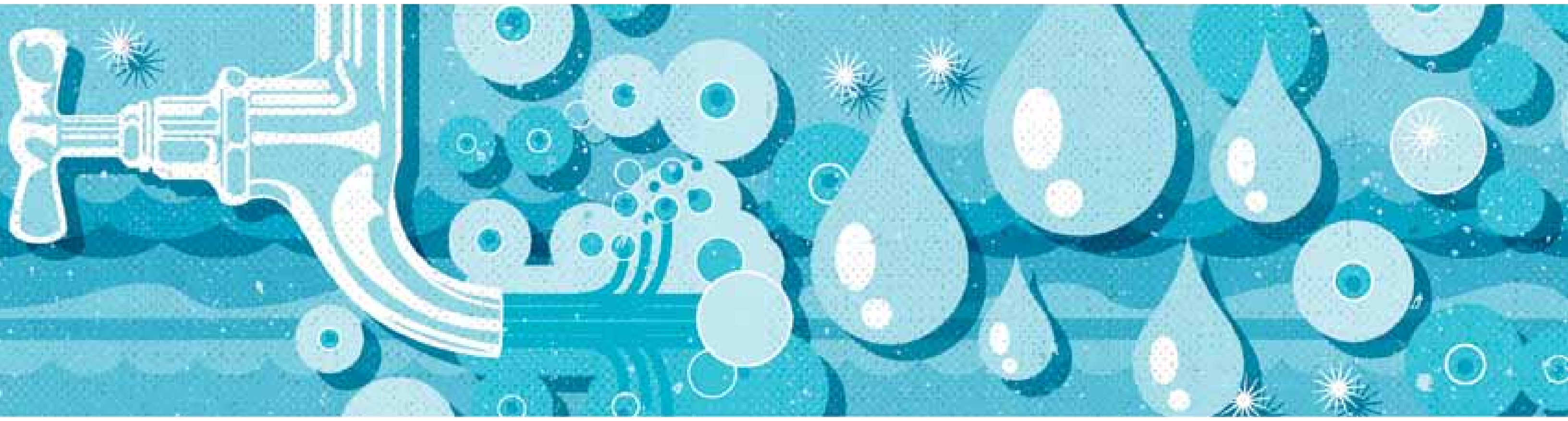


Transforming water economies

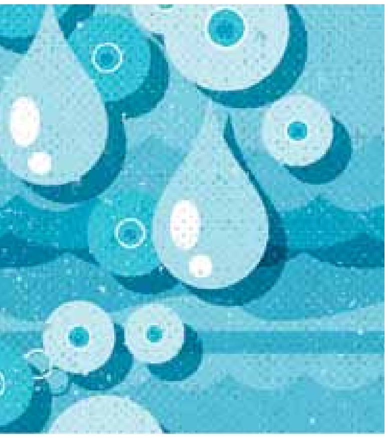
To increase water security, countries must glean insights from information, understand trade-offs among policy choices, and establish institutional mechanisms to support execution.

Giulio Boccaletti, Sudeep Maitra, and Martin Stuchtey

Without action, global water demand could outstrip supply by up to 40 percent by 2030. Rapid population growth and economic development, particularly in emerging markets, will increase the need for food and energy and accelerate industrialization and urbanization, driving a corresponding increase in the need for water. At the same time, many scientists warn that temperatures may rise around the world, which could increase water scarcity. The climate may also become less predictable, which could increase volatility in the water supply, compounding the challenge.

As many countries already know firsthand, limited and uncertain access to water can jeopardize economic growth and social well-being. Given the potential impact of shortfalls, ensuring access to water is rapidly becoming a challenge that could define our times.

Some countries have already developed innovative approaches to managing water under extreme conditions. Australia developed a market-based approach that enables it to minimize the impact of scarcity and volatility of supply without compromising growth. Singapore implemented an approach based on long-term planning and centralized investment in infrastructure and the latest technologies to increase its domestic supply of water. And Israel has leveraged its culture of innovation to establish itself



as an international hub for water-technology development, increasing its water security while establishing a local multibillion-dollar industry.

Economic, political, social, and other conditions may make it difficult for many governments to implement the solutions developed by these pioneers, but virtually every country can benefit from adopting the principles underlying their success.

