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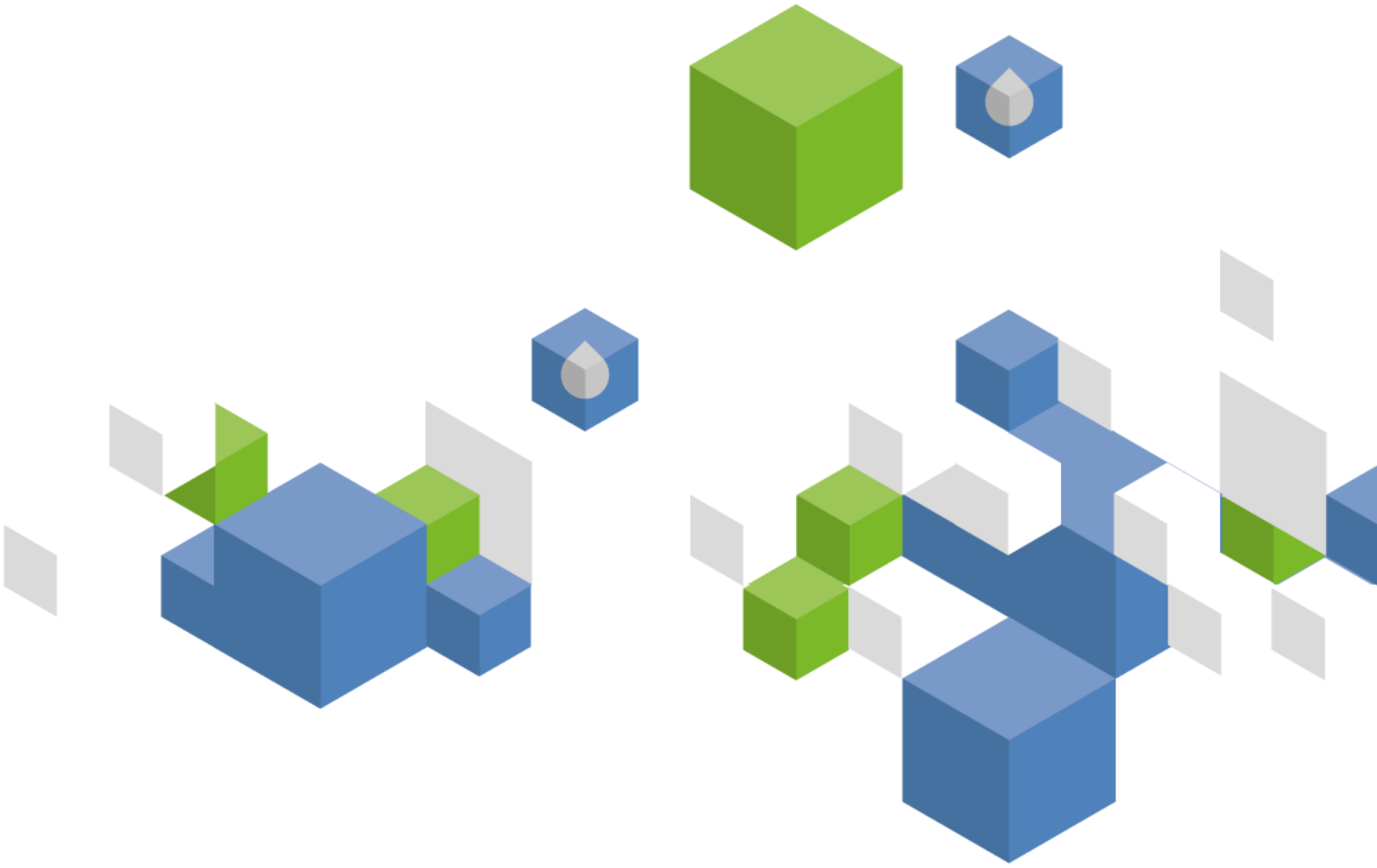

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Saudi Arabia

GEOGRAPHY, CLIMATE AND POPULATION

Geography

The Kingdom of Saudi Arabia, with a total area of about 2.15 million km^2, is by far the largest country on the Arabian Peninsula. It is bordered in the north by Jordan, Iraq and Kuwait, in the east by the Persian Gulf with a coastline of 480 km, in the southeast and south by Qatar, the United Arab Emirates, Oman and Yemen, and in the west by the Red Sea with a coastline of 1 750 km.

It can be divided into four main physiographic units:

- the Western Mountains, called the Arabian Shield, with the highest peak at 2 000 metres above sea level and crossed by deep valleys;
- the Central Hills, which run close to the western mountains and lie in the centre of the country. Their elevation ranges from 900 to 1 800 metres above sea level;
- the Desert Regions, which lie to the east of the Central Hills, with elevations ranging from 200 to 900 metres. Sand dunes are commonly found in these deserts;
- the Coastal Regions, which include the coastal strip along the Red Sea with a width of 16 to 65 km. The important part is the Tahama Plain in the south. The plain on the eastern side overlooks the Persian Gulf, is generally wide and includes the region of oases

The cultivable area has been estimated at 52.7 million ha, which is almost 25 percent of the total area. In 2005, the cultivated area was 1 213 586 ha, of which 1 011 923 ha consisted of annual crops and 201 663 ha of permanent crops (Table 1). The cultivated area in 2005 was 23 percent less than it was in 1992. The area under annual crops decreased by 33 percent, while the area covered by permanent crops increased by 111 percent.

