit urban research, technical and consulting organization
Arab Water Academy	www.awacademy.ae/	Regional	Regional centre of excellence, water scarcity issues, education and capacity development programs
Center for Environment and Development for the Arab Region and Europe	www.cedare.int/	Regional	Environment and development
Center of Arab Women for Training and Research	www.cawtar.org/	Regional (gender)	Research, training and networking
Euro-Mediterranean Water Information System	www.emwis.net/overview	Regional	Training, research, exchanging information and knowledge in the water sector, assistance and financing
International Network on Water, Environment and Health (Dubai marine laboratory)	www.inweh.unu.edu/index.html	Canada, with regional office in Dubai	Education and research
Middle East Desalination Research Center	http://www.medrc.org/index.cfm?area=about	Regional research centre	Desalination and water reuse technology, research studies and technical assistance
National Center for Water Research, King Abdel-Aziz City for Science and Technology	www.kacst.edu.sa/en/about/centers/Pages/ncw.aspx	National centre	Water resources, water technologies, water pollution
The Nile Basin Initiative	www.nilebasin.org/index.php?option=com_content&task=view&id=13&Itemid=42	Regional	Water resources
Water Research Center, King Abdulaziz University	http://wrc.kau.edu.sa/Default.aspx?Site_ID=123&Lng=EN	Research centre	Water resources, water and waste treatment, coastal pollution
Water Science and Technology Association	http://wstagcc.org/	Regional	Water issues in Gulf Cooperation Council countries

Source: The Report team.

Annex III: Statistics

Table A.3.1 Physical characteristics of Arab countries

Country	Area, 2011 (thousand square kilometres)	Length of coast, 2005 (kilometres)	Rainfall, 2002 (millimetres per year)	Total actual renewable water sources, 2011 (109 cubic metres per year)
Algeria	2,381.74	998	257	11.67
Bahrain	0.76	161	..	0.12
Comoros	1.86	340	2,448	1.2
Djibouti	23.2	314	107[a]	0.3
Egypt	1,001.45	2,450	107	57.3
Iraq	435.24	58	225[b]	89.86
Jordan	89.32	26	179	0.94
Kuwait	17.82	499	36	0.02
Lebanon	10.45	225	656	4.5
Libya	1,759.54	1,770	131	0.7
Mauritania	1,030.70	754	199	11.4
Morocco	446.55	1,835	340	29
Oman	309.5	2,092	29	1.4
Palestine	6.02	40	..	0.84
Qatar	11.61	563	36[b]	0.06
Saudi Arabia	2,149.69	2,640	151	2.4
Somalia	637.66	3,025	408[a]	14.7
Sudan	1,879.36	853	741[c]	64.50[c]
Syria	185.18	193	366	16.8
Tunisia	163.61	1,148	355	4.6
UAE	8.36	1,318	52	0.15
Yemen	527.97	1,906	231	2.1

a. Data are for 1999.

b. Data are for 1998.

c. Available only for Sudan former—currently Sudan (Arab state) and South Sudan (non-Arab state).

Source: FAO 2013; UNDESA 2011; UNDP 2013.

Table A.3.2 Conventional water resources availability in Arab countries, 2011 (10^9 cubic metres per year)

Country	Surface water: total renewable		Groundwater: total renewable		Water dependency ratio
	Actual	Natural	Actual	Natural	
Algeria	10.2	10.2	1.5	1.5	3.6
Bahrain	0.0	0.0	0.1	0.1	96.6
Comoros	0.2	0.2	1.0	1.0	0.0
Djibouti	0.3	0.3	0.0	0.0	0.0
Egypt	56.0	84.5	1.3	1.3	96.9
Iraq	88.6	95.3	3.3	3.3	60.8
Jordan	0.7	1.2	0.5	0.7	27.2
Kuwait	0.0	0.0	0.0	0.0	100.0
Lebanon	3.8	4.1	3.2	3.2	0.8
Libya	0.2	0.2	0.6	0.6	0.0
Mauritania	11.1	11.1	0.3	0.3	96.5
Morocco	22.0	22.0	10.0	10.0	0.0
Oman	1.1	1.1	1.3	1.3	0.0
Palestine	0.1	0.1	0.8	0.8	3.0
Qatar	0.0	0.0	0.1	0.1	3.5
Saudi Arabia	2.2	2.2	2.2	2.2	0.0
Somalia	14.4	14.4	3.3	3.3	59.2
Sudan	62.5	147.0	7.0	7.0	76.9
Syria	12.6	41.8	6.2	16.0	72.4
Tunisia	3.4	3.4	1.6	1.6	8.7
UAE	0.2	0.2	0.1	0.1	0.0
Yemen	2.0	2.0	1.5	1.5	0.0

Source: FAO 2013.

Table A.3.3 Nonconventional water resources availability in Arab countries, various years (10^9 cubic metres per year)