Drawing on our experience working with governments around the world, we have developed the "ICE framework" for water-sector transformations. This framework organizes the most important principles for success into three categories:

Inform: calculate a dynamic water gap and develop a cost curve to prioritize improvement opportunities by effectiveness and efficiency

Choose: evaluate a set of strategies to close the water gap, accounting for their impact on key economic- and social-development objectives

Execute: establish the institutional mechanisms (national, regional, and local) necessary to guide program and policy implementation

Countries that incorporate these principles into their water strategies can accelerate their progress toward greater water security and improve the economics of water-dependent sectors even in times of drought.

The double threat: Scarcity and unpredictability

Assuming current levels of water efficiency, unconstrained global water demand is likely to grow at a rate of about 2 percent a year until 2030. This expansion in demand will be driven chiefly by population and economic growth, particularly in agricultural and industrial production. The rise of the middle class in emerging economies is also likely to increase water use. Thus, global demand for water in 2030 could prove close to double what it was in 2005—exceeding existing capacity by 40 percent[1] (Exhibit 1).

Higher temperatures would increase demand in many parts of the economy, particularly in irrigation for agriculture, and changes in the frequency and intensity of rainfall and extreme-weather events could reduce the predictability of supply. Indeed, lack of clarity about climate evolution is increasing uncertainty about how to manage water, adding to the risk that countries' investments might prove insufficient or ineffective.

The leading edge

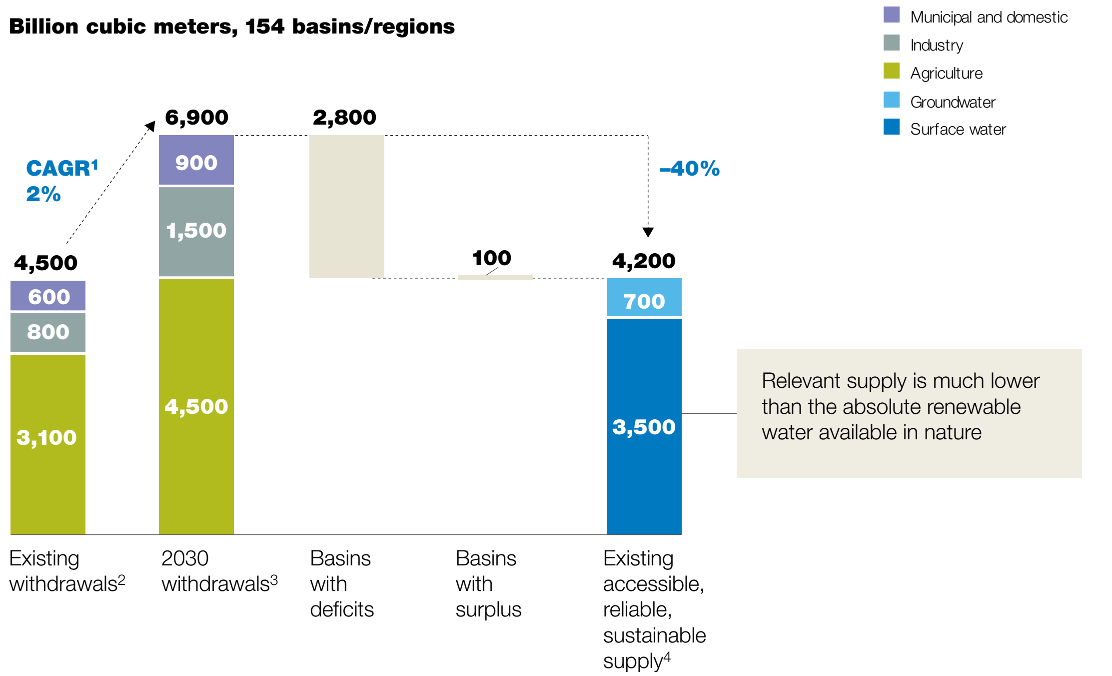
Many countries have been grappling with scarcity for decades, and some have already developed sophisticated solutions to improve water security under extreme conditions. Such nations include Australia, Singapore, and Israel—all of which face significant threats of scarcity and increasing volatility of supply due to factors such as climate, geography, and demographics.

