Kuwait

GEOGRAPHY, CLIMATE AND POPULATION

Geography

Kuwait, with a total area of 17 820 km², lies at the head of the Persian Gulf. It is bordered in the north and northwest by Iraq, in the west and south by Saudi Arabia and it overlooks the Persian Gulf to the east. The land is generally flat with slightly undulating desert plains sloping gently towards the northeast, reaching an altitude of about 300 metres above sea level. Most of the area is desert with a few oases.

In 2003, the total cultivated area covered 7 050 ha, of which about 80 percent was occupied by annual crops (Table 1). The arable land of Kuwait is characterized by a soil with a sandy texture, containing 80–90 percent sand. It has good drainage and airing characteristics but a very low water retention capacity. It is very poor in organic matter and the nutritional elements needed by plants. Hard pans (locally known as "gutch") prevail at different depths of the soil, and are a constraint on water permeability.

About 154 000 ha have been judged as potentially cultivable land. However, it is almost completely covered by permanent pasture. Estimates for crop production potential vary between 25 000 and 37 500 ha, mainly located in: i) the Al Wafra area near the southern border where there are an estimated 1 495 farms that cover a total area of 10 000 ha; ii) the Al Abdali area near the northern border that contains 810 farms in a total area estimated at 20 000 ha; iii) the Al Sulaibiya agricultural area in the centre of the country, where the soil is much better, as it is deep with a sandy texture, good drainage characteristics and good airing and without salt, hard pans or impermeable layers; the number of productive farms in this area, covering an area of about 5 000 ha, is estimated at 68, including 13 vegetable and crop farms, 37 cattle farms, 4 sheep and goat farms, and 14 poultry farms.

Climate

Kuwait has a desert climate characterized by a long, dry, hot summer, with temperatures reaching more than 45 °C with frequent sandstorms, and a cooler winter, with temperatures sometimes even falling below 4 °C. The rainy season extends from October to May. Over an area of about 100 km² annual rainfall is less than 100 mm, while in the remaining part it varies between 100 and 300 mm. The long-term average annual rainfall for the whole country is about 121 mm. In recent years rainfall has varied between 106 and 134 mm/year.

Population

Total population is 2.69 million (2005), of which only 4 percent is rural (Table 1). However, exact figures are difficult to give because of the large amount of immigrant labour. For example, in 1994 about 63 percent of the total population was estimated to