Country	Desalinated water produced	Treated wastewater (municipal)			
		Produced municipal wastewater	Collected municipal wastewater	Treated municipal wastewater	Direct use of treated municipal wastewater
Algeria	0.017 (2002)	0.73 (2010)	0.150 (2010)	0.15 (2010)	..
Bahrain	0.102 (2003)	0.08 (1997)	0.073 (1997)	0.06 (2005)	0.016 (2005)
Djibouti	0.0001 (2000)	..	..	..	0.0001 (2000)
Egypt	0.100 (2002)	8.50 (2011)	6.500 (2011)	4.80 (2011)	0.700 (2011)
Iraq	0.007 (2000)	..	0.579 (2009)	..	..
Jordan	0.100 (2005)	0.18 (2008)	0.118 (2010)	0.11 (2010)	0.084 (2005)
Kuwait	0.420 (2002)	0.25 (2008)	..	0.25 (2005)	0.078 (2002)
Lebanon	0.473 (2006)	0.31 (2011)	0.103 (2009)	0.004 (2006)	0.002 (1991)
Libya	0.018 (2000)	0.55 (1999)	0.167 (2009)	0.04 (2009)	0.040 (1999)
Mauritania	0.002 (2000)	..	..	0.0007 (1998)	0.0007 (1998)
Morocco	0.007 (2000)	0.70 (2010)	0.292 (1991)	0.12 (2010)	0.070 (2008)
Palestine	..	..	..	..	0.010 (1998)
Oman	0.109 (2006)	0.09 (2000)	0.073 (2009)	0.04 (2006)	0.037 (2006)
Qatar	0.180 (2005)	0.06 (2005)		0.06 (2006)	0.043 (2005)
Saudi Arabia	1.033 (2006)	0.73 (2000)	0.649 (2009)	0.67 (2003)	0.217 (2006)
Somalia	0.0001 (2000)	..	..	0.0 (2003)	..
Sudan and South Sudan	0.0004 (2000)	..	..	..	..
Syria	..	1.36 (2002)	0.302 (2009)	0.55 (2002)	0.550 (2002)
Tunisia	0.013 (2001)	0.25 (2010)	0.240 (2003)	0.19 (2008)	0.068 (2010)
UAE	0.950 (2005)	0.50 (1995)	..	0.29 (2006)	0.248 (2005)
Yemen	0.025 (2006)	0.07 (2000)	0.136 (2009)	0.0 (1999)	0.006 (2000)

Note: Insufficient data for Comoros.

Source: FAO 2013.

Table A.3.4 Fluctuations in renewable water resources availability from 1962 to 2011 (cubic metres per capita per year)

Country	1962	1972	1982	1992	2002	2011
Algeria	1,041	799	581	439	371	324
Bahrain	674	509	302	223	181	88
Comoros	6,000	4,819	3,409	2,609	2,024	1,592
Djibouti	3,125	1,648	824	505	392	331
Egypt	1,948	1,525	1,216	971	817	694
Iraq	11,561	8,398	6,215	4,879	3,561	2,751
Jordan	965	513	378	246	188	148
Kuwait	59	23	13	10	10	7.097
Lebanon	2,220	1,733	1,592	1,438	1,164	1,057
Libya	482	323	207	155	129	109
Mauritania	12,611	9,492	7,090	5,408	4,071	3,219
Morocco	2,363	1,801	1,406	1,129	985	899
Oman	2,397	1,779	1,059	689	608	492
Palestine	742	709	523	370	249	202
Qatar	1,036	450	211	119	93	31
Saudi Arabia	557	380	216	140	112	85
Somalia	4,980	4,001	2,225	2,247	1,887	1,538
Sudan and South Sudan	5,321	4,125	3,006	2,315	1,801	1,445
Syria	3,448	2,464	1,760	1,286	990	809
Tunisia	1,050	863	676	539	477	434
UAE	1,376	464	130	74	46	19
Yemen	395	332	244	159	112	85

Source: FAO 2013.

Table A.3.5 Major drainage basins in the Arab region

Basin	Basin tributaries	Basin size (thousand square kilometres)	River length (kilometres)	Average discharge (million cubic metres per year)	Countries
Euphrates	Sajour, Jallab/ Balikh, Khabour	500	2,781	33,500[a]	Iraq, Syria, Turkey and Iran
Jordan-Yarmouk	Yarmouk, Banias, Hasbani, Jordan	18[b]	251[b]	250–300[c]	Lebanon, Syria, Jordan, Palestine and Israel
Nahr Al Kebir[d]		1	90	330	Lebanon and Syria
Nileb	White Nile, Sobat, Blue Nile	3,400	6,695	109,500	Egypt, Sudan, South Sudan, Burundi, Congo, Eritrea, Ethiopia, Rwanda, Tanzania and Uganda
Orontes (Al-Assi)[d]	Afrin and Karasu	38	448	2,800	Lebanon, Syria and Turkey
Senegal		218	1,790	24,400	Senegal, Mauritania and Mali
Tigris	Batman, Khabour, Greater Zab, Lesser Zab, Adhaim, Diyala, Cizre, Wadi Tharthar	375	1,850	50,000[a]	Iraq, Syria and Turkey

a. UN-ESCWA 2009a.
b. Nile Basin Initiative n.d.b.
c. Kliot 2000.
d. UN-ESCWA and BGR 2013.