In the 1990s, Australia launched a national agenda to develop market mechanisms to improve its water security. Early steps included redefining property rights to separate water rights from land ownership and disaggregating the water-industry value chain to enable water trading among states and private entities. The country also took steps to manage demand, including charging higher fees for consumption that exceeds levels of basic

Exhibit 1

The global gap between existing accessible, reliable supply and 2030 water withdrawals could reach 40%.

Billion cubic meters, 154 basins/regions



[1]Compound annual growth rate.
[2]Based on 2010 agricultural-production analyses from International Food Policy Research Institute (IFPRI).
[3]Based on GDP, population projections, and agricultural-production projections from IFPRI; considers no water productivity gains between 2005 and 2030.
[4]Existing supply that can be provided at 90% reliability, based on historical hydrology and infrastructure investments scheduled through 2010, net of environmental requirements.

Source: 2030 Water Resources Group; global water supply and demand model; agricultural production based on IFPRI IMPACT-WATER base case

necessity. Australia's current supply of water is significantly lower than it was a decade ago, but its improved water management has helped limit negative impact on economic growth. (See the sidebars "The double threat in Australia" and "Australia's water transformation" for details about the country's water challenge and how it has been addressed.)

Singapore has taken a top-down approach to expanding its domestic supply of water. Its "Four National Taps" policy is designed to reduce its dependence on Malaysian imports by increasing its ability to procure water via local catchments, reclamation, and desalination. The country has classified two-thirds of its land as partially protected catchment areas, and it

The double threat in Australia

Australia's climate has always been extreme. Much of the country is semi-arid or desert—indeed, 40 percent of its landmass is covered by sand. Australia receives less rain than any other continent, barring Antarctica, and it experiences frequent and long-lasting droughts. And due to geographic and other factors, it is only able to capture a small portion of the water that does fall within its borders—less than 10 percent, compared with a world average of 20 percent; some regions, including parts of North America, capture more than 40 percent.

Australia also experiences extraordinary variability in its supply of water. The country's Murray-Darling Basin, its most significant agricultural area, is fed by the Murray and Darling Rivers and drains one-seventh of the Australian landmass. But both of these rivers have highly variable flow volumes. The Murray River's ratio of maximum to minimum annual flows is 15, while the Darling River's ratio is an extraordinary 4,000. In comparison, China's Yangtze River has a ratio of 2.0, and the Amazon River's ratio is a mere 1.3.

Historically, Australia has managed this variability by building storage capacity to compensate for low river flows in times of undersupply. For example, the Murray-Darling Basin has more than 30 cubic kilometers of storage capacity, enabling it to hold a quantity of water equal to about one-and-a-half years of flow from the Murray and Darling Rivers. Thus, Australia ranks among the top-three countries for water-storage capacity in the world.

But Australia's climate has changed dramatically over the past decade, posing serious threats to the country's historical approach to water management. In particular, a prolonged drought, which began in 2003, has dramatically reduced inflows to the country's water reservoirs.

Infrastructure that had been built to contend with historical rates of variability suddenly became inadequate. At the beginning of the millennium, Perth expected to have enough water to meet demand through 2030. But it has since needed to hastily build a number of desalination plants to ensure the city's security of supply.

Such conditions give rise to increasingly fierce competition for resources among a range of stakeholders, including municipalities, agriculture producers, energy companies, and heavy industry. The challenge lies not only in investing to capture the maximum amount of water but also in allocating the water a country captures most productively, ensuring both economic and social well-being.

now has 19 raw-water reservoirs, 9 treatment works, and 17 service reservoirs for treated water. NEWater is the brand name for reclaimed water produced by Singapore's public utilities; the country currently has five factories that generate 50 million gallons of NEWater per day. In 2005, Singapore opened its first desalination plant, one of the largest in the world, capable of producing 135 million liters of water a day. It also launched demand-side-management efforts that have reduced consumption to 160 liters per day per capita in 2005 from 172 liters in 1995.

Historically, Singapore has imported about half its water supply from Malaysia. Today, that figure has fallen to about 40 percent, though the country's population doubled from almost 2.5 million in 1980 to more than 5 million in 2010. The government expects to be self-sufficient in water by 2061, when existing import agreements with Malaysia expire.