Climate

Saudi Arabia lies in the tropical and subtropical desert region. The winds reaching the country are generally dry, and almost all the area is arid. Because of the aridity, and hence the relatively cloudless skies, there are great extremes of temperature, but there are also wide variations between the seasons and regions. In the central region, the summer (May to October) is overwhelmingly hot and dry, with maximum temperatures of over 50 °C, while the winter is dry and cool with night temperatures close to freezing. There can be severe frost generally and even weeks of snow in the mountains. The western and eastern regions are hot and humid in the summer months, with maximum temperatures around 42 °C, while the winters are warm. Prevailing winds are from the north and when they blow coastal areas become bearable in the summer and even pleasant in winter. The northwardly wind produces sand and dust storms that can decrease visibility to a few metres in some areas.

In the north, annual rainfall varies between 100 and 200 mm. Further in the south, except near the coast, annual rainfall drops below 100 mm. The higher parts of the west and south do, however, experience appreciable rainfalls and over some small areas 500 mm/year is not uncommon. Long-term average annual precipitation has been estimated at 245.5 km^3/year, which is equal to 114 mm/year over the whole country.

FIGURE 1
Map of Saudi Arabia

SAUDI ARABIA **FAO - AQUASTAT, 2008**

TABLE 1
Basic statistics and population

Physical areas			
Area of the country	2005	214 969 000	ha
Cultivated area (arable land and area under permanent crops)	2005	1 213 586	ha
• as % of the total area of the country	2005	0.6	%
• arable land (annual crops + temp. fallow + temp. meadows)	2005	1 011 923	ha
• area under permanent crops	2005	201 663	ha
Population			
Total population	2005	24 573 000	inhabitants
• of which rural	2005	11.5	%
Population density	2005	11.4	inhabitants/km^2
Economically active population	2005	8 694 000	inhabitants
• as % of total population	2005	35.4	%
• female	2005	21	%
• male	2005	79	%
Population economically active in agriculture	2005	600 000	inhabitants
• as % of total economically active population	2005	6.9	%
• female	2005	9	%
• male	2005	91	%
Economy and development			
Gross Domestic Product (GDP) (current US$)	2007	381 680	million US$/yr
• value added in agriculture (% of GDP)	2007	3	%
• GDP per capita	2005	12 843	US$/yr
Human Development Index (highest = 1)	2005	0.812	
Access to improved drinking water sources			
Total population	1990	89	%
Urban population	2006	97	%
Rural population	1990	63	%

Population

The total population is 24.6 million (2005) of which 11.5 percent is rural (Table 1). In 2005, about 76 percent were estimated to be Saudi nationals. During the period 2000-2005, the annual demographic growth rate in Saudi Arabia was 2.7 percent.

In 2006, 97 percent of the urban population had access to improved water sources. In 2006, the whole urban population had access to improved sanitation.

ECONOMY, AGRICULTURE AND FOOD SECURITY

In 2007, the national Gross Domestic Product (GDP) was US$ 381.7 billion. The share of GDP accounted for by agriculture rose during the 1980s, mainly as a result of the decline in revenue from the petroleum sector and government efforts to pursue a policy of greater self-sufficiency in agriculture. It was 8.8 percent in 1993. Since the late 1990s it has fallen again, mainly as a result of the decline in subsidies from the government to national farmers in an effort to reduce water consumption in agriculture. In 2007, agriculture accounted for only 3 percent of GDP. The total economically active population was 8.7 million or over 35 percent of the total population (2005). The population economically active in agriculture was estimated at 600 000 in 2005, of which only 9 percent was female.

Even though environmental conditions are not ideal, Saudi Arabia has always attached great importance to the agricultural sector and has given it priority in its various development plans. The sector is expected to achieve the goals of economic development among which food security, diversification of the production base and minimization of the reliance on petroleum as a main source for the national income.

Various government policies and programmes have been devised and implemented in the past so as to permit the achievement of such goals.

These policies and programmes included a great deal of support and encouragement for the private sector to invest in the agricultural sector, such as subsidies, interest-free loans, and free distribution of uncultivated land, in addition to the development of infrastructure (roads, dams, irrigation and drainage canals), extension services, protection, quarantine, research services and training of agricultural workers, farmers and their sons. All this led to the achievement of self-sufficiency for some important food crops such as wheat, dates, table eggs, fresh milk and some vegetable products, besides increasing the levels of self-sufficiency for other vegetables, fruits, poultry meat and lean meat (FAO, 2007).

WATER RESOURCES

Heavy rainfall sometimes results in flash floods of short duration. River beds are dry for the rest of the time. Part of the surface runoff percolates through the sedimentary layers in the valleys and recharges the groundwater, while some is lost through evaporation. The largest quantity of runoff occurs in the western region, which represents 60 percent of the total runoff although it covers only 10 percent of the total area of the country. The remaining 40 percent of the total runoff occurs in the far south of the western coast (Tahama), which only covers 2 percent of the total area of the country. Total renewable surface water resources have been estimated at 2.2 km^3/year, most of which infiltrates to recharge the aquifers. Total renewable groundwater resources have been estimated at 2.2 km^3/year and the overlap at 2 km^3/year, which brings the total Internal Renewable Water resources (IRWR) to 2.4 km^3/year. Total groundwater reserves (including fossil groundwater) have been estimated at about 500 km^3 of which 340 km^3 are probably abstractable at an acceptable cost in view of the economic conditions of the country.