Table A.3.6 Characteristics of selected non-renewable shared aquifers

Aquifer	Area (square kilometres)	Shared countries	Renewability (millimetres per year)	Thickness (metres)	Average annual abstraction (million cubic metres)	Water quality (milligrams per litre [total dissolved solids])
Jabal El Arab Basaltic	8,500	Syria, Jordan	South: medium North: high	<100m - >500m	Northern part: 15–20	Mainly fresh, brackish in some areas
Neogene Aquifer System (North-West), upper and lower Fars: Jezira basin	65,000	Iraq, Syria	Medium to high 20 ->100	500–550	..	Most common: brackish to saline (2,000–4,000)
Neogene Aquifer System (South-East), Dibdibba-Kuwait Group: Dibdibba Delta basin	153,000	Iraq, Kuwait, Saudi Arabia	0–20	30–200 (common range) Maximum: 550	Iraq: ~370 Kuwait: 88	Brackish to saline (2,500–15,000)
Nubian Sandstone	200,000	Libya, Egypt, Sudan, Chad	..	500-3500	..	Fresh in the south to hypersaline in the north
Saq-Ram Aquifer System (West)	308,000	Jordan, Saudi Arabia	Low (2–20)	250–700	Jordan: 90 Saudi Arabia: > 1,000	Fresh (mostly < 1,000)
Um Er Raduma Dammam Aquifer System (South): Rub' al Khali	680,000	Oman, Saudi Arabia, United Arab Emirates, Yemen	Very low to low (0–20)	Dammam: 60–490 Umm er Radhuma: 50–550	Oman: 45 United Arab Emirates: 8	Fresh to hypersaline
Umm er Radhuma-Dammam Aquifer System (Centre): Gulf	281,000	Bahrain, Qatar, Saudi Arabia	Very low to low (0–20)	Dammam: 35–180 Umm er Radhuma: 240–500	Bahrain: Dammam: 97 (2010) Umm er Radhuma: 54.3 (2006) Qatar: 91 (1983) Saudi Arabia: ~608 (2006)	Fresh (mostly < 1 to hypersaline in some coastal areas
Umm er Radhuma-Dammam Aquifer System (North): Widyan-Salman	246,000	Iraq, Kuwait, Saudi Arabia	Very low to low (0–20)	Dammam: 30–80 Umm er Radhuma: 240–600	Iraq:~45 (early 1990s) Kuwait: ~90 (1993)	Fresh to hypersaline
Wajid aquifer system	455,000	Saudi Arabia, Yemen	Very low to low (0–20)	100–900 (average: 300)	Saudi Arabia: 2,260 (2004) Yemen: ~100 (2002)	Fresh to slightly brackish (700–1,000)
Wasia-Biyadh-Aruma (North): Sakaka-Rutba	~112,000	Saudi Arabia, Iraq	Very low to low (0–20)	Iraq: 250 Saudi Arabia: 400	≥ 30–35	Fresh to slightly brackish (400–3,000)
Wasia-Biyadh-Aruma (South): Tawila-Mahra/Cretaceous Sands	157,000	Saudi Arabia, Yemen	Very low (0–2)	100–200	Unknown, but very limited	Fresh (400–800)

Source: UN-ESCWA and BGR 2013 ; UN-ESCWA, 2009a.

Table A.3.7 Agricultural land and land use in Arab countries, 1990 and 2011 (Thousand hectares)

Country	Area	Inland water	Land area	Agricultural area		Arable land		Permanent crops		Forest area	
	2011	2011	2011	1990	2011	1990	2011	1990	2011	1990	2011
Algeria	238,174	..	238,174	38,676	41,211	7,081	7,511	554	852	1,667	1,536
Bahrain	76	..	76	8	8.7	2	1.5	2	3	0.2	0.5
Comoros	186	..	186	128	148	78	80	35	53	12	5
Djibouti	2,320	2	2,318	1,299	1,701	1	1	..	..	6	6
Egypt	100,145	600	99,545	2,648	3,523	2,284	2,563	364	960	44	67
Iraq	43,524	92	43,432	9,230	9,390	5,000	5,200	230	190	804	825
Jordan	8,932	54	8,878	1,040	1,013	179.2	185	70	86	98	98
Kuwait	1,782	..	1,782	141	150	4	11	1	3	4	6
Lebanon	1,045	22	1,023	605	653	183	142	122	141	131	137
Libya	175,954	..	175,954	15,455	15,585	1,805	1,750	350	335	217	217
Mauritania	103,070	..	103,070	39,656	39,661	400	400	6	11	415	267
Morocco	44,655	25	44,630	30,343	29,989	8,707	8,122	736	867	5,049	5,081
Oman	30,950	..	30,950	1,080	1,765	35	28	45	37	2	2
Palestine	602	..	602	375	364	109	99	115	114.8	9	9
Qatar	1,161	..	1,161	61	64	10	12	1	2	0	0
Saudi Arabia	214,969		214,969	123,481	173,717	3,390	3,500	91	217	977	977
Somalia	63,766	1,032	62,734	44,042	44,377	1,022	1,350	20	27	8,282	7,131
Sudan	187,936	..	..	..	..	..	..	..	..	..	..
Sudan (former)	..	..	..	122,910	135,220	12,800	18,750	110	130	76,381	70,220
Syria	18,518	155	18,363	13,495	13,828	4,885	4,675	741	887	372	461
Tunisia	16,361	825	15,536	8,644	9,824	2,909	2,730	1,942	2,166	643	924
UAE	8,360	..	8,360	285	562	35	68	20	189	245	312
Yemen	52,797	..	52,797	23,626	23,523	1,523	1,287	103	236	549	549

Source: FAO 2013.

Table A.3.8 Water losses in the water supply distribution system in selected Arab countries, 2005

Country	% of loss
Bahrain	15
Egypt	50
Iraq	50
Jordan	50
Kuwait	8–10
Lebanon	50
Oman	23
Palestine	40
Saudi Arabia	25–40
Syria	48
Yemen	30

Source: FAO 2013.

Table A.3.9 Investments needs in water supply and sanitation facilities in selected Arab countries, 2000–2025

Country	Required water supply coverage (thousands of people)	Investment needs in water supply, ($ millions)	Percentage share of regional investment in water	Required sanitation coverage (thousands of people)	Investment needs in sanitation, ($ millions)	Percentage share of regional investment for sanitation
Bahrain	247.0	19.3	0.2	247.0	34.0	0.2
Egypt	28930.0	2260.0	21.1	28251.0	3862.0	20.3
Iraq	20794.0	1624.0	15.1	22171.0	3031.0	15.9
Jordan	3950.0	309.0	2.9	3802.0	520.0	2.7
Kuwait	1305.0	102.0	1.0	1343.0	184.0	1.0
Lebanon	1084.0	85.0	0.8	1119.0	153.0	0.8
Oman	4421.0	346.0	3.2	3076.0	421.0	2.2
Palestine	4401.0	344.0	3.2	3954.0	541.0	2.8
Qatar	189.0	15.0	0.1	206.0	28.0	0.2
Saudi Arabia	21144.0	1652.0	15.4	20127.0	2752.0	14.5
Syria	14460.0	1130.0	10.5	12841.0	1756.0	9.2
UAE	862.0	67.0	0.6	940.0	129.0	0.7
Yemen	35545.0	2777.0	25.9	41233.0	5637.0	29.6

Source: UN-ESCWA 2003.