Israel is well-known as a water-technology innovator. Netafim, a company formed after its founders invented drip irrigation in 1965, helped to establish a culture of water innovation in the country; today, Netafim ranks among the largest "blue tech" firms in the world. In 1993, Israel's government launched (and later privatized) Kinrot Ventures, the world's only start-up incubator specializing in water technologies. And in 2006, the government launched NewTech to promote the country's domestic water industry globally by supporting research and development, facilitating marketing efforts to increase exports, and bringing companies together to form an international blue-tech hub that drives further innovation. Due in

Australia's water transformation

Australia's transformation is rooted in its effort to optimize the allocation of water by tying water use to economic and market principles. An early enabling step, initiated in the mid-1980s in the state of Victoria, established cost recovery for new irrigation systems to minimize the risk of investment by private companies. This facilitated the expansion and improvement of irrigation networks, greatly increasing the efficiency of water distribution and consumption.

In 1994, the Council of Australian Governments (COAG) endorsed a national framework to overhaul the country's water economy. The framework adapted Victoria's cost-recovery system for national rollout. It implemented tariff reforms that factored opportunity cost into the price of water so that luxury uses, such as watering private gardens, would be more expensive than critical uses, such as irrigating crops.

In 1995, the Standing Committee on Agriculture and Resource Management developed the National Framework for the Implementation of Property Rights in Water, which separated land rights from water rights such that land ownership was no longer a condition of water ownership. Regulators also disaggregated the industry value chain, turning ownership of irrigation infrastructure over to states or private entities. These actions facilitated the creation of markets that enabled water trading among states, which increased the efficiency of water allocation by factoring scarcity into its price. As a result, Australia became one of the most integrated water markets in the world.

In 2003, COAG established the National Water Initiative to promote the economically efficient and sustainable use of water, encourage adoption of "user pays" principles, increase pricing transparency, and facilitate the efficient functioning of water markets.

Australia established the National Water Commission in 2004 to oversee the implementation of the National Water Initiative. The Murray-Darling Basin Authority was established under the Water Act of 2007 to manage issues relating to the drought that began in 2003 and to address potential effects of climate change. More recently, the government has begun to act as a market participant on behalf of the environment, buying water to preserve ecological assets.

Traded water in Australia was valued at almost AU $2 billion (about US $2.06 billion) in 2007 and 2008, with more than 95 percent traded among states in the Murray-Darling Basin. There are a variety of exchanges and brokerages that facilitate trading, but a majority of the trades are done for agricultural purposes.

part to these efforts, the Israeli water sector generated revenues of $1.4 billion from exports in 2010.

The importance of country specificities

Many countries that are facing water challenges are not in a position to implement advanced strategies to transform their water sectors. They can learn much from cases such as Australia, Singapore, and Israel, but their particular success will depend on their ability to develop strategies that work within their unique political, social, and economic contexts.

Such countries face a mix of "hard" barriers related to physical assets, capital, and technology and "soft" barriers related to skills, institutions, and leadership. For example, many lack the basic infrastructure that is a prerequisite to implement some proven strategies; the assets they do have are often outdated or need repair. Utilities often lack access to the capital and capabilities they need to transform their water sectors. Countries frequently lack the institutions necessary to set effective water policies or monitor and enforce rules. And regulators may be weak, either because they lack authority (for instance, to recover costs) or because they are embedded within cumbersome institutional arrangements.

Political conditions may impede action, particularly when stakeholders do not understand the issues at hand. And social conditions can also present powerful barriers to progress. For example, reform can be particularly challenging in countries with significant populations of subsistence farmers who cannot easily adopt more capital-intensive, water-efficient agricultural methods.

The ICE approach to water transformations

Through our research and experience supporting water-sector reform in several countries, we have recognized that successful transformations often hinge on the ability of stakeholders to gather and analyze information about water availability and usage, make choices that account for critical trade-offs, and establish processes and procedures to ensure execution. We developed the ICE framework to highlight core principles in these areas that every country seeking to transform its water economy should consider.

Inform

Countries benefit from aggregating and organizing economic data about water use. In our experience, water cost curves can be useful tools for assessing data to understand the relative effectiveness and cost of the full spectrum of approaches to improving water security. When coupled with realistic assessments of operational risk, cost curves can also help policy makers and investors improve water-sector productivity.