Groundwater is stored in six major consolidated sedimentary old-age aquifers located in the eastern and central parts of the country. This fossil groundwater, formed some 20 000 years ago, is confined in sand and limestone formations of a thickness of about 300 m at a depth of 150 – 1 500 m. Fossil aquifers contain large quantities of water trapped in fissures. For example, the Saq aquifer in the eastern part of the country extends over 1 200 km northwards. Nevertheless all of these aquifers are poorly recharged (water entered these aquifers thousands of years ago), yet continuously 'mined'. The natural recharge of these aquifers is only about 3.5 million m^3/day, or 1.28 km^3/year. These resources are precious as they are not the product of an ongoing hydrological cycle. According to the Water Atlas of Saudi Arabia, these resources are estimated at 253.2 km^3 as proven reserves, while the probable and possible reserves of these aquifers are 405 and 705 km^3 respectively. In a similar study the Ministry of Planning (MOP) showed that the reserves amount to 338 km^3 with secondary reserves reaching 500 km^3 (probable). Estimates made by the Scientific Research Institute's Water Resources Division at Dahran city of 36 000 km^3 are more than seventy times higher than the above estimates. However, they estimated 870 km^3 as being economically abstractable which is somewhat closer to the above figures. Furthermore, they stressed that with technological advances more amounts could be utilized. An engineering firm, the Saudi Arabia Engineering Consult, gave an estimate of about 2 175 km^3. These studies may indicate that the estimates of the ministries are very conservative (Al-Mogrin, 2001). In total, an estimated 394 million m^3/year flow from aquifers from Saudi Arabia to Jordan (180), Bahrain (112), Iraq (80), Kuwait (20), and Qatar (2).

In 2004, there were approximately 223 dams of various sizes for flood control, groundwater recharge and irrigation, with a collective storage capacity of 835.6 million m^3. A major dam, the King Fahd dam in Bisha in the southwest with a capacity of 325 million m^3, was built in 1997 and there are plans to build another 17 dams.

Saudi Arabia is the largest producer of desalinated water from the sea. In 2004 there were 30 desalination and power plants. There were 24 plants on the west coast and six on the east coast. In 2006, 1.03 km^3 of desalinated water were produced (Table 2). The water produced is used for municipal purposes. The

quantities produced cover some 48 percent of municipal uses. In fact, the desalinated water produced is sometimes exported to distant cities. For instance, in 2004 some 528 million m^3 were produced on the western coast of which over 50 percent was exported to the city of Jiddah, while 536 million m^3 were produced on the eastern coast, of which over 65 percent was exported to the city of Riyadh, which is located in the centre of the country at about 400 km from the sea on both sides. The total length of pipelines used for the transmission of desalinated water is about 4 156 km. The capacity of desalinated water reservoirs amounted to 9.38 million m^3.

TABLE 2
Water resources

Renewable freshwater resources			
Precipitation (long-term average)	-	114	mm/yr
	-	245.1	10^9 m^3/yr
Internal renewable water resources (long-term average)	-	2.4	10^9 m^3/yr
Total actual renewable water resources	-	2.4	10^9 m^3/yr
Dependency ratio	-	0	%
Total actual renewable water resources per inhabitant	2005	98	m^3/yr
Total dam capacity	2004	835.6	10^6 m^3

In 2002 total treated wastewater reached almost 548 million m^3, of which 123 million m^3 were reused. In 2003 70 sewage treatment plants were in operation. The use of treated wastewater is still limited at present (166 million m^3 in 2006), but it represents a potentially important source of water for irrigation and other uses.

WATER USE

It is estimated that in 2006 total water withdrawal was at 23.7 km^3, an increase of 40 percent compared to 1992, shared between the various sectors as follows: agriculture 88 percent, municipal 9 percent, and industry 3 percent (Table 3 and Figure 2). The boom in desert agriculture tripled the volume of water used for irrigation from about 6.8 km^3 in 1980 to about 21 km^3 in 2006. The total surface water and groundwater withdrawal represented 943 percent of the total renewable water resources. Groundwater resources of Saudi Arabia are being depleted at a very fast rate. Most water withdrawn comes from fossil, deep aquifers and some predictions suggest that these resources may not last more than about 25 years. The quality of the abstracted water is also likely to deteriorate with time because of the flow of low quality water in the same aquifers towards the core of the depression at the point of use. In 2003 there were 5 661 government wells assigned for municipal purposes and 106 370 multipurpose private wells. Treated wastewater is used to irrigate non-edible crops, for landscape irrigation and for industrial cooling, while desalinated water is used for municipal purposes (Figure 3).