Table A.3.10 Total dam capacity and share of freshwater stored in reservoirs in selected Arab countries

Country	Estimated total dam capacity (cubic kilometres)	Share of total freshwater resources stored in reservoirs (%)	Share of Arab region's total dam capacity (%)	Per capita dam capacity, 2008 (cubic metres)
Algeria	5.68 (2008)	51.5	2.2	158 (2008)
Bahrain	0 (1995)	..	..	0 (1995)
Egypt	168.20 (2008)	289.9	64.6	2,038 (2008)
Iraq	151.80 (2008)	66.6	19.2	4,647 (2008)
Jordan	0.27 (2008)	16.3	0	43 (2008)
Lebanon	0.23 (2008)	5.7	0.1	54 (2008)
Libya	0.38 (2008)	64.5	0.2	60 (2008)
Mauritania	0.50 (2008)	..	..	141 (2008)
Morocco	16.90 (2008)	55.5	6.2	524 (2008)
Oman	0.09 (2008)	5.9	0	31 (2008)
Palestine	0 (1997)	..	..	0 (1997)
Saudi Arabia	1.00 (2008)	35	0.3	36 (2008)
Somalia	0 (2003)	..	..	0 (2003)
Sudan	8.73 (2008)	..	..	196 (2008)
Syria	19.65 (2007)	60.4	6.1	1,017 (2007)
Tunisia	2.51 (2008)	55.6	1	237 (2008)
UAE	0.06 (2008)	53.3	0	8 (2008)
Yemen	0.46 (2006)	4.4	0.1	21 (2006)

Note: The share of freshwater refers to total actual renewable water resources; countries not listed (Comoros, Djibouti, Kuwait and Qatar) do not have dams.
Source: World Bank 2007; FAO 2013.

Table A.3.11 Socio-economic profile of Arab countries

Country	Population, 2011 (millions)	People per square kilometre, 2010	Rural population (% of total)	Urban population (% of total)	Population growth, 2011 (%)	GDP per capita, 2011 (PPP $)
Algeria	36.0	14.9	27.1	72.9	1.4	5244.0
Bahrain	1.3	1660.3	11.3	88.7	4.8	18,184.2[a]
Comoros	0.8	395.0	71.9	28.1	2.6	809.6
Djibouti	0.9	38.3	22.9	77.1	1.9	1,202.9[b]
Egypt	82.5	81.5	56.5	43.5	1.7	2781.0
Iraq	33.0	73.8	33.5	66.5	2.9	3500.7
Jordan	6.2	68.1	17.3	82.7	2.2	4665.9
Kuwait	2.8	153.6	1.8	98.3	2.9	62664.1
Lebanon	4.3	413.3	12.8	87.3	0.8	9413.1
Libya	6.4	3.6	22.3	77.7	1.1	9,957.5[b]
Mauritania	3.5	3.4	58.5	41.5	2.3	1150.8
Morocco	32.3	71.6	43.0	57.0	1.0	3053.5
Oman	2.9	9.0	26.6	73.4	2.3	25220.6
Palestine	4.0	648.7	25.7	74.4	2.9	..
Qatar	1.9	151.8	1.2	98.8	6.1	92501.5
Saudi Arabia	28.1	12.8	17.7	82.3	2.3	20540.3
Somalia	9.6	14.9	62.2	37.8	2.4	..
Sudan	34.3	18.3	66.8	33.2	2.1	1435.1
Syria	20.8	111.4	43.9	56.1	1.8	2,892.8[a]
Tunisia	10.7	67.9	33.7	66.3	1.04[a]	4296.9
UAE	7.9	89.9	15.7	84.3	4.9	45653.1
Yemen	24.8	45.6	67.7	32.3	3.1	1361.2

PPP is purchasing power parity;

a. Data are for 2010.

b. Data are for 2009.

Source: World Bank n.d.; UNDESA 2011.

Table A.3.12 Total population estimates and projections for Arab countries, 1955–2100 (Thousands)