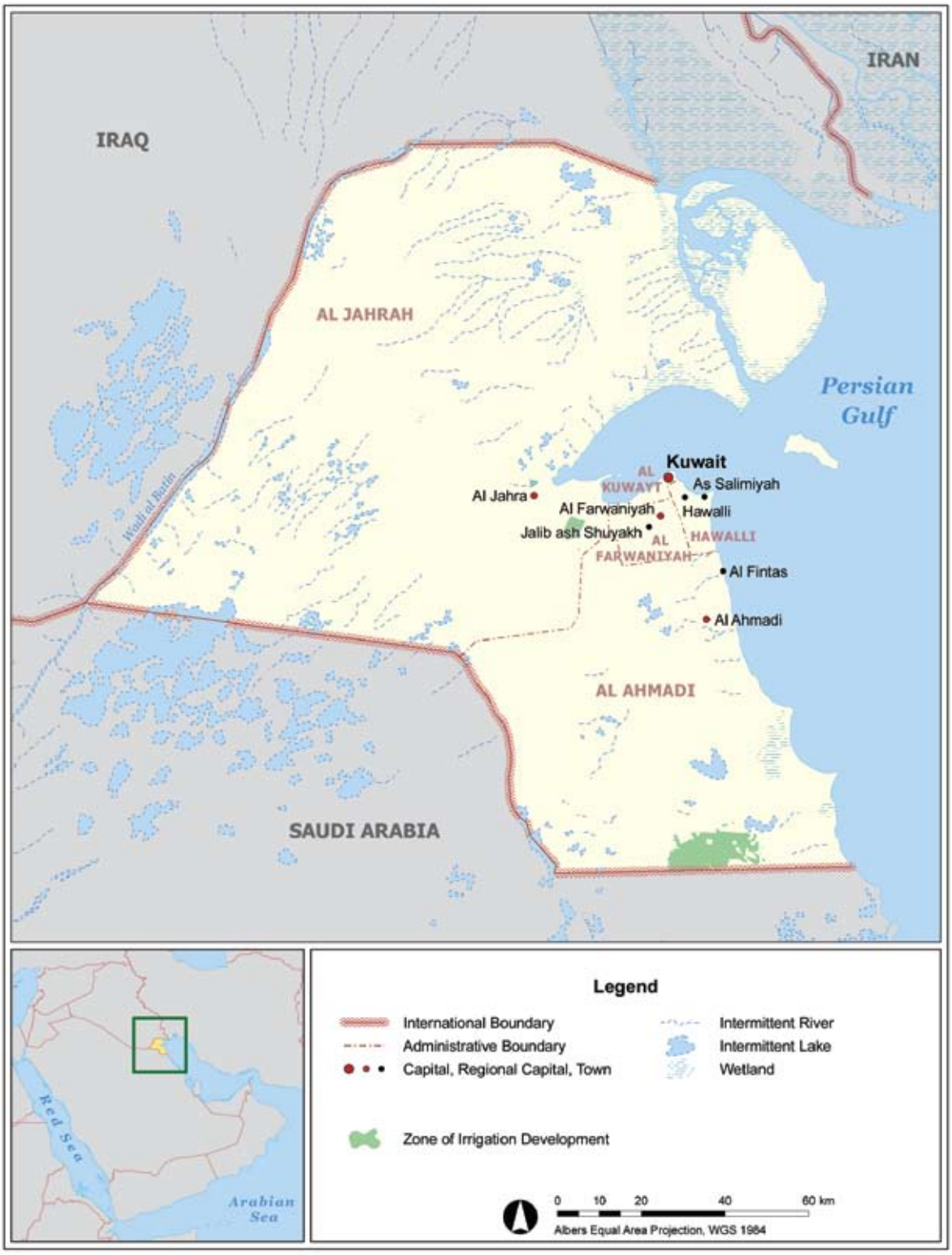

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TABLE 1
Basic statistics and population

Physical areas			
Area of the country	2005	1 782 000	ha
Cultivated area (arable land and area under permanent crops)	2003	7 050	ha
• as % of the total area of the country	2003	0.4	%
• arable land (annual crops + temp. fallow + temp. meadows)	2003	5 665	ha
• area under permanent crops	2003	1 385	ha
Population			
Total population	2005	2 687 000	inhabitants
• of which rural	2005	3.6	%
Population density	2005	151	inhabitants/km²
Economically active population	2005	1 469 000	inhabitants
• as % of total population	2005	54.7	%
• female	2005	25.6	%
• male	2005	74.4	%
Population economically active in agriculture	2005	15 000	inhabitants
• as % of total economically active population	2005	1.0	%
• female	2005	0	%
• male	2005	100	%
Economy and development			
Gross Domestic Product (GDP) (current US$)	2006	102 100	million US$/yr
• value added by agriculture (% of GDP)	2000	0	%
• GDP per capita	2005	30 071	US$/yr
Human Development Index (highest = 1)	2005	0.891	
Access to improved drinking water sources			
Total population		-	%
Urban population		-	%
Rural population		-	%

be non-Kuwait residents. The average population density is 151 inhabitants/km², but varies widely from one region to another. The annual population growth, including both Kuwaiti and non-Kuwait residents, is estimated at 3 percent (2005).

ECONOMY, AGRICULTURE AND FOOD SECURITY

The economy is dominated by petroleum, which accounts for 90-95 percent of merchandise export earnings, 80 percent of budget revenues and around 40 percent of nominal gross domestic product (GDP). The GDP is US$102.1 billion (2006) (Table 1). Agriculture (including fisheries) accounts for almost 0 percent of GDP and does not offer an important source of employment. The total economically active population is about 1.47 million (2005) of which 74 percent is male and 26 percent female. Around 1 percent of the economically active population works in agriculture, almost all foreigners (2005). Most farm owners are investors and also have other sources of income.

Livestock production is an important component of the agricultural sector and contributes about 67 percent to total agricultural GDP, as compared to 23 percent for plant production and 10 percent for fisheries.

WATER RESOURCES AND USE

Water resources

The prevailing hyper-arid climate of Kuwait is not favourable to the existence of any river systems in the country. There are no permanent rivers or lakes, but small wadis develop in the shallow depressions in the desert terrain. Surface runoff sometimes occurs in the large wadi depressions during the rainy season. Flash floods are reported to last from only a few hours to several days. Due to the extremely high evaporation losses and the high deficit in soil moisture, only a small percentage of the precipitation infiltrates into the groundwater supply. Internal renewable groundwater sources

are negligible. Groundwater inflow has been estimated at about 20 million m³/year through lateral underflow from Saudi Arabia (Table 2).

