

# Water supply and sanitation in Saudi Arabia

*This article was written in 2007 and has last been partially updated in March 2015. However, some sections of the article may be out of date, for example if the data and information found in sources are from an older date.*

**Water supply and sanitation in Saudi Arabia** is characterized by significant investments in seawater desalination, water distribution, sewerage and wastewater treatment leading to a substantial increase in access to drinking water and sanitation over the past decades. About 50% of drinking water comes from desalination, 40% from the mining of non-renewable groundwater and 10% from surface water, especially in the mountainous South-West of the country. The capital Riyadh, located in the heart of the country, is supplied with desalinated water pumped from the Persian Gulf over a distance of 467 km. Given the substantial oil wealth, water is provided almost for free. Despite improvements service quality remains poor. For example, in Riyadh water was available only once every 2.5 days in 2011, while in Jeddah it is available only every 9 days.<sup>[3]</sup> Institutional capacity and governance in the sector are weak, reflecting general characteristics of the public sector in Saudi Arabia. Since 2000, the government has increasingly relied on the private sector to operate water and sanitation infrastructure, beginning with desalination and wastewater treatment plants. Since 2008, the operation of urban water distribution systems is being gradually delegated to private companies as well.



*Old water tower in Riyadh*

## 1 Access

There are no reliable and up-to-date data on access to drinking water supply and sanitation in Saudi Arabia.

According to the WHO, the latest reliable source is the 1993 census. It indicates that in urban areas, where 88% of the population lives, 97% had access to drinking water from house connections and 100% had access to improved sanitation. Urban sanitation was primarily through on-site solutions and only 43% of the urban population was connected to sewers. In rural areas, however, only 63% had access to an improved source of water supply. There are no reliable figures on access to sanitation in rural areas.<sup>[1]</sup> However, according to a 2004 study of Elie Elhadj from the School of Oriental and African Studies “one half of Saudi householders still have no municipal water connections and two thirds are without sanitation connections”. Also, Saudi cities have no rainwater drainage systems to deal with the brief and occasional, but severe deluges of winters.<sup>[4]</sup>

## 2 Service quality

**Drinking water.** Despite clear improvements the quality of service remains insufficient. For example, few cities enjoy continued service, and water pressure is often inadequate. In Riyadh water was available only once every 2.5 days in 2011, while in Jeddah it is available only every 9 days. This is still better than in 2008, when the respective figures were 5 and 23 days.<sup>[3]</sup> While systematic data on service quality are now available for several cities, they are not publicly available. In some localities groundwater used for drinking water supply is naturally contaminated with levels of fluoride in excess of the recommended level of 0.7 to 1.2 mg/l. For example, a 1990 study showed that the fluoride level in drinking water in Mecca was 2.5 mg/l.<sup>[5]</sup> In Riyadh the level of fluoride is reduced far below the recommended level by blending groundwater with desalinated seawater.<sup>[6]</sup>

**Wastewater.** There are 33 wastewater treatment plants

with a capacity of 748 million cubic meters per year, and 15 more are under construction. Much of the treated wastewater is being reused to water green spaces in the cities (landscaping), for irrigation in agriculture and other uses.

Concentrated sewage from septic tanks is collected through trucks. In Jeddah the trucks dumped sewage for 25 years in a valley that was euphemistically called the “Musk Lake”. The pond, holding more than 50 million cubic meters of sewage, almost overflowed during heavy rains in November 2009 threatening to flood parts of the city. After that, the King ordered the lake to be dried up within a year with the help of the National Water Company.<sup>[7]</sup>

### 3 Water use

Total municipal water use in Saudi Arabia has been estimated at 2.28 cubic kilometers per year in 2010, or 13% of total water use. Agriculture accounts for 83% of water use and industry for only 4%.<sup>[8]</sup> Demand has been growing at the rate of 4.3% per annum (average for the period 1999-2004), in tandem with urban population growth (around 3%). Water supply is usually not metered, neither at the source nor the distribution point. It is tentatively estimated that average water consumption for those connected to the network is about 235 liters per capita per day, a level lower than in the United States.<sup>[2]</sup>