Country	Actual population					Projected population (medium conservation level)						
	1955	1975	1995	2005	2010	2015	2020	2030	2040	2060	2080	2100
Algeria	9,715	16,018	28,292	32,888	35,468	37,954	40,180	43,475	45,490	46,166	43,065	39,983
Bahrain	133	265	559	725	1,262	1,404	1,508	1,654	1,758	1,766	1,658	1,580
Comoros	175	270	494	643	735	832	933	1,160	1,426	2,002	2,588	3,047
Djibouti	70	224	627	808	889	975	1,066	1,263	1,447	1,743	1,889	1,923
Egypt	24,431	40,132	62,064	74,203	81,121	88,179	94,810	106,498	116,232	127,730	128,441	123,227
Iraq	6,562	11,784	20,288	27,359	31,672	36,977	42,684	55,257	68,950	97,895	124,854	145,276
Jordan	649	2,001	4,382	5,342	6,187	6,797	7,366	8,415	9,289	10,192	10,104	9,495
Kuwait	196	1,054	1,628	2,264	2,737	3,087	3,394	4,012	4,633	5,559	6,072	6,371
Lebanon	1,632	2,765	3,463	4,052	4,228	4,385	4,516	4,701	4,749	4,508	4,015	3,612
Libya	1,126	2,466	4,775	5,770	6,355	6,606	7,083	7,783	8,360	8,893	8,643	8,073
Mauritania	744	1,312	2,292	3,047	3,460	3,869	4,298	5,200	6,146	7,976	9,484	10,434
Morocco	10,132	17,305	26,929	30,392	31,951	33,570	35,078	37,502	38,806	38,750	35,948	33,068
Oman	501	898	2,232	2,430	2,782	3,059	3,290	3,603	3,749	3,611	3,249	2,839
Palestine	988	1,322	2,596	3,556	4,039	4,648	5,317	6,755	8,230	11,153	13,468	14,868
Qatar	36	163	501	821	1,759	2,033	2,199	2,371	2,524	2,597	2,388	2,162
Saudi Arabia	3,535	7,345	18,492	24,041	27,448	30,538	33,535	38,481	42,183	46,291	45,291	42,427
Somalia	2,522	4,118	6,525	8,360	9,331	10,607	12,237	16,360	21,669	35,954	54,004	72,976
Sudan	10,275	17,132	30,141	38,410	43,552	49,072	54,919	66,856	79,056	102,055	119,025	127,621
Syria	3,904	7,546	14,171	18,484	20,411	22,184	24,079	27,859	30,921	34,464	34,701	32,623
Tunisia	3,860	5,668	8,936	9,912	10,481	11,026	11,518	12,212	12,533	12,475	11,551	10,891
UAE	79	534	2,349	4,069	7,512	8,374	9,174	10,489	11,518	12,172	11,242	10,357
Yemen	4,685	6,691	15,148	20,649	24,053	27,980	32,232	41,342	51,256	71,418	88,002	99,032

Source: UNDESA 2011.

Table A.3.13 **Human development indicators in Arab countries**

Country	Human Development Index (HDI)	HDI rank	Life expectancy at birth (years)	Gender Inequality Index	Multidimensional Poverty Index (k greater than or equal to 3; %)[a]	Population living below $1.25 PPP per day (%)[b]	Intensity of deprivation[c]
Algeria	0.698	96	73.1	0.412	..	6.8	..
Bahrain	0.806	42	75.1	0.288	..	..	..
Comoros	0.433	163	61.1	..	0.408	..	55.2
Djibouti	0.430	165	57.9	..	0.139	..	47.3
Egypt	0.644	113	73.2	0.599	0.024	2	40.7
Iraq	0.573	132	69	0.579	0.059	4	41.3
Jordan	0.698	95	73.4	0.456	0.008	0.4	34.4
Kuwait	0.760	63	74.6	0.229	..	..	..
Lebanon	0.739	71	72.6	0.44	..	..	..
Libya	0.760	64	74.8	0.314	..	..	..
Mauritania	0.453	159	58.6	0.605	0.352	21.2	57.1
Morocco	0.582	130	72.2	0.51	0.048	2.5	45.3
Oman	0.705	89	73	0.309	n/a	..	..
Palestine	0.641	114	72.8	n/a	0.005	..	37.3
Qatar	0.831	37	78.4	0.549	..	..	..
Saudi Arabia	0.770	56	73.9	0.646	..	..	..
Somalia	..	..	51.2	..	..	..	..
Sudan	0.408	169	61.5	0.611	..	..	..
Syria	0.632	119	75.9	0.474	0.021	..	37.5
Tunisia	0.698	94	74.5	0.293	0.01	2.6	37.1
UAE	0.846	30	76.5	0.234	0.002	n/a	35.3
Yemen	0.462	154	65.5	0.769	0.283	17.5	53.9

PPP is purchasing power parity.

a. Calculated from various household surveys, including ICF Macro Demographic and Health Surveys, United Nations Children's Fund Multiple Indicator Cluster Surveys and World Health Organization World Health Surveys conducted between 2000 and 2010.

b. World Bank n.d.

c. Calculated based on data on household deprivation in education, health and living standards from various household surveys.

Source: UNDP 2013.

Table A.3.14 **Population with access to improved water source, 1995, 2000, 2005 and 2010 (%)**

Country	Rural				Urban				Total			
	1995	2000	2005	2010	1995	2000	2005	2010	1995	2000	2005	2010
Algeria	86	84	81	79	98	93	88	85	93	89	85	83
Bahrain	0	0	0	0	100	100	100	100	100	100	100	100
Comoros	87	92	96	97	96	93	91	91	90	92	95	95
Djibouti	69	63	57	54	82	88	95	99	79	82	86	88
Egypt	92	95	97	99	97	98	99	100	94	96	98	99
Iraq	44	49	53	56	97	95	93	91	80	80	80	79
Jordan	91	91	92	92	98	98	98	98	96	96	97	97
Kuwait	99	99	99	99	99	99	99	99	99	99	99	99
Lebanon	100	100	100	100	100	100	100	100	100	100	100	100
Libya	55	55	..	..	54	54	..	..	54	54	..	..
Mauritania	32	37	43	48	41	45	49	52	36	40	45	50
Morocco	56	58	59	61	94	96	97	98	76	78	80	83
Oman	72	74	76	78	84	87	90	93	81	83	86	89
Palestine	90	86	83	81	100	95	90	86	97	92	88	85
Qatar	100	100	100	100	100	100	100	100	100	100	100	100
Saudi Arabia	63	..	..	..	97	97	97	97	90	..	..	..
Somalia	18	15	9	7	21	35	57	66	19	22	26	29
Sudan	56	55	53	52	80	76	71	67	63	62	60	58
Syria	76	79	82	86	97	95	94	93	87	87	88	90
Tunisia	69	77	84	..	96	98	99	99	86	90	94	..
UAE	100	100	100	100	100	100	100	100	100	100	100	100
Yemen	55	52	49	47	89	83	76	72	63	60	57	55

Source: World Bank n.d.