Thick geological sequences are of sedimentary origin from the Palaeocene to Recent, in two groups known as Hasa and Kuwait. The Hasa group, which consists of limestone, dolomite, anhydrite and clays, comprises three formation units, known as Umm er Radhuma in the Palaeocene to the Middle Eocene, Rus in the Lower Eocene, and Damman in the Middle Eocene. The Kuwait group, which consists of fluvial sediments of sand and gravel, calcareous sand and sandstone with some clays, gypsums, limestone, and marls, comprises three formation units, known as Ghar in the Miocene, Fars in the Pliocene, and Dibdibba in the Pleistocene (UNU, 1995).

Groundwater can be divided into the following three categories according to its salt content (Public Authority of Agriculture Affairs and Fish Resources, 2006):

- Fresh groundwater: its content of soluble salt is less than 1 000 mg/l and such water is not used for agriculture but is considered as a strategic freshwater reservoir for drinking water purposes. It is mostly available in the two fields of Rawdatian and Umm Al Eish. These freshwater lenses are formed due to a combination of unique conditions that include high intensity rainfall of short duration, and a geomorphology and lithology that enable rapid infiltration to the underlying groundwater. From historical pumping and water quality variation data acquired between 1963 and 1977, the sustainable extraction rate for Rawdatain and Umm Al Eish, which would avoid the upcoming of deeper saline water, is estimated to be 5 500 and 3 500 m³/day respectively (Kwarteng *et al*, 2000).
- Brackish groundwater: its soluble salt content is from 1 000 to 7 000 mg/l and is used for agricultural and domestic purposes and as drinking water for cattle. This water is produced from the Al Shaya, Al Qadeer, Al Solaybeia, Al Wafra and Al Abdali fields. The production capacity of these fields is around 545 000 m³/day.
- Saline groundwater: the soluble salt content in this water is between 7 000 to 20 000 mg/l and it is therefore not appropriate for agricultural or domestic use.

In general groundwater quality and quantity are deteriorating due to the continuous pumping of water. In Al Wafra in the south, 50 percent of the wells pumped water

TABLE 2
Water: sources and use

Renewable freshwater resources			
Precipitation (long-term average)	-	121	mm/yr
	-	2.16	10^9 m³/yr
Internal renewable water resources (long-term average)	-	0	10^9 m³/yr
Total actual renewable water resources	-	0.02	10^9 m³/yr
Dependency ratio	-	100	%
Total actual renewable water resources per inhabitant	2005	7.4	m³/yr
Total dam capacity		-	10^6 m³
Water withdrawal			
Total water withdrawal	2002	913.2	10^6 m³/yr
- irrigation + livestock	2002	491.9	10^6 m³/yr
- municipalities	2002	400.5	10^6 m³/yr
- industry	2002	20.8	10^6 m³/yr
per inhabitant	2002	375	m³/yr
Surface water and groundwater withdrawal	2002	415	10^6 m³/yr
• as % of total actual renewable water resources	2002	2 075	%
Non-conventional sources of water			
Produced wastewater	2003	244	10^6 m³/yr
Treated wastewater	2005	250	10^6 m³/yr
Reused treated wastewater	2002	78	10^6 m³/yr
Desalinated water produced	2002	420.2	10^6 m³/yr
Reused agricultural drainage water		-	10^6 m³/yr

with a salinity level higher than 7 500 ppm in 1989, reaching 75 percent and 85 percent in the years 1997 and 2002 respectively. In Al Abdali in the north, these figures were estimated at 55, 75 and 90 percent respectively.

The first plant for desalinating sea water was established at Al Ahmadi port in 1951, with a capacity of 364 m^3/day. The production capacity increased over the years until it reached 1.1 million m^3/day, while maximum consumption reached 0.9 million m^3/day in the summer of 1995 (PAAFR, 2006). In 2002 the annual quantity of desalinated water produced was 420 million m^3 (FAO, 2005). The problem with seawater distillation is the high cost of the multi-stage flash (MSF) evaporation process. The cost of the thermal process is largely dependent on the rate of energy (fuel) consumption for operating the system, which can account for as much as about 50 percent of the water unit cost, thus being sensitive to the unstable world market price of crude oil (UNU, 1995).