To develop a water cost curve, countries should first understand their current supply and demand dynamics. To identify potential shortfalls, they also need to estimate their future supply and demand for water. This involves accounting not only for demographic and competitive factors that affect demand but also for emerging dynamics that can affect supply, such as the potential for higher temperatures, lower rain volumes, and an increase in the incidence of extreme-weather events.

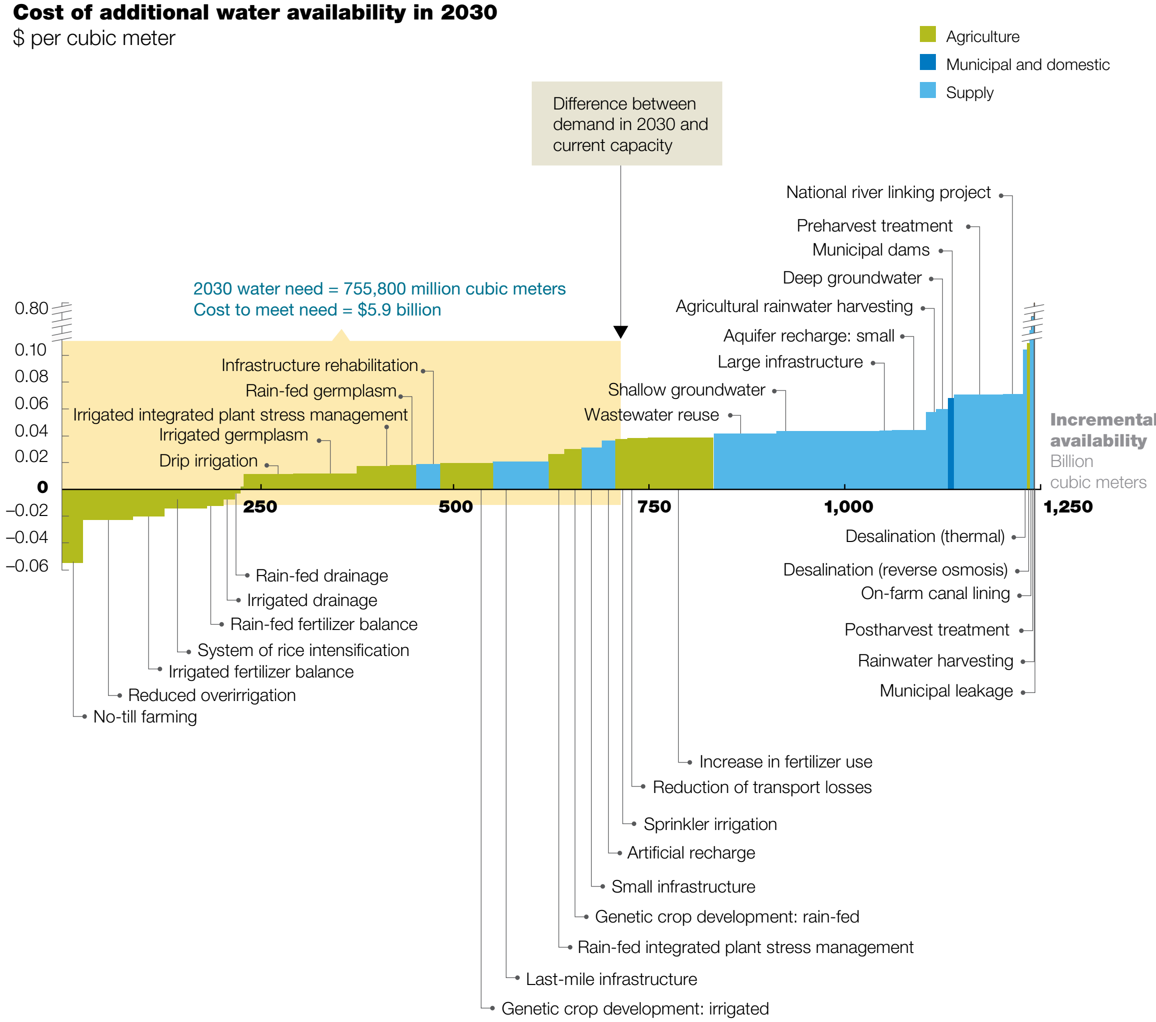
Once a country has estimated its potential water gap (the difference between its projected future demand and its current capacity to supply water),[2] it can conduct an audit to identify all potential improvements that could reduce water consumption; it can also estimate the cost of implementing each of these. The country then arranges the opportunities on a curve—such as the one shown for India in Exhibit 2—enabling it to identify the most cost-effective solutions to meet its estimated needs.