**Water reuse** in Saudi Arabia is growing, both at the level of buildings and at the level of cities. For example, **ablution** water in mosques is being reused for the flushing of toilets.<sup>[9]</sup> At the city level, treated **wastewater** is being reused for landscaping, irrigation and in industries such as refining. In Riyadh 50 million cubic meter per year is pumped over 40 km (25 mi) and 60m elevation to irrigate 15,000 hectares of wheat, fodder, orchards and palm trees.<sup>[10]</sup>

**Water conservation** measures, such as awareness campaigns through the media and educational pamphlets, have been carried out. In addition, in Riyadh a leakage control program has been carried out and a special, higher water tariff has been introduced. Furthermore free water appliances (taps, shower heads, toilet boxes) were distributed, reportedly resulting in a decrease of residential water use of between 25-35%.<sup>[11]</sup>

An unknown, but large proportion of the population is dependent on supply through **water tankers**. For example, Riyadh experiences water shortages and intermittent supply, especially during the summer peak demand. To cope with the shortage, 18 million cubic meters of water was distributed during one summer by private contractors. With the commissioning of a new large well field at Al Honai this problem has been reduced.<sup>[11]</sup>

## 4 Water resources

See also: [Geography of Saudi Arabia § Water resources](#)

Saudi Arabia is one of the driest regions in the world, with no perennial rivers. Water is obtained from four distinct sources:

- non-renewable **groundwater** from the deep **fossil aquifers**
- **desalinated water**
- surface water
- renewable **groundwater** from shallow **alluvial aquifers**

Only the last two sources are renewable. Their volume, however, is minimal. Desalination plants provide about half the country’s drinking water. About 40% comes from groundwater. The remainder comes from surface water (about 10%). Desalinated water is prevalent along the coasts, surface water in the southwest region and groundwater elsewhere. The capital Riyadh, however, is supplied to a great extent with desalinated water pumped from the Persian Gulf over 467 km to the city located in the heart of the country.

### 4.1 Fossil groundwater

Current levels of groundwater extraction far exceed the level of natural recharge: Groundwater is being “mined”. For example, the **Al-Ahsa** aquifer in the Eastern Province experienced a drop of 150 meters over the past 25 years. Since the usable volume of the aquifers is not known, it is not clear how long groundwater mining can be sustained. Estimates of the groundwater stored in the principal aquifers are controversial. Ongoing resource assessments are expected to provide reliable estimates of the volume of water left in storage in each aquifer, and estimates of the portion of that volume that can be extracted on a sustainable basis.

### 4.2 Desalination

In 2011 the volume of water supplied by the country’s 27 government-operated desalination plants at 17 locations was 3.3 million m<sup>3</sup>/day (1.2 billion m<sup>3</sup>/year). 6 plants are located on the East Coast and 21 plants on the Red Sea Coast. Saudi Arabia is the largest producer of desalinated water in the world. 12 plants use multi-stage flash distillation (MSF) and 7 plants use multi-effect distillation (MED). In both cases the desalination plants are integrated with power plants (dual-purpose plants), using steam from the power plants as a source of energy.

8 plants are single-purpose plants that use reverse osmosis (RO) technology and power from the grid. By far the largest plant, Jubail II on the East Coast, is a MSF plant built in subsequent stages since 1983 with a capacity of almost 950,000 m<sup>3</sup>/day that supplies Riyadh. The largest RO plant is located in Yanbu on the Red Sea. It supplies the city of Medina and has a capacity of 128,000 m<sup>3</sup>/day. The MED plants are much smaller. Mekka receives its water from plants in Jeddah and Shoaiba just south of Jeddah. In Ras al Khair, the largest plant of the country with a capacity of 1 million m<sup>3</sup>/day was under construction as of 2012.<sup>[12]</sup>