Over 90 percent of the population is connected to a central sewerage system. This offers an important potential for treated wastewater reuse that can contribute to alleviating the water shortage problem. However, various conditions affect the quality and quantity of sanitary sewage from the time it enters the local collector sewers until it is converted to sludge and treated sewage effluent at the sewage treatment plants. Qualitative and quantitative monitoring of the system and of the effluent from the time it leaves treatment plants to the end use for irrigation is essential to prevent the potential hazards associated with wastewater reuse. The sewerage system consists of an assemblage network that is based on gravity and which collects wastewater and transfers it to 60 pump stations (17 main and 43 secondary) from which it is pumped into pipelines all the way to wastewater treatment plants (WWTP) where it is treated. Total length of pipelines is 650 km. The sewerage system collects over 90 percent of the raw domestic and some industrial wastewater (220 million m^3/yr), in addition to part of the storm water runoff in the residential areas which are connected to the sewerage system. The main WWTP, including those in operation, planning and implementation, are shown in Table 3 where the current treated volumes are indicated. Wastewater treatment has two main purposes: i) to protect public health and the environment; ii) to use treated wastewater for irrigation to compensate for the water deficit. In 2002 the wastewater treated represented 152 million m^3 of which 78 million m^3 was reused, which means an increase of 48 and 50 percent respectively compared to 1994. In 2005 the total amount of treated sewage water was estimated at 250 million m^3/year (FAO, 2005). Treatment plants are gradually being upgraded to advanced levels of treatment with the first plant (Al Solaybeia) planned to begin operating by the end of 2004 using a very advanced level of treatment, the RO-Plant (FAO, 2005).

Water use

In 2002 the total water withdrawal was around 913 million m^3, compared to 538 million m^3 in 1993 (Table 4 and Table 5). The per capita water consumption in Kuwait is high.

TABLE 3
Current and projected treated wastewater production in Kuwait

Plant	Effluent production in m^3/d		Remarks
	Design	2004	
Al Ardiya	150 000	270 000	To be replaced by the Al Solaybeia plant
Al Rigga	100 000	180 000	Tertiary treatment by sand filtration
Al Jahra	70 000	66 000	Same
Al Hayman	10 000	10 000	Tertiary treatment by sand filtration plus UV disinfection
Al Wafra	10 000	4 000	SBR
Total		**530 000**	

A new wastewater treatment plant at Sulaibiya, considered one of the biggest and most advanced (RO-wastewater) plants in the world, should now be in operation with a design capacity of 425 000 m^3/day

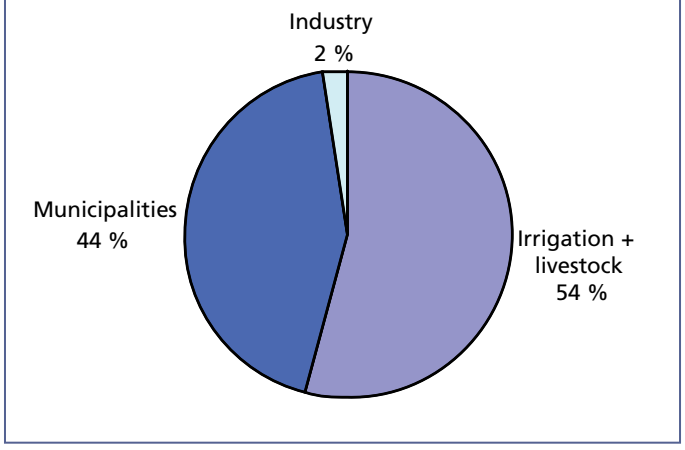
TABLE 4
Water resources availability and use in 2002 (million m³/yr)

Source of water	Water availability	Water use
Desalinated water	420.2	420.2
Treated wastewater effluents	152	78
Brackish water (MOE 94% and Kuwait Oil Co. 6%)	115	415
Groundwater from private farms' boreholes	1 047	
Total	**1 734.2**	**913.2**

TABLE 5
Water use in 2002 (million m³/yr)

Uses	Desalinated water	Reused treated wastewater	Brackish groundwater	Total	%
Potable	368.5	-	32.0	400.5	43.86
Landscape	6.9	12.0	25.9	44.8	4.91
Agricultural	27.0	66.0	300.0	393.0	43.03
Industrial	17.8	-	3.0	20.8	2.28
Others	-	-	54.1	54.1	5.92
Total	**420.2**	**78.0**	**415.0**	**913.2**	**100.00**
%	**46.0**	**8.5**	**45.5**	**100.0**	

FIGURE 1
Water withdrawal by sector
Total: 0.913 km³ in 2002



54 percent of the water withdrawn was used for agriculture, 44 percent for municipal purposes and 2 percent for industrial purposes (Figure 1). Of the 492 million m³ withdrawn for agriculture, 80 percent was used for productive agriculture, 9 percent for landscape greening and 11 percent for garden watering (but it also includes some non-drinking uses at household level). Of the water withdrawn for productive agriculture, 300 million m³ is brackish water from private farms' boreholes at Al Abdali and Al Wafra (based on 12 hours operation and 270 days/year with an average discharge of 40 m³/h per well). 66 million m³ are treated wastewater effluent (50 percent tertiary treatment and 50 percent more advanced treatment).