TABLE 3
Water use

Water withdrawal			
Total water withdrawal	2006	23 666	10^6 m^3/yr
- irrigation + livestock	2006	20 826	10^6 m^3/yr
- municipalities	2006	2 130	10^6 m^3/yr
- industry	2006	710	10^6 m^3/yr
• per inhabitant	2006	963	m^3/yr
Surface water and groundwater withdrawal	2006	22 636	10^6 m^3/yr
• as % of total actual renewable water resources	2006	943	%
Non-conventional sources of water			
Produced wastewater	2000	730	10^6 m^3/yr
Treated wastewater	2002	547.5	10^6 m^3/yr
Reused treated wastewater	2006	166	10^6 m^3/yr
Desalinated water produced	2006	1 033	10^6 m^3/yr
Reused agricultural drainage water		-	10^6 m^3/yr

FIGURE 2
Water withdrawal by sector
Total 23.666 km^3 in 2006

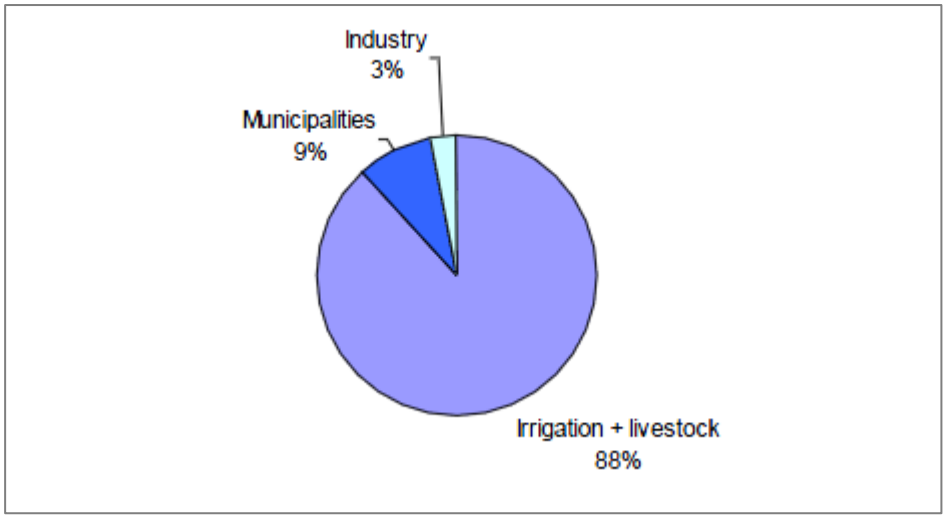
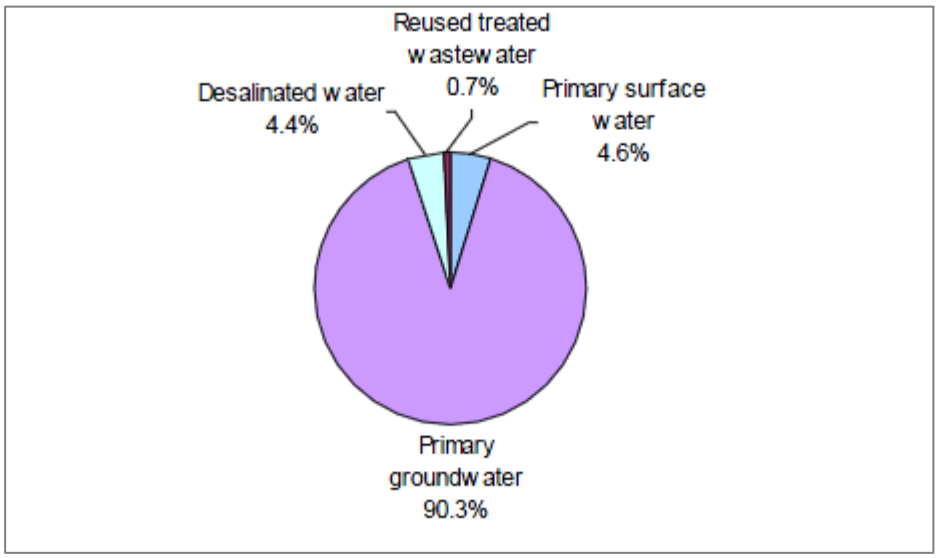


FIGURE 3
Water withdrawal by source
Total 23.666 km^3 in 2006



IRRIGATION AND DRAINAGE

Evolution of irrigation development

In 2000, 1 730 767 ha were equipped for irrigation, meaning an average increase of 0.9 percent per year since 1992. Only around 70 percent were actually irrigated (Table 4 and Table 5). The source of water is almost exclusively fossil groundwater (more than 95 percent) (Figure 4).