India's water cost curve indicates that if the country focuses on the most cost-effective approaches available, it could meet its 2030 water needs—estimated to be 755,800 million cubic

Exhibit 2

India's water cost curve illustrates a number of available options.

Cost of additional water availability in 2030
$ per cubic meter



Source: 2030 Water Resources Group

meters, or roughly 200 million gallons more than current supply—by investing $5.9 billion (Exhibit 2). The curve lists every approach, arranged from left to right according to increasing cost, that the nation could use to meet its water-consumption needs. In India's case, the approaches listed on the far left actually offer savings, and the vast majority of the most cost-effective approaches involve optimizing agricultural processes and practices.

Each country's cost curve will be unique. For example, China's cost curve points to the potential of measures to improve water use in industrial contexts, which would require significant investment. South Africa's cost curve suggests that the greatest potential could be achieved through roughly equal investment in agriculture, industry, and municipalities.

Choose

To ensure that their water policies are balanced, countries should also account for trade-offs involving areas such as economic development and quality of life. This is critical, as a narrow focus on efficiency and cost can have negative unintended consequences. For example, a country could prioritize approaches that minimize water use only to find that the policy leads to higher unemployment or reduces industrial productivity, which has a negative effect on GDP.

Countries can use scenario planning to account for as many relevant trade-offs as possible. This involves analyzing a range of options that are designed to achieve different policy objectives, each with its own demand profile and set of technical solutions that would enable the country to close its water gap.

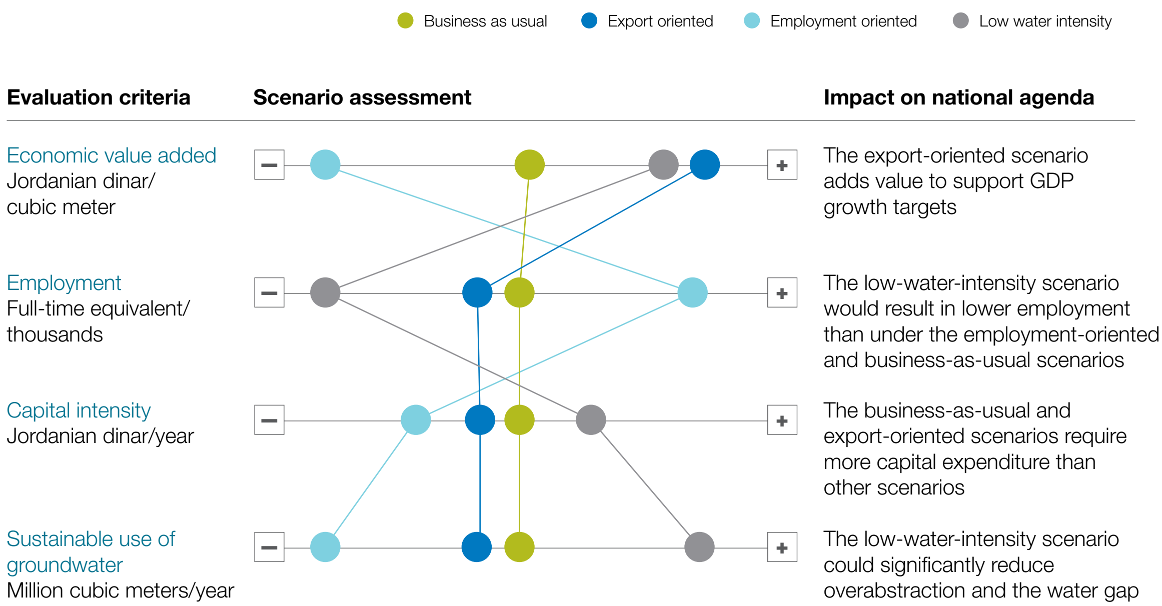
Jordan—leveraging a water-resource diagnostic conducted with support from the Water Resources Group[3]—considered four scenarios when setting its water policy in agriculture. A business-as-usual scenario simply extrapolated current economic activity into the future. An export-oriented scenario emphasized production of crops that could be sold in foreign markets. An employment-oriented scenario prioritized jobs. And a low-water-intensity scenario focused on reducing unsustainable use of groundwater. Each scenario had a different cost structure—the employment-oriented approach was the most expensive—but Jordan had the technological capability to pursue any of them and still close its water gap.