Fresh groundwater withdrawal amounts to 255 million m³/year, leading to an extraction of more than 12 times the annual groundwater inflow (20 million m³) (Figure 2). Farmers are only allowed to withdraw water from the Kuwait group aquifer and there were about 1 767 wells in 1994. The water used for livestock purposes is pumped by the Ministry of Electricity and Water (MEW) from the Damman group aquifer through deep artesian wells. Continued heavy extraction was estimated to have led to a decline in the groundwater level of 200 metres by the year 2000.

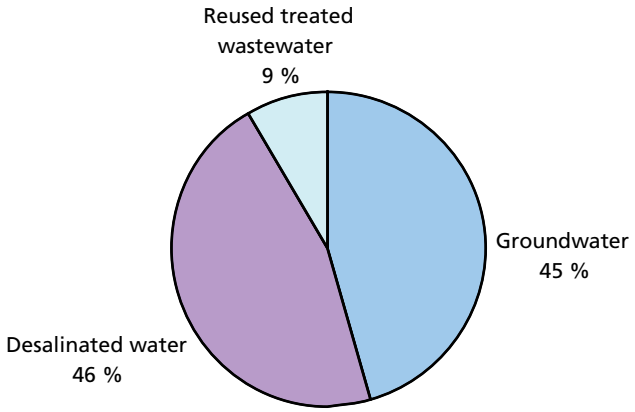
Overdrafting of brackish groundwater over the past decades has led to high drawdown and at times even depletion as well as increased salinity levels. Its use for agriculture is limited to plant species that tolerate high salinity levels. As an example, in 1985 crop irrigation was being carried out by pumping 53–67 million m³ of brackish groundwater

per year from the well fields in Al Wafra and Abdali-Um Nigga. Existing yield, estimated potential yield, and water salinity of each well field at that time are shown in Table 6 (UNU, 1995).

Desalinated seawater is currently used for all purposes, although the largest share is allocated to the drinking supply. Treated wastewater effluent is usually a mix of tertiary and more advanced treatment of wastewater. Tertiary treated sewage water is mainly used for the irrigation of fodder crops and date palms and also for landscaping.

During the period 1925-1950, Kuwait imported freshwater from the Shatt al-Arab in Iraq, some 100 km northwest from Kuwait, to supplement the water obtained from wells. Further exploitation of water resources was initiated by the rapid development of the oil industry and commerce in the 1950s, when shortage problems became a constraint to economic development (UNU, 1995).

FIGURE 2
Water withdrawal by source
Total: 0.913 km³ in 2002



IRRIGATION AND DRAINAGE DEVELOPMENT

Evolution of irrigation development

Irrigation in Kuwait started in the late 1950s. Initially surface irrigation techniques (furrow and basin irrigation) were used. Sprinkler irrigation was introduced in 1977, using treated wastewater. Localized irrigation was introduced in 1979, first for agricultural production in greenhouses, but from 1981 onwards also for irrigation in open fields in order to preserve the water resources.

In 1994 the total water managed area, all with full or partial control irrigation, was 4 770 ha, which is in fact equal to the cultivated area, as the entire cultivated area is irrigated. Out of this area, almost 61 percent was irrigated with groundwater (Figure 3). Surface irrigation is the main irrigation technology used in Kuwait, covering 63 percent of the area equipped for irrigation (Figure 4). Localized and sprinkler irrigation cover 24 and 13 percent respectively. In 2003, the total area equipped for irrigation was 7 050 ha (Table 7).