TABLE 4
Irrigation and drainage

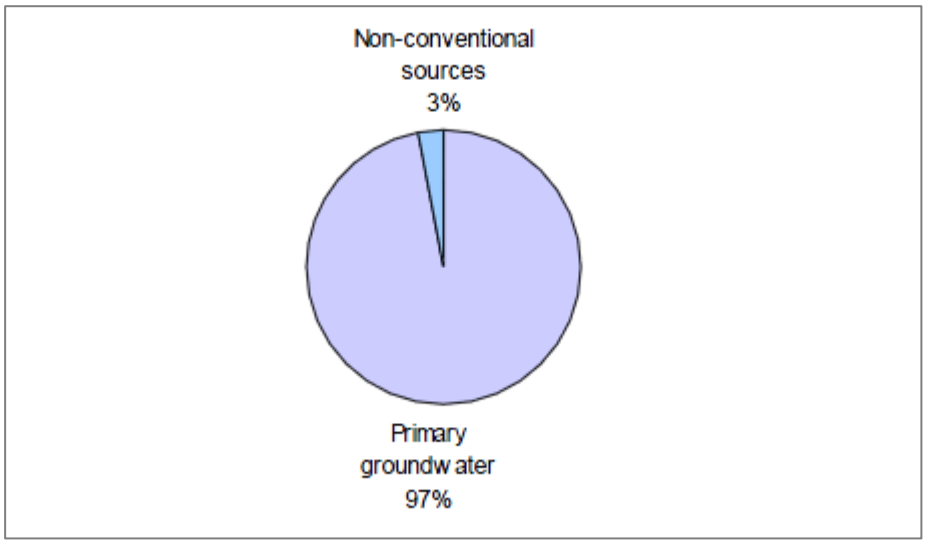
Irrigation potential			-	ha
Irrigation				
1. Full or partial control irrigation: equipped area		2000	1 730 767	ha
- surface irrigation		1992	547 000	ha
- sprinkler irrigation		1992	1 029 000	ha
- localized irrigation		1992	32 000	ha
• % of area irrigated from primary surface water		2000	0	%
• % of area irrigated from primary groundwater		2000	97	%
• % of area irrigated from mixed surface water and groundwater		2000	0	%
• % of area irrigated from non-conventional sources of water		2000	3	%
• area equipped for full or partial control irrigation actually irrigated		1999	1 191 351	ha
- as % of full/partial control area equipped		2000	69	%
2. Equipped lowlands (wetland, ivb, flood plains, mangroves)		2000	0	ha
3. Spate irrigation			-	ha
Total area equipped for irrigation (1+2+3)		**2000**	**1 730 767**	**ha**
• as % of cultivated area			-	%
• % of total area equipped for irrigation actually irrigated		2000	69	%
• average increase per year over the last 8 years		1992–2000	0.9	%
• power irrigated area as % of total area equipped		2000	97	%
4. Non-equipped cultivated wetlands and inland valley bottoms		2000	0	ha
5. Non-equipped flood recession cropping area		2000	0	ha
Total water-managed area (1+2+3+4+5)		**2000**	**1 730 767**	**ha**
• as % of cultivated area			-	%
Full or partial control irrigation schemes	**Criteria**			
Small-scale schemes	< 5 ha	1992	450 000	ha
Medium-scale schemes		1992	730 000	ha
large-scale schemes	> 200 ha	1992	428 000	ha
Total number of households in irrigation		1992	188 370	
Irrigated crops in full or partial control irrigation schemes				
Total irrigated grain production (wheat and barley)		2006	2 538 000	metric tons
• as % of total grain production		2006	100	%
Harvested crops:				
Total harvested irrigated cropped area		2006	1 213 587	ha
• Annual crops: total		2006	1 011 924	ha
- Wheat		2006	490 272	ha
- Sorghum		2006	143 745	ha
- Barley		2006	22 091	ha
- Maize		2006	12 123	ha
- Millet		2006	6 119	ha
- Other cereals		2006	229	ha
- Vegetables		2006	113 122	ha
- Potatoes		2006	14 709	ha
- Sesame		2006	2 216	ha
- Fodder		2006	207 298	ha
• Permanent crops: total		2006	201 663	ha
- Citrus		2006	10 848	ha
- Fruit		2006	190 815	ha
Irrigated cropping intensity (on full/partial control area actually irrigated)		1999	101	%
Drainage - Environment				
Total drained area		2007	10 850	ha
- part of the area equipped for irrigation drained			-	ha
- other drained area (non-irrigated)			-	ha
• drained area as % of cultivated area			-	%
Flood-protected areas			-	ha
Area salinized by irrigation			-	ha
Population affected by water-related diseases			-	inhabitants

TABLE 5
Total actually irrigated area by irrigation method and region
(Agricultural census, 1999)

	Traditional irrigation		Modern irrigation		Total	
Region	**Area (ha)**	**%**	**Area (ha)**	**%**	**Area (ha)**	**%**
Riyad	43 010	15	243 275	85	286 286	24
Makkah	43 924	98	1 032	2	44 957	4
Madinah	26 618	93	2 020	7	28 638	2
Quassim	15 541	7	208 712	93	224 253	19
Eastern	16 081	15	92 987	85	109 067	9
Asir	22 232	99	296	1	22 527	2
Tabuk	5 113	11	42 057	89	47 169	4
Hail	12 368	10	116 139	90	128 507	11
Northern	19	14	114	86	133	0
Jazan	177 375	99	1 995	1	179 370	15
Najran	8 811	69	4 008	31	12 819	1
Baha	2 658	98	55	2	2 713	0
Jouf	11 688	11	93 224	89	104 912	9
Total (*)	**385 438**	**32**	**805 913**	**68**	**1 191 351**	**100**