Once a country has identified a range of scenarios, it can use the economic-choices framework we have developed to determine which scenario will enable it to achieve its overall economic and social objectives most effectively. Jordan used the framework to assess each of its four scenarios on four priority measures: economic value added, employment, capital intensity, and sustainable use of groundwater (Exhibit 3). It found that the export-oriented approach would support its target for GDP growth, but both the export-oriented and business-as-usual approaches would require higher capital investments than other approaches. It found that the low-water-intensity approach would reduce not only unsustainable use of groundwater but also employment.

Tailored appropriately, the framework provides countries with a quantified understanding of how each scenario is likely to affect critical components of their national agendas, helping them clarify their purpose and catalyze decision making to improve water productivity.

Exhibit 3

The economic-choices framework allows countries to assess different scenarios.



Source: 2030 Water Resources Group

Execute

Establishing institutional mechanisms to guide and monitor delivery is critical, both to coordinate government-level action and to drive initiative-based rollout.

Governments may need to establish a cross-ministerial "water delivery unit" to make quick decisions about how to allocate water to its most productive use. This may prove particularly important for countries that lack market mechanisms for pricing water. The delivery unit should obtain input from all relevant parts of government, but it should be headed by a secretariat empowered to make decisions that may affect all aspects of the economy. The unit should also have the capability to monitor progress of implementation and manage delivery of reform at a granular level.

A number of countries have established delivery units, often to support implementation of a broad government agenda. For example, the Prime Minister's Delivery Unit in the United Kingdom helped the government achieve its key priorities in education, health, crime, and transportation from 2001 to 2010. Malaysia's Performance Management and Delivery Unit was established in 2009 to oversee and support a broad range of transformation efforts. Other nations have established units that are focused on particular areas of the economy.

For example, Ethiopia launched its Agricultural Transformation Agency in 2011 to coordinate and accelerate reform of the country's agricultural system.

Countries can also develop institutional mechanisms that target the execution of particular initiatives, especially those that require public support to finance infrastructure investments. In 2005, for example, India established a National Mission on Micro Irrigation that has enabled the use of drip and sprinkler irrigation systems in 1.8 million hectares of cultivated land in 18 states.

To achieve efficiency targets, governments may need to set policies and incentives that require or encourage the efficient use and conservation of water. For example, Singapore meters virtually all water use within its borders, which enables it to set incentives for use that support its national agenda. It also sets policies to ensure that water equipment installed in new residential buildings meets high standards of efficiency. Singapore sets the price of water so that all residents can meet their basic needs, but it charges higher rates for nonessential consumption. And it encourages water reuse by setting the price for recycled water at one-fifth the price charged for water that has not been recycled.

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Most countries that face water challenges have begun to develop strategies to manage water more effectively, but few have succeeded in establishing approaches equal to the challenges they face. Rapid population and economic growth is likely to drive increasing demand for water in the coming years, and the challenge of meeting this demand could be exacerbated by rising temperatures and growing weather-related unpredictability. But even countries that lack the resources to pursue sophisticated solutions such as those pioneered in Australia, Singapore, and Israel can achieve greater water security by adopting the principles of successful transformations. Countries that develop solid information, clearly understand their economic choices, and establish the necessary institutional mechanisms to execute their policies can accelerate their progress to greater water security at lower cost.

[1] 2030 Water Resources Group, *Charting our water future*, 2009 (www.mckinsey.com). The 2030 Water Resources Group was formed in 2008 to contribute new insights to the issue of water scarcity. Members include McKinsey & Company, the World Bank Group, and a consortium of business partners: The Barilla Group, The Coca-Cola Company, Nestlé SA, New Holland Agriculture, SABMiller PLC, Standard Chartered, and Syngenta AG.

[2] The gap is not a prediction of future water shortage; it is a reflection of the effort required to ensure that future demand is met.

[3] 2030 Water Resources Group, *Charting our water future*, 2009 (www.mckinsey.com).

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