Table A.3.15 Population with improved sanitation facilities, 1995, 2000, 2005 and 2010 (%)

Country	Rural				Urban				Total			
	1995	2000	2005	2010	1995	2000	2005	2010	1995	2000	2005	2010
Algeria	78	82	86	88	99	99	98	98	90	92	94	95
Bahrain	0	0	0	0	100	100	100	100	0	0	0	0
Comoros	17	23	29	30	36	42	49	50	22	28	35	36
Djibouti	42	30	18	10	72	69	65	63	65	60	54	50
Egypt	68	79	90	93	93	95	97	97	79	86	93	95
Iraq	46	54	61	67	76	76	76	76	67	69	71	73
Jordan	95	96	97	98	98	98	98	98	97	98	98	98
Kuwait	100	100	100	100	100	100	100	100	100	100	100	100
Lebanon	87	87	87	87	100	100	100	100	98	98	98	98
Libya	96	96	96	96	97	97	97	97	97	97	97	97
Mauritania	9	9	9	9	31	38	45	51	18	21	24	26
Morocco	35	43	50	52	81	82	83	83	59	64	68	70
Oman	58	71	84	95	97	98	99	100	86	90	95	99
Palestine	78	83	88	92	91	91	92	92	87	89	91	92
Qatar	100	100	100	100	100	100	100	100	100	100	100	100
Saudi Arabia	0	0	..	..	100	100	100	100	..	..	..	..
Somalia	12	10	7	6	42	45	50	52	21	22	22	23
Sudan	17	16	15	14	49	48	46	44	27	27	26	26
Syria	76	81	87	93	95	95	96	96	86	88	92	95
Tunisia	51	57	64	..	95	95	96	96	78	81	85	..
UAE	95	95	95	95	98	98	98	98	97	97	97	98
Yemen	18	24	30	34	76	82	89	93	32	39	47	53

Source: World Bank n.d.

Table A.3.16 **Water demand in Arab countries by sector, 2011** (Percentage of freshwater withdrawals, unless otherwise noted)

Country	Agriculture	Domestic	Industry	Total (billion cubic metres)
Algeria	63.95	22.51	13.54	6.16
Bahrain	44.54	49.78	5.68	0.36
Comoros	47.00	48.00	5.00	0.01
Djibouti	15.79	84.21	0.00	0.02
Egypt	86.38	7.76	5.86	68.30
Iraq	78.79	6.52	14.70	66.00
Jordan	64.96	30.96	4.08	0.94
Kuwait	53.87	43.86	2.28	0.91
Lebanon	59.54	29.01	11.45	1.31
Libya	82.85	14.10	3.05	4.33
Mauritania	93.69	4.74	1.58	1.60
Morocco	87.31	9.81	2.86	12.61
Oman	88.42	10.14	1.44	1.32
Palestine	45.22	47.85	6.94	0.42
Qatar	59.01	39.19	1.80	0.44
Saudi Arabia	88.00	9.00	3.00	23.67
Somalia	99.48	0.45	0.06	3.30
Sudan	97.12	2.28	0.60	37.14
Syria	87.53	8.80	3.67	16.76
Tunisia	75.96	12.81	3.86	2.85
UAE	82.84	15.43	1.73	4.00
Yemen	90.74	7.43	1.82	3.57

Note: Percentage totals might not sum to 100 because of rounding.

Source: World Bank n.d.

Table A.3.17	Water use and GDP contribution of agriculture and industry (%)

Country	Agriculture		Contribution of 1% of water to GDP[a]	Industry		Contribution of 1% of water to GDP[a]
	Water use (2011)	GDP (2011)		Water use (2011)	GDP (2011)	
Algeria	64	7	0.10	14	62	4.4
Bahrain	45	..	..	6	..	..
Comoros	47	46	0.97	5	12	2.4
Djibouti	16	..	..	..	..	..
Egypt	86	14	0.16	6	37	6.2
Iraq	79	..	..	15	..	..
Jordan	65	3	0.04	4	31	7.8
Kuwait	54	..	..	2	..	..
Lebanon	60	6	0.10	11	21	1.9
Libya	83	..	..	3	..	..
Mauritania	94	16	0.17	2	50	25.0
Morocco	87	15	0.17	3	30	10.0
Oman	88	..	..	1	..	..
Palestine	45	..	..	7	..	..
Qatar	59	..	..	2	..	..
Saudi Arabia	88	2	0.02	3	60	20.0
Somalia	99	..	..	..	..	..
Sudan	97	24	0.24	1	28	28.0
Syria	88	..	..	4	31	7.7
Tunisia	76	9	0.11	4	31	7.8
UAE	83	1	0.01	2	56	27.8
Yemen	91	8	0.08	2	29	14.5

a. Shetty (2006) suggested a rough indicator indicating how much 1% of water contributes to GDP share by dividing the GDP share percentage by the water use percentage. For example, Algeria uses 64% of its water in agriculture and 14% in industry, but agriculture contributes 7% to GDP and industry 62% to GDP. Hence, 1% of water consumption contributes to 0.1% of GDP in agriculture and 4.42% of GDP in industry.

Source: World Bank n.d.