**Solar desalination.** The first contract for a large solar-powered desalination plant in Saudi Arabia was awarded in January 2015 to a consortium consisting of Abengoa from Spain and Advanced Water Technology (AWT), the commercial arm of the King Abdulaziz City for Science and Technology (KACST). The \$130 million reverse osmosis plant, co-located with a photovoltaic plant in Al Khafji near the Kuwaiti border, will have a capacity of 60,000 m<sup>3</sup>/day.<sup>[13]</sup> The plant relies on grid power at night and its operator expects to sell electricity to the grid in the future. A ten times larger plant at a hitherto undisclosed location is due to be launched once the first plant has been commissioned as part of a national plan to massively expand solar desalination launched in 2010 called the King Abdullah Initiative for Solar Water Desalination.<sup>[14]</sup>

**Floating desalination.** In 2010 the largest floating desalination plant in the world with a production capacity of 25,000 m<sup>3</sup>/day (9 million m<sup>3</sup>/year) was launched on a barge in Yanbu. While this capacity is just a small fraction of total installed desalination capacity, it is sufficient to supply a city with more than 100,000 inhabitants with drinking water. Just like smaller desalination barges that operate since 2008 they are designed to meet high seasonal demand for potable water anywhere along the Red Sea coast of the Kingdom.<sup>[15]</sup>

### 4.3 Surface water and alluvial aquifers

The country's mean annual surface runoff has been estimated at more than 2 billion cubic meters per year. The country has eleven renewable alluvial aquifers with an estimated combined mean annual recharge of nearly 1 billion cubic meters per year. According to the World Resources Institute the renewable groundwater and surface water resources overlap, i.e. the entire renewable groundwater resources originate in recharge from rivers (Wadis) so that total renewable water resources are in the order of 2 cubic kilometres/year.<sup>[16]</sup> Surface resources and renewable aquifers are concentrated in the west and southwest, where rainfall is higher.

## 5 History and recent developments

The Saudi water sector, like the entire country, has undergone tremendous changes over the past decades from a system based on the use of local renewable water resources for small-scale irrigation and limited domestic uses to a system largely based on the use of desalinated water and fossil groundwater for large-scale irrigation and domestic, commercial and industrial uses at a level comparable to developed countries. The Saline Water Conversion Corporation, created in 1965, has been an important player in this process of change.

Until 1994 domestic water use was entirely free in Saudi Arabia. Only then a very moderate tariff has been introduced. In the early 2000s the government decided to involve the private sector not only in the construction of infrastructure, but to expand its role also to the financing and operation of infrastructure through Build-Operate-Transfer (BOT) projects. The first BOT project in the water sector was a wastewater treatment plant in Jeddah, followed by Independent Water and Power Projects (IWPPs) for integrated power and desalination plants.

In 2003 the Ministry of Water and Energy was created. It took over the water resources management function from the Ministry of Agricultural and Water and the responsibility for water supply and sanitation from the Ministry of Municipal and Rural Affairs. In the same year the Water & Electricity Company was created as an off-taker for water and electricity produced by the IWPPs.

In 2008 the privatization program was expanded to drinking water supply when the Kingdom's first management contract was signed for the capital Riyadh, followed by two more management contracts (see below). Beginning with the expiration of the management contract in Riyadh in 2014, it is planned to award 20 to 30-year lease contracts for the cities covered by management contracts.<sup>[17]</sup> As of late 2014, the timing was pushed back to 2017/18 and NWC expected to take a 40% share in each of the Joint Ventures that would be selected to run the water and sewer systems of the three cities. According to NWC CEO Loay Al-Musallam the Joint Ventures can be profitable despite low water tariffs through the sale of treated effluent, because bulk water and capital investments are provided for free.<sup>[18]</sup>

## 6 Responsibility for water supply and sanitation

Until the establishment of the National Water Company (NWC) in 2008 there was no separation between institutions in charge of policy and regulation on the one hand, and service provision on the other. Instead all key sector functions were the direct responsibility of a single Ministry, the Ministry of Water and Electricity.