There are three types of farming in the irrigation sector:

TABLE 6
Well fields in Kuwait in 1985 (Kuwait Institute for Scientific Research, 1990)

Field	Aquifer	Number of wells	Yield (million m³/year)		Salinity (TDS, mg/l)	Purpose
			Existing	Potential		
Rawdatain and Um Al Eish	Dibdibba F	52	2.5	6.6	700-1 200	water supply
Shigaya A, B. C	Kuwait G	60	53	66	3 000-4 000	water supply
Shigaya D, E	DammanF	54	-	42	3 000-4 500	water supply
Solaybeia	Damman F	133	25-33	33	4 500-5 500	water supply
Abduliya	Damman F	14	8	-	4 500	water supply
Wafra	Kuwait G	(110)	33-42	50	4 000-6 000	irrigation
Abdali Um Nigga	Dibdibba F	(110)	20-25	33-42	3 000-7 000	irrigation

FIGURE 3
Source of irrigation water
Total: 4 770 ha in 1994

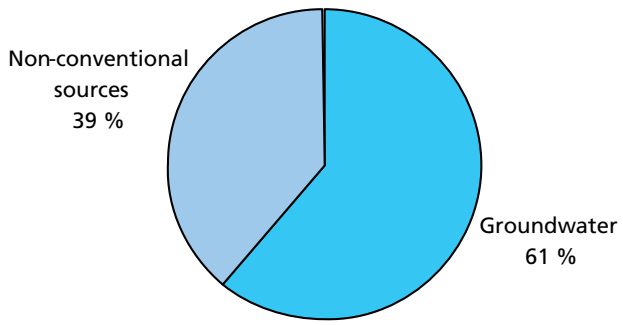
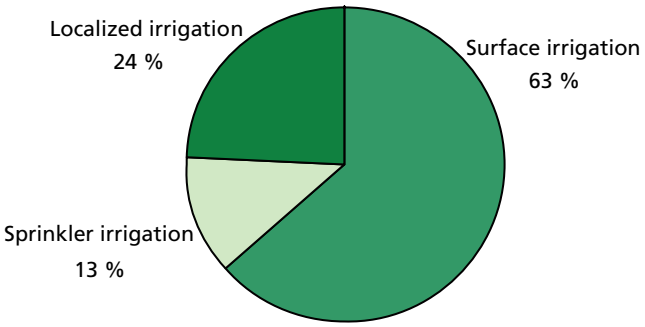


FIGURE 4
Irrigation techniques
Total: 4 770 ha in 1994



- Private farms, which are leased by the government to investors (25 years renewable) and operated by labourers. These are the most numerous. The smaller ones are mostly located in Al Wafra in the south, the larger ones in Al Abdali in the north;
- Institutional schemes, which are operated by the government through the Public Authority for Agricultural Affairs and Fish Resources (PAAFR);
- Company-owned schemes such as the United Company for Agricultural Production, located in Al Solaybeia in the centre of the country.

Role of irrigation in agricultural production, the economy and society

The cost of irrigation development for small schemes (< 10 ha), equipped with localized irrigation including one well and a pump, amounts to US$19 000/ha. The cost decreases as the irrigation scheme size increases and for large schemes (> 30 ha) it is about US$15 000/ha. Annual operation and maintenance costs per ha are estimated at 2 percent of the investment costs.

There are no water charges for groundwater use. Farmers are charged for desalinated water use and the charge varies from US$0.9/m³ for small schemes to US$1.5/m³ for large schemes. The treated sewage water charge is US$0.07/m³.

In 2006, about 45 percent of the harvested land was devoted to vegetable production, mainly tomatoes, eggplants, cucumbers and sweet peppers, and 19 percent concerned cereals, mainly barley and wheat. Date palm trees are the most important fruit trees grown, which occupy about 20 percent of the cultivated land. The remaining crops grown are potatoes and some other annual and permanent crops (Figure 5). In 2003, agricultural production included 207 000 tonnes of vegetables, 18 000 tonnes of fruits and about 3 300 tonnes of cereals.