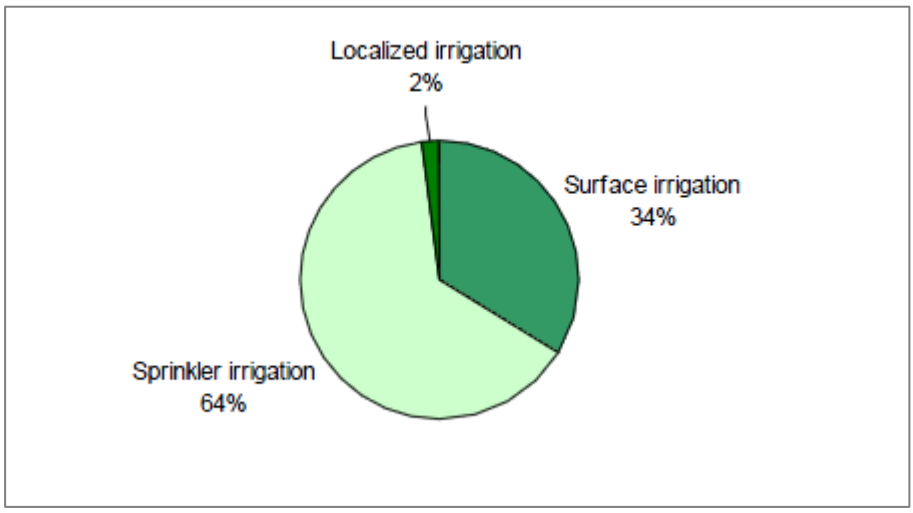
(*)The area for grains, vegetables, and forage grown under permanent crops is not included
Modern irrigation generally refers to trickle irrigation for trees and sprinkler irrigation for grains and forage.

FIGURE 4
Irrigation techniques
Total 1 730 767 ha in 2000



Localized and sprinkler irrigation, called modern irrigation, covers about 66 percent, while the remaining 34 percent is under surface irrigation, called traditional irrigation (Figure 5). The largest irrigated areas are located in the regions of Riyadh, Quassim, Jazan, Hail, Eastern, and Al Jouf.

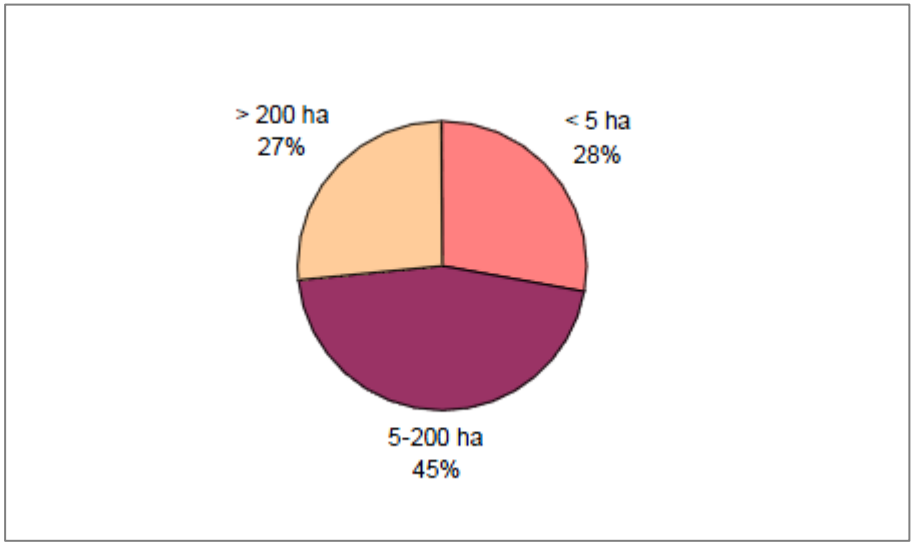
FIGURE 5
Irrigation techniques
Total 1 608 000 ha in 1992



There are three types of schemes that differ in terms of size, level of modernization and ownership (Figure 6):

1. Very large private societies, such as National Agricultural Development Societies and Companies, are owned by private firms belonging to one or several owners. Some of these farms have an area of tens of square kilometers.
2. Large to medium size farms of a few hundred hectares owned by private individuals.
3. Medium to small farms, most of which existed prior to the agricultural development boom that started in the mid-1970s.

FIGURE 6
Type of irrigation schemes
Total 1 608 000 ha in 1992



The first two categories of farms are located in regions with important and good quality groundwater aquifers and are specialized in terms of production, depending on the region and its vocational production potential. The most important crops are fodder for dairy production, date palms, vegetables, cereals, citrus fruits, olives and tropical fruits. They originate from the land distribution by the government in the late 1970s and early 1980s as part of the policy to develop agriculture.

Both categories are equipped with pressurized or modern irrigation technologies and are run as 'capitalist' enterprises by foreign managers and technicians, with the exception of a few cases where surface irrigation methods still prevail. The existence of modern irrigation techniques is not however necessarily an indication of high water use efficiency. No data are available on the amounts of water used by these farms, but as a general rule there is overuse in most, if not all, farms.

The existence of such large estates may not be compatible with the available water resources. Non-sustainability of the water resources used jeopardizes the sustainability of the farms themselves and puts at stake the profitability of the investments made. In many regions of the country several of these farms have already abandoned business as a result of groundwater depletion or non-profitability of the investments made. Based on the information and data available, all farms have been installed with no prior sound assessment of water resources to determine the extent of safe use or even the rate and duration of use in the case of limited fossil water.