The quality and efficiency of service provision are hampered by the many weaknesses afflicting the public sector in Saudi Arabia in general. These include an inadequate civil servants recruitment policy, insufficient salaries, limited skills, no accountability for action taken (or not taken), a lack of strategic planning, and ad-hoc investment decisions.

## 6.1 Policy and regulation

Since 2003 the Ministry of Water and Electricity (MOWE) is responsible for policy and regulation of water and sanitation services. There is no separate regulatory agency for the sector. The recently established Electricity and Co-generation Regulatory Authority (ECRA) only regulates privately owned desalination plants. The functions of the Ministry of Agriculture overlap with those of MOWE, since agriculture is by far the main water user in the country and contributes in the depletion of fossil aquifers on which a large share of the country's drinking water supply depends. There is also some overlap between the two Ministries in the area of wastewater reuse. There is no Ministry of Environment in Saudi Arabia.

## 6.2 Service provision

The responsibility for service provision is shared by the private and public sectors. The National Water Company (NWC) is in charge of water supply and sanitation in the largest cities - Riyadh, Jeddah, Mecca and Taif as of 2013 in partnership with foreign private operators. In other cities water supply and sanitation is still the direct responsibility of MOWE through its regional directorates and branches. Local government, which is in charge of service provision in many other countries, has no role in service provision in Saudi Arabia.

Desalination plants are run by the Saline Water Conversion Corporation (SWCC) which provides water for free to the NWC or by private companies called Independent Water and Power Projects (IWPPs) which sell water and energy to a public entity called the Water & Energy Company. Many wastewater treatment plants are run by private companies under BOT contracts.

### 6.2.1 The National Water Company and management contracts

The National Water Company (NWC) plans to become a "leading water utility in the region" within 4 to 7 years after its creation in 2008. NWC's twelve-member Board is chaired by the Minister of Water and Electricity and includes the CEO of the company.<sup>[19]</sup>

NWC contracts out water distribution services for individual cities to the private sector under management contracts. Key objectives include improving service qual-

ity, operational efficiency and customer satisfaction. The contracts are preceded by one-year technical assistance contracts. This is followed by a further 1-2 year validation period during which the baseline and target data for key performance indicators are being reviewed.<sup>[20]</sup> Tariff levels will not be affected. The scope of the contracts includes training and qualifying Saudi nationals, as well as research and development with the aim to transfer technology.<sup>[21]</sup>

The three contracts signed so far are:

- In April 2008 for the capital for Riyadh with the French firm Veolia, covering six years and valued at \$60m,
- A seven-year contract with the French firm SUEZ for Jeddah,
- In June 2010 for Mecca and Taif with the French firm SAUR, covering five years and valued at \$46m.

As required by Saudi law SAUR's team working in Mecca consists entirely of Muslims. Further management contracts are expected to be tendered for Medina and Greater Damman.<sup>[22]</sup>

NWC says that between its creation in 2008 and 2012 it has saved 115.4 million m<sup>3</sup> of water through leak reduction, improved water quality compliance from 82% to 98.7%, increased customer satisfaction from 45% to 83%, reduced the number of projects that are behind schedule from 104 to 3, and has improved its annual cash collection from SAR561 million (\$149 million) to SAR1,119 million (\$298 million).<sup>[23]</sup>

NWC also plans and oversees infrastructure projects such as the SAR 1.6 billion (\$426 million) Riyadh Water Supply Programme completed in 2013 that included drilling 43 new wells and building 27 brackish water desalination plants.<sup>[23]</sup>

NWC had initially been expected to take over Medina in 2011, as well as Damman and Al-Khobar in 2013.<sup>[24]</sup>

### 6.2.2 The Saline Water Conversion Corporation

The Saline Water Conversion Corporation (SWCC), an entity under the authority of the Ministry, is in charge of operating the country's publicly owned desalination plants, and operating a network of water transmission pipelines 4,300 kilometres (2,700 mi) to transport the water in bulk from the plants to the major consumption centers, some of them located far inland such as Riyadh. SWCC is the biggest water desalination entity in the world. It has more than 3.3 million m<sup>3</sup>/day water installed capacity, and its plants are designed to reliably provide more than 2.8 million m<sup>3</sup>/day.