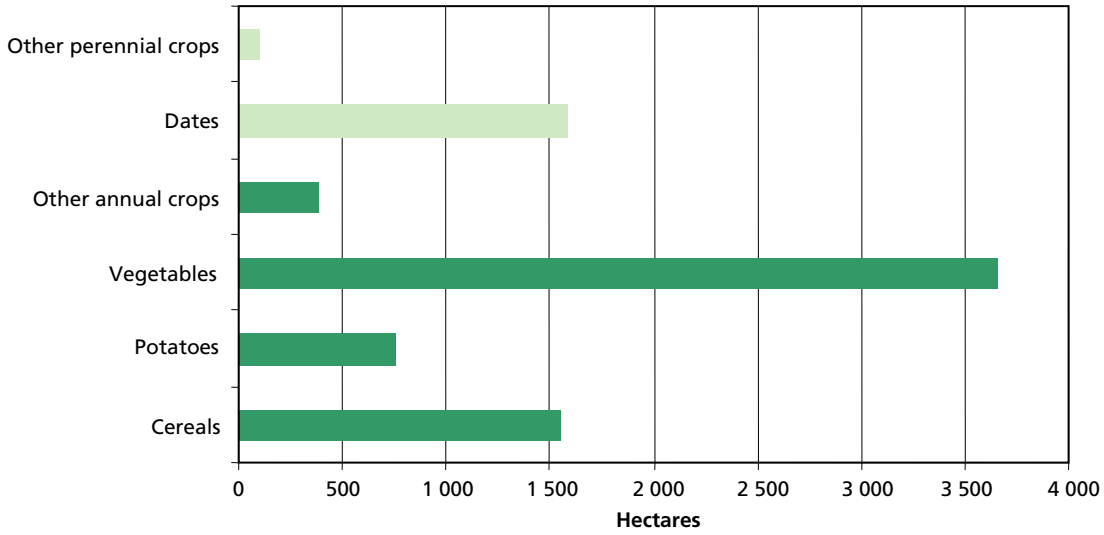
Status and evolution of drainage systems

Impervious layers exist at various depths in the Al Wafra area creating waterlogging in some areas. In 1994 this was estimated at 2 840 ha, due to poor natural drainage. On-farm drainage systems have not yet been developed, but some studies related to this subject are being conducted by the Public Authority for Agricultural Affairs and Fish Resources (PAAFR) and the Ministry of Electricity and Water (MEW). Small-scale subsurface drainage systems were installed in some public gardens (2 ha). The area salinized by irrigation was estimated at 4 080 ha in 1994.

TABLE 7
Irrigation and drainage

Irrigation potential	**-**	**25 000**	**ha**
Irrigation			
1. Full or partial control irrigation: equipped area	2003	7 050	ha
- surface irrigation	1994	3 020	ha
- sprinkler irrigation	1994	600	ha
- localized irrigation	1994	1 150	ha
• % of area irrigated from surface water	1994	0	%
• % of area irrigated from groundwater	1994	61	%
• % of area irrigated from mixed surface water and groundwater	1994	0	%
• % of area irrigated from non-conventional sources of water	1994	39	%
• area equipped for full or partial control irrigation actually irrigated	2003	100	ha
- as % of full/partial control area equipped		-	%
2. Equipped lowlands (wetland, ivbs, flood plains, mangroves)	2003	0	ha
3. Spate irrigation	2003	0	ha
Total area equipped for irrigation (1+2+3)	**2003**	**7 050**	**ha**
• as % of cultivated area	2003	100	%
• % of total area equipped for irrigation actually irrigated	2003	100	%
• average increase per year over the last 9 years	1994-2003	4.4	%
• power irrigated area as % of total area equipped	1994	100	%
4. Non-equipped cultivated wetlands and inland valley bottoms	2003	0	ha
5. Non-equipped flood recession cropping area	2003	0	ha
Total water-managed area (1+2+3+4+5)	**2003**	**7 050**	**ha**
• as % of cultivated area	2003	100	%
Full or partial control irrigation schemes	**Criteria**		
Small-scale schemes	< ha	-	ha
Medium-scale schemes		-	ha
large-scale schemes	> ha	-	ha
Total number of households in irrigation		-	
Irrigated crops in full or partial control irrigation schemes			
Total irrigated grain production	2006	3 833	metric tonnes
• as % of total grain production	2006	100	%
Harvested crops			
Total harvested irrigated cropped area	2006	8 055	ha
• Annual crops: total	2006	6 363	ha
- Wheat	2006	290	ha
- Barley	2006	1 263	ha
- Potatoes	2006	760	ha
- Vegetables	2006	3 660	ha
- Other annual crops	2006	390	ha
• Permanent crops: total	2006	1 692	ha
- Dates	2006	1 589	ha
- Other perennial crops	2006	103	ha
Irrigated cropping intensity (on full/partial control irrigation: equipped area)	2003	106	%
Drainage – Environment			
Total drained area	1994	2	ha
- part of the drained area equipped for irrigation		-	ha
- other drained area (non-irrigated)		-	ha
• drained area as % of cultivated area	1994	0.04	%
Flood-protected areas		-	ha
Area salinized by irrigation	1994	4 080	ha
Population affected by water-related diseases		-	inhabitants

FIGURE 5
Irrigated crops
Total harvested area: 8 055 ha in 2006 (cropping intensity on equipped area actually irrigated: 106%)