As far as the third category is concerned, some of these farms went out of business either because of their non-viable sizes or the incapacity of their owners to drill wells or both. They are less specialized in production compared with the first two and less modernized. Their irrigation systems and practices are essentially traditional, with low efficiency surface irrigation methods (FAO, 2007).

Role of irrigation in agricultural production, the economy and society

Of the area equipped for irrigation, estimated at 1 730 767 ha in 2000, on average 1 213 586 ha were actually irrigated during the period 2001-2005. In 2006 the harvested irrigated crop area covered around 1 214 000 ha, of which 56 percent consisted of cereals (mainly wheat, following sorghum and barley), 17 percent of fodder, 17 percent of permanent crops (mainly date palms) and 9 percent of vegetables (Table 4 and Figure 7). In 1999 permanent crops were predominantly irrigated by surface irrigation, while annual crops were mainly benefiting from pressurized irrigation methods (Table 6).

FIGURE 7
Irrigated crops
Total harvested area 1 213 587 ha in 2006 (In 1999, cropping intensity on equipped area actually irrigated: 101%)

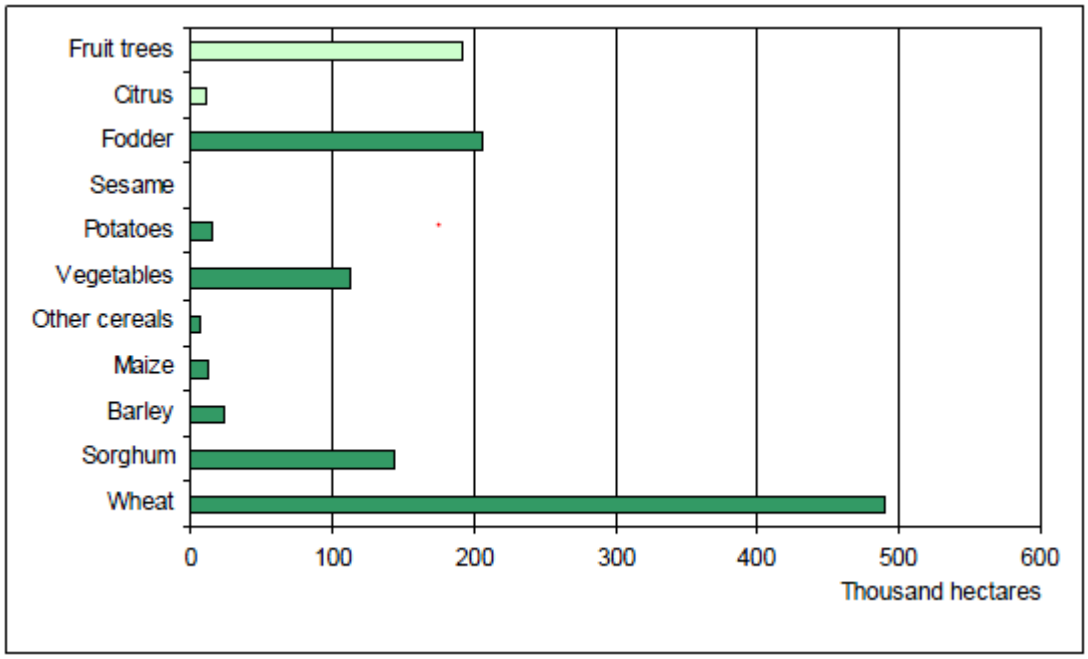


TABLE 6
Total harvested irrigated area by crop type and irrigation method
(Agricultural census, 1999)

	Traditional irrigation		Modern irrigation		Total	
	Area (ha)	%	Area (ha)	%	Area (ha)	%
Permanent crops	136 177	74	47 368	26	183 545	15
- Date Palm	117 473	83	24 098	17	141 571	12
- Citrus	3 320	41	4 708	59	8 028	1
- Grapes	3 463	46	4 088	54	7 551	1
- Olives	4 047	39	6 434	61	10 481	1
Temporary crops	273 053	27	748 361	73	1 021 413	85
- Cereals	182 342	26	510 544	74	692 886	58
- Vegetables	34 658	38	55 703	62	90 361	7
- Fodder	56 053	24	182 114	76	238 166	20
Total (*)	**409 229**	**34**	**795 728**	**66**	**1 204 958**	**100**

(*)The area for grains, vegetables, and forage grown under permanent crops is not included
Modern irrigation generally refers to trickle irrigation for trees and sprinkler irrigation for grains and forage.
The area for modern vegetables includes 3 214 ha of cultivation in greenhouses.

Irrigation development in Saudi Arabia was the result of government policies to boost agricultural production in the 1970s. Well digging permits were granted to farmers and private companies in the regions where explorations by the public sector had revealed the existence of groundwater. The permits allowed farmers to drill wells with interest-free loans and with a subsidy of 50 percent of the cost of pumping stations. In addition, farmers could get interest free-loans for equipping their farms with modern irrigation systems, such as centre pivots, as well as for other purposes. At present about two thirds of the irrigated area is equipped with modern irrigation systems.