Table A.3.18 Economically active people overall, by gender and in agriculture, 2011 (Thousands)

Country	Total	In agriculture	In agriculture, men	In agriculture, women
Algeria	15,285	3,187	1,506	1,681
Bahrain	658	4	4	0
Comoros	330	227	109	118
Djibouti	396	291	156	135
Egypt	26,977	6,599	3,925	2,674
Iraq	8,260	430	209	221
Jordan	1,851	112	42	70
Kuwait	1,419	14	14	0
Lebanon	1,571	27	18	9
Libya	2,351	68	19	49
Mauritania	1,523	764	346	418
Morocco	11,965	2,973	1,535	1,438
Oman	1,136	321	299	22
Palestine	1,422	109	29	80
Qatar	1,214	8	8	0
Saudi Arabia	10,355	492	465	27
Somalia	3,824	2,489	1,346	1,143
Sudan and South Sudan	14,305	7,231	4,355	2,876
Syria	6,839	1,342	515	827
Tunisia	3,993	808	542	266
UAE	4,972	148	148	0
Yemen	6,194	2,343	1,394	949

Source: FAO 2013.

Table A.3.19 **Share of the agricultural domestic product to the total GDP and per capita share for Arab countries**

Country	2000				2010				Average annual change, 2000–2010 (%)	
	GDP ($ million)	Gross agricultural product ($ million)	Share of gross agricultural product in GDP (%)	Per capita share from gross agricultural product ($)	GDP ($ million)	Gross agricultural product ($ million)	Share of gross agricultural product in GDP (%)	Per capita share from gross agricultural product ($)	GDP	Gross agricultural product
Algeria	54,790	4,600	8.4	151	161,778	11,195	9	381	12.8	11.5
Bahrain	7,791	61	0.8	95	22,945	72	0.4	71	12.5	4.4
Comoros	202	98	48.6	178	543	281	50.5	407	11.6	11.1
Djibouti	551	17	3.1	25	1,129	32	3.3	39	8.3	7.9
Egypt	99,839	15,474	15.5	242	218,888	20,520	13.3	370	9.1	6.5
Iraq	25,857	1,206	5.8	50	135,488	4,477	6	218	20.2	19.7
Jordan	8,464	171	2.0	35	26,425	542	2.7	129	13.5	16.6
Kuwait	37,718	134	0.4	60	124,348	268	0.2	58	14.2	4.4
Lebanon	17,260	1,007	6.2	286	37,124	2,313	5	489	8.9	6.2
Libya	202	2,813	8.1	499	557	1,630	2.2	210	11.9	–5.3
Mauritania	1,294	276	25.8	104	3,671	402	15.8	171	12.3	7.6
Morocco	37,021	4,908	13.3	172	90,771	11,202	13.4	396	10.5	9.9
Oman	19,868	404	2.1	168	57,849	610	1.4	251	12.6	7.8
Qatar	17,760	66	0.4	108	127,332	74	0.1	54	24.5	3.4
Saudi Arabia	188,442	9,326	4.9	458	450,792	10,947	2.6	406	10.2	1.9
Sudan	12,257	4,796	35.8	154	64,792	17,922	31.4	546	20.3	16.8
Syria	19,326	4,667	24.6	286	59,147	10,741	20.4	583	13.2	9.9
Tunisia	21,473	2,147	10.0	225	44,378	3,963	7.2	301	8.4	4
UAE	104,337	2,361	2.3	788	297,648	3,504	0.9	316	12.4	1
Yemen	9,636	1,308	12.0	75	31,883	2,972	11.9	151	14.2	10.3

Note: Insufficient data for Somalia and the State of Palestine

Source: World Bank n.d.; AMF 2011.

Table A.3.20 Estimates of Worldwide Governance Indicators for Arab countries

Panel 1									
Country	Voice and Accountability			Political Stability and Absence of Violence			Government Effectiveness		
	1996	2006	2011	1996	2006	2011	1996	2006	2011
Algeria	−1.27	−0.94	−1.03	−1.86	−1.10	−1.35	−0.95	−0.56	−0.66
Bahrain	−0.74	−0.91	−1.17	−0.42	−0.40	−0.64	0.63	0.40	0.65
Comoros	−0.58	−0.28	−0.46	0.38	−0.31	−0.46	−1.73	−1.69	−1.74
Djibouti	−0.85	−1.09	−1.33	−0.47	−0.23	0.27	−0.94	−0.9	−0.96
Egypt	−0.76	−1.20	−1.13	−0.58	−0.85	−1.29	−0.21	−0.55	−0.60
Iraq	−1.96	−1.40	−1.13	−1.86	−2.83	−1.95	−1.95	−1.77	−1.15
Jordan	−0.17	−0.69	−0.88	−0.15	−0.76	−0.42	0.12	0.17	0.05
Kuwait	−0.20	−0.55	−0.54	0.12	0.35	0.33	0.13	0.23	−0.04
Lebanon	−0.29	−0.37	−0.41	−0.76	−1.91	−1.55	−0.06	−0.39	−0.33
Libya	−1.40	−1.94	−1.57	−1.08	0.34	−1.01	−0.86	−1.11	−1.47
Mauritania	−0.54	−0.88	−0.95	0.27	0.27	−1.19	−0.14	−0.81	−0.90
Morocco	−0.36	−0.73	−0.71	-0.30	−0.47	−0.47	−0.03	−0.15	−0.22
Oman	−0.52	−1.13	−0.99	0.80	0.81	0.62	0.55	0.27	0.43
Palestine	−1.10	−0.57	−0.98	−1.65	−1.69	−1.98	−1.20	−1.11	−0.64
Qatar	−0.69	−0.72	−0.96	0.19	0.90	1.21	0.47	0.55	0.83
Saudi Arabia	−1.42	−1.74	−1.84	−0.27	−0.53	−0.30	−0.26	−0.18	−0.43
Somalia	−2.09	−1.84	−2.09	−2.65	−2.79	−3.07	−2.10	−2.32	−2.16
Sudan	−1.89	−1.72	−1.71	−2.51	−2.11	−2.61	−1.12	−1.14	−1.39
Syria	−1.33	−1.73	−1.74	−0.42	−0.35	−1.84	−0.64	−0.91	−0.44
Tunisia	−0.45	−1.23	−0.37	0.16	0.27	−0.23	0.41	0.58	0.02
UAE	−0.40	−0.99	−0.98	0.86	0.91	0.96	0.63	0.91	0.95
Yemen	−0.68	−1.17	−1.35	−1.39	−1.32	−2.29	−0.59	−0.99	−1.14