WATER MANAGEMENT, POLICIES AND LEGISLATION RELATED TO WATER USE IN AGRICULTURE

Institutions

The main institutions involved in water resources management are:

- The Public Authority for Agricultural Affairs and Fish Resources (PAAFR), established in 1983. Traditionally, the PAAFR was affiliated to the Ministry of Public Works (MPW), but recently it has been moved under the Council of Ministers in order to provide it with more autonomy. The PAAFR is responsible for managing the agricultural economic development and enhancing food security. Administratively, the PAAFR is organized into five main sectors: i) animal resources, ii) fisheries resources, iii) plant resources, iv) landscaping, v) finance and administration (FAO, 2005). The Soil and Water Division is responsible for the design and evaluation of farm irrigation systems, testing irrigation equipment, crop water requirement research, monitoring of groundwater quality and quantity and water resources planning. The Landscape and Greenery Department is responsible for irrigation designs for highways and forestry areas.
- The Ministry of Electricity and Water (MEW), established in 1962: responsible for studies, development, exploration, monitoring and giving licences for drilling and using groundwater;
- The Ministry of Public Works (MPW), established in 1962: responsible for sewage water networks and collection reservoirs, wastewater treatment and utilization and water quality monitoring laboratories. Also responsible for the delivery of treated sewage effluent to farms and public gardens.
- The Kuwait Institute for Scientific Research (KISR): in charge of research related to water resources with the Water Resources Division and Environment and the Urban Development Division.
- The Environmental Public Authority (EPA), in charge of monitoring water quality, with water analysis laboratories, a research and studies centre and a soil and arid land division.
- The Ministry of Health (MOH).

Water management

In addition to government institutions, several farmers' associations and cooperatives are active in the agricultural and fisheries sector, including the two agricultural cooperative societies in Al Wafra and Al Abdali, the Kuwaiti Farmers' Federation, the Kuwait Association of Fishermen, the Animal Wealth Cooperative Society, the Federation of Fresh Milk Producers and the Society for Poultry Growers (FAO, 2005).

Finances

The Industrial Bank of Kuwait (IBK) is responsible for administering the "Agriculture and fisheries credit portfolio", which is a fund earmarked for soft loans for investment in agriculture and fisheries (FAO, 2005).

ENVIRONMENT AND HEALTH

The only natural freshwater resource of Kuwait occurs as lenses floating on the saline groundwater in the northern part of the country near to the oil fields. Rainwater is the only means of recharging this limited groundwater resource. This groundwater is used as bottled drinking water and the fresh groundwater aquifer is considered as a strategic drinking water reserve for Kuwait. As a result of the 1991 Gulf War, the upper soil layer was contaminated by crude oil and crude oil combustion products, which are potential pollutants likely to affect the groundwater resources (Literathy *et al, 2003*).

In Kuwait, as in other countries of the world, the main concerns in water recycling and reuse are: (a) reliable treatment of wastewater to meet strict water quality requirements for the intended reuse, (b) protection of public health and (c) gaining public acceptance. In the case of reusing recycled water for irrigation of vegetables and other crops that are consumed uncooked or for green residential spaces with high public contact and for groundwater recharge, several public health concerns are encountered.

While potable reuse of treated wastewater is still a distant possibility, groundwater recharge with advanced wastewater treatment technologies is a viable option. However, in Kuwait, as well as in other countries in the region, a lack of experimental data on groundwater recharge from local research means that efforts should be focused in that direction (Angelakis *et al*, 2005).

PROSPECTS FOR AGRICULTURAL WATER MANAGEMENT

Kuwait is planning to reclaim more land in order to provide food for the population by putting it under irrigation. This will increase irrigated areas and boost demand for water in the irrigation sector. Faced with these conditions, it is imperative to rationalize the water use efficiency of the existing water resources and to increase the supply as much as possible. The water economy of the country is based on non-conventional sources of water. The use of treated wastewater becomes one of the most important solutions for extending irrigation of agricultural crops and landscape. While its use poses potential health hazards and environmental problems, these could be faced effectively with the available technology and good management. It is the main source of non-conventional water that can be used in a cost-effective manner for irrigation. Desalinated water can also be used, but because of its high cost only high-value cash crops produced under intensive conditions are cost-effective today (FAO, 2005).

Waterlogging and salinization problems are prevalent, which underlines the urgent need to improve drainage, both for agricultural and landscaping areas and to convince the farmers/users of the need for adequate drainage facilities.

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