SWCC is not an independent company run on commercial principles, but rather a branch of the government. Its

water is provided for free to the branches of MOWE and to NWC. SWCC has a research department and a training center. In 2008 the government announced plans to “privatize” SWCC by transforming it in a holding company. The holding company would initially supervise affiliated production firms that would run the desalination plants. Subsequently it would sell off the firms and include the private sector in a way similar to what has been done with the Independent Water and Power Projects (see below). The first plant to be privatized would be in Yanbu.<sup>[25]</sup> However, the plants have subsequently been modified: The Yanbu 1 and 2 plants will continue to be operated by SWCC, and the Yanbu plant will be built by a private company, but operated by SWCC.<sup>[26]</sup>

### 6.2.3 Independent Water and Power Producers for desalination

Since the early 2000s, Saudi Arabia has invited the private sector not only to build, but also to finance and operate new desalination plants. A Water and Energy Corporation (WEC) has been established as an off-taker that buys water from the IWPPs through 20-year power and water purchase agreements (PWPAs). The government fully guarantees the payments due from WEC to the IWPPs. This follows the example of the Persian Gulf countries, which had introduced IWPPs several years earlier. The first such project was the Shoaiba III Independent Water and Power Producer (IWPP) completed in 2005.<sup>[27]</sup> It is located on the Red Sea and provides water to Jiddah, Mecca and Taif. The second IWPP was the Jubail II project, located next to the Jubail industrial complex on the Persian Gulf coast.

In 2007 Saudi Arabia had planned to launch ten further IWPPs by 2016 with a total investment of \$16 billion. The first phase of this plan with an approximate cost of US\$7.3 billion, consists of three IWPPs: Shuqaiq II, Ras Al-Khair and Jubail III.<sup>[28]</sup>

### 6.2.4 The Water & Energy Company

The Water & Energy Company, created in 2003, is the off-taker for desalinated water produced by privately operated desalination plants. It is jointly owned by SWCC and the Saudi Electricity Company (SEC).<sup>[29]</sup>

### 6.2.5 Project finance for wastewater treatment plants

Project finance, i.e. financing secured primarily by the projected revenue stream of the project, has been commonly used to finance wastewater treatment plants in Saudi Arabia. In May 2002 the first wastewater contract in Saudi Arabia financed in this way, in this case as a BOT contract, was awarded to a consortium of local firms. The

consortium was to rehabilitate, operate, maintain and upgrade the wastewater system of the Jeddah Industrial City over a period of 20 years and invest US\$32 million.<sup>[30]</sup> The government has awarded many more BOT wastewater treatment contracts since then, based on the revenue stream of long-term sales agreements for treated wastewater sold to major customers.<sup>[31]</sup>

## 7 Efficiency

The operational efficiency of water and sanitation services is typically measured through the level of non-revenue water and the ratio of staff per 1,000 connections.

Because of the low level of metering it is difficult to estimate the level of non-revenue water in Saudi Arabia. Only in the case of Riyadh, where meters exist, a meaningful estimate has been done, resulting in an estimated 34% of non-revenue water. It is broken down into 21% physical losses and 13% commercial losses from undermetering, illegal connections and authorized unbilled consumption such as for mosques. In addition, 24% of billed consumption is not being paid. The overall level is high by international standards.

A recent benchmarking study showed that the regional directorates are employing 10,500 people to serve 5.7 million customers. This corresponds to about 10 staff per 1,000 connections, which is more than three times higher than in the case of efficiently run utilities. The actual number of people employed in service provision is even higher because many directorates contract out specific services.