Note: Indicators are calculated on a scale of −2.5 (weakest performance) to 2.5 (strongest).

Source: World Bank 2012.

Table A.3.20 Estimates of Worldwide Governance Indicators for Arab countries

Panel 2									
Country	Regulatory Quality			Rule of Law			Control of Corruption		
	1996	2006	2011	1996	2006	2011	1996	2006	2011
Algeria	−0.77	−0.58	−1.16	−1.19	−0.66	−0.83	−0.48	−0.48	−0.56
Bahrain	0.53	0.70	0.80	0.04	0.42	0.35	0.17	0.24	0.23
Comoros	−1.16	−1.48	−1.36	−1.05	−0.98	−1.02	−0.93	−0.64	−0.70
Djibouti	−0.95	−0.73	−0.53	−0.96	−0.82	−0.75	−0.47	−0.62	−0.30
Egypt	0.01	−0.41	−0.33	0.05	−0.22	−0.42	−0.07	−0.66	−0.68
Iraq	−2.02	−1.40	−1.10	−1.51	−1.79	−1.51	−1.53	−1.56	−1.22
Jordan	0.03	0.34	0.25	0.28	0.41	0.23	−0.12	0.30	0.01
Kuwait	0.07	0.33	0.08	0.60	0.57	0.50	0.72	0.54	0.07
Lebanon	−0.44	−0.20	0.02	−0.24	−0.62	−0.68	−0.47	−0.94	−0.91
Libya	−1.81	−1.46	−1.52	−1.06	−0.99	−1.16	−0.78	−1.03	−1.31
Mauritania	−0.55	−0.37	−0.78	−0.39	−0.70	−0.89	−0.01	−0.68	−0.57
Morocco	−0.17	−0.17	−0.09	0.24	−0.22	−0.21	0.33	−0.39	−0.26
Oman	−0.07	0.59	0.39	0.69	0.37	0.63	0.04	0.19	0.08
Palestine	−0.92	−1.14	0.28	−0.11	−0.50	−0.43	−0.93	−1.10	−0.83
Qatar	−0.07	0.35	0.44	0.09	0.73	0.78	−0.09	1.09	1.02
Saudi Arabia	−0.15	−0.04	0.00	0.25	0.10	0.07	−0.64	−0.25	−0.29
Somalia	−2.54	−2.67	−2.38	−2.22	−2.55	−2.35	−1.74	−1.84	−1.72
Sudan	−1.36	−1.20	−1.30	−1.63	−1.31	−1.26	−1.28	−1.17	−1.30
Syria	−1.2	−1.34	−0.97	−0.38	−0.82	−0.66	−0.78	−0.99	−0.97
Tunisia	0.01	0.15	−0.18	−0.20	0.22	−0.10	−0.22	−0.07	−0.21
UAE	0.73	0.65	0.40	0.69	0.38	0.46	−0.09	0.95	1.08
Yemen	−0.45	−0.75	−0.79	−1.35	−1.04	−1.25	−0.35	−0.69	−1.18

Note: Indicators are calculated on a scale of −2.5 (weakest performance) to 2.5 (strongest).
Source: World Bank 2012.

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The current water situation in the Arab countries is alarming, with critical implications for the future of development in the region. The demand for water is increasing exponentially as a result of rapid population expansion, changing lifestyles, urbanization, and the pressures of economic growth. The high dependency of the region on transboundary waters and growing competition over water use further intensifies the water crisis. Furthermore, the repercussions of climate change, both current and projected, will exacerbate these ongoing challenges. The complex nexus between this fragile water situation, food security, and the energy sector further emphasizes the social, economic, and political implications of the water crisis in the region.

This water crisis is, at its core, an issue of governance. The water sector, in many cases, is managed by fragmented government institutions, with inadequate capacities, low coordination, and overlapping responsibilities leading to inefficient provision of potable water and sanitation services. Furthermore, in many countries, lack of government funding and low cost recovery constrains the financial sustainability of the water sector. The water security of the region requires an integrated and comprehensive approach of "effective water governance", and is necessary to ensure sustainable development in the Arab region. Identifying and adopting the principles and practices of effective water governance can guide the evolving socioeconomic needs of the people in an equitable and environmentally sound manner.

Going beyond the traditional debates on availability, uses and dependency of water resources, this *Report* places the issue in a socioeconomic and environmental context and lays out the building blocks of good water management. These include: "cost effectiveness" analysis as a tool for weighing the options and competing interests involved in complex water decisions; setting up and enhancing enabling environments through legislation, regulations and institutions; supporting shifts in patterns of water demand; and creating incentives for investment in more sustainable approaches. Lastly, the Arab region's current political and economic transformations present an opportunity to advance water governance reform, while effective water governance systems can in turn catalyse region-wide aspirations for overall good governance and sustainable human development.

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