## 8 Tariffs and cost recovery

**Tariffs.** Average water tariffs range from US\$0.06 to US\$0.10/m<sup>3</sup>, which are among the lowest in the world. The Kingdom has an increasing block tariff structure, but the majority of the consumers fall in the first two blocks where water charges are minimal. Customers with a water use of less than 100 cubic meter per month pay only 0.1 Riyals/m<sup>3</sup> (US\$0.03/m<sup>3</sup>).<sup>[3]</sup> In other countries where increasing-block tariffs are used - such as in Jordan, Yemen or Tunisia - the lifeline consumption benefiting from a lower tariff level is typically set at 20 cubic meters per month or less. The tariff level and structure, combined with a low share of metering, provide little or no incentive to conserve water. Proposals for water tariff adjustments have been formulated, for example by a Saudi think tank, the Al-Aghar Group in partnership the Bushnak Academy, presented at the Saudi Water and Power Forum 2010.<sup>[32][33]</sup> For at least a decade tariffs remained unchanged, and when an increase was announced for December 2015 it was limited to non-domestic tariffs while domestic tariffs remained unchanged.

**Prices for water sold by tanker trucks.** A cubic meter of water supplied by a water tanker may cost as much as 6 Riyals (US\$1.50), or about 20 times more than water supplied through the network. Citizens who are not connected to the piped network, who are often poor, pay up to 40 times more for water than connected households. The monthly water bill is about 1 Riyal (US\$0.27), compared to an average mobile phone bill of 200 Riyals.<sup>[32]</sup>

**Sale of treated effluent.** Through the Treated Sewage Effluent Initiative (TSEI) of the National Water Company, treated wastewater is sold to major water customers, such as industries or golf course operators, under long-term contracts of up to 25 years. This generates a revenue stream that recovers the costs of wastewater treatment under Build-Operate Transfer (BOT) projects financed by the private sector. As of 2011, it was estimated that NWC had signed TSE agreements worth more than 5 billion Saudi Riyals (USD 1.33 billion).<sup>[31]</sup>

**Cost recovery and subsidies.** Few – if any – of the regional branches of MOWE have sufficient revenues to recover costs, despite the fact that they receive desalinated water for free. For example, the Riyadh branch – probably one of the best performing branches - had revenues of 370 million Riyals in 2004, but expenses of 570 million Riyals. On average, “the government is only recovering one or two percent of its costs, and the (subsidy) plans are benefiting the rich, not the poor”, according to Adil Bushnak.<sup>[32]</sup> There is no recovery of the cost of wastewater collection and treatment from those who generate the wastewater. According to a 2000 estimate by the World Bank, the government paid annual subsidies of US\$3.2 billion, equivalent to 1.7% of GDP and 7% of oil revenues.<sup>[34]</sup> Desalinated water is provided for free by SWCC to NWC.

## 9 Investment and financing

All investment for water and sanitation, including desalination, is funded directly by the central government’s budget. The 7th and 8th Development Plans (covering the periods 2000-2005 and 2006-2010 respectively) allocations for water (including irrigation), covering a period of ten years, amounted to Saudi Riyal 34.9 billion (US\$9.2 billion) and Saudi Riyal 41.6 billion (US\$11.1 billion) respectively, equivalent to US\$2 billion per year.

It has been estimated that between 1975 and 2000 a total of more than US\$100bn has been invested in water supply and sanitation, and that a further US\$130bn will be needed between 2002 and 2022, corresponding to US\$6.5 billion per year or more than US\$200 per capita and year.<sup>[2]</sup> This level of investment in water per capita is among the highest in the world, higher than in the US, the UK or Germany, due to the high cost of desalination and the need to transport water over long distances. It corresponds to about 1.5% of GDP.

## 10 See also

- Peak water

## 11 References

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## 12 Further reading

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- World Bank / Kingdom of Saudi Arabia: The Water Sector of the Kingdom of Saudi Arabia, 2007.
- International Benchmarking Network (IB-Net) for water and sanitation
- Elie Elhadj: Dry Aquifers In Arab Countries And The Looming Food Crisis, 2008

## 13 External links

- Ministry of Water and Electricity
- National Water Company
- Saline Water Conversion Corporation (SWCC)
- Water & Electricity Co.
- Electricity and Co-Generation Regulatory Authority

## 14 Text and image sources, contributors, and licenses

### 14.1 Text

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