To promote the generalization of modern irrigation techniques, the Ministry of Agriculture (MOA) is currently providing subsidized tree seedlings, but only to those farms already equipped with these systems. In fact, subsidized seedlings have been provided for around twenty years in order to promote the production of fruit crops, such as citrus trees in Najran, tropical species in Jizan, palm trees in several regions and other types elsewhere (olive trees, etc.) This is actually encouraging farmers to switch from wheat to fruit trees as a result of the government policy to reduce the area cropped by wheat by reducing the quantity of wheat purchased from farmers. However, depending on the area involved in the shift from wheat to fruit trees, it may well be that reducing the wheat area will actually result in putting more pressure on water resources once the trees become adult. Being perennial crops, fruit trees require more water than the annual cereals on an equal area basis.

Reducing the quantity of wheat purchased by the government from farmers has resulted in a gradual decrease in annual production over more than five years from over 4 million tonnes at the beginning of the 1990s to about 2 million tonnes. Other measures taken by the government with the objective of 'reducing pressure on water' include: banning wheat and forage exports and not purchasing barley from farmers (FAO, 2007). In general, the production of cereals is about 60 percent of what it was at the beginning of the 1990s.

Status and evolution of drainage systems

Drainage problems occur in several parts of the country because of the existence of shallow, impermeable layers. About 10 850 ha, equivalent to 0.6 percent of the equipped area for irrigation, have drainage facilities under governmental management (Table 4). The drainage systems mainly consist of open drainage canals. In several projects, such as the Al-Hassa irrigation project in the east, agricultural drainage water is reused for irrigation after being mixed with fresh groundwater.

Soil salinity is being noticed in parts of the newly developed areas because of poor irrigation water quality and the poor drainage conditions of some soils.

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

Institutions

In 2001 a Ministry of Water was created to contain part of the Ministry of Municipal and Rural Affairs (MOMRA) and part of the former Ministry of Agriculture and Water (MOAW). This new ministry was responsible for supervising the water sector, developing water related policies and setting up mechanisms and instruments aimed at managing the water resources and water services delivery in an efficient and sustainable way. In 2004 the Ministry of Water also became responsible for the electricity sector and was restructured as the Ministry of Water and Electricity (MOWE) in order to ensure optimum coordination between the development of water desalination and electricity production.

The Water Sector within the MOWE has two main programmes:

- Water resources development, which includes all activities related to geological and hydrological studies, wastewater reuse investigations, well drilling and dam construction, and the preparation of the national water plan
- Drinking water supply, which includes the construction of drinking water supply networks to various towns and cities that do not have local water authorities or municipalities

The Ministry of Agriculture (MOA) is responsible for the scheme's operation and maintenance programme, while on-farm water management is the farmers' responsibility. The Ministry is responsible for issues affecting more than one farmer, such as for example irrigation networks, drainage, pest control and so on.

In January 2005 the MOA created the General Administration of Irrigation Affairs (GAIA), following the creation of the MOWE that inherited the MOA's water sector. The GAIA is responsible for organizing, planning, monitoring, developing, operating and maintaining irrigation and drainage projects and programs, together with the application of modern systems, the determination of crop water requirements, as well as ensuring that irrigation water will have no harmful effects on public health.

The National Irrigation Authority (NIA) started operating in 1982 in the Province of Riyadh to reuse the largest amount of treated wastewater in Saudi Arabia, amounting to 33 percent of the total annually treated effluent, mainly for irrigation. The NIA is responsible for the operation of the infrastructure and the monitoring of water reuse practices and the compliance of farmers with standards and guidelines. In 2004 it covered a total of 455 farms for a total area of 17 429 ha (about 12 000 ha irrigated). The average distributed volume of wastewater is about 50 million m^3 per year.

The Al-Hassa Irrigation and Drainage Authority (HIDA) is part of the MOA and is in charge of hydrological studies and data collection to improve the use of water for irrigation. It is also responsible for irrigation water conservation, estimation of crop water requirements, irrigation water distribution to the farms and the operation and maintenance of irrigation and drainage canal systems in the irrigation schemes managed by the MOA.

The Irrigation and Drainage project in Domat AI Jandal (IDD) started in 1989. It consists of a collective project covering a designated area of 1 600 ha, serving about 2 000 farms in Al-Jouf in the northern part of the country.

The Saline Water Conversion Corporation (SWCC) is responsible for the construction, operation and maintenance of desalination plants.

Water management

Due to the government's awareness of the scarcity of water, the MOA implemented several measures to encourage farmers to apply irrigation water saving techniques. Furthermore, some of the subsidies and support programmes that contributed to the depletion of groundwater resources in agriculture have been discontinued or revised. A collaborative programme has been initiated with the World Bank to provide technical assistance in reorganizing the water sector as a whole.

The MOA provides technical training courses and workshops regarding irrigation water management for its employees as well as others in different public and private sectors. Some courses are coordinated with international organizations, such as the FAO. Unfortunately the MOA lacks sound and effective extension services, has no strategy for capacity building, and has weak information management systems. Furthermore, no water user associations exist in the country.

An academic association was recently created, the Saudi Water Science Society hosted by the King Fahd University of Petroleum and Minerals. Its main purpose is to provide a union of experts, scientists, businessmen, and so on, all of whom have an interest in water concerns and issues in the country.

Policies and legislation

Since the creation of the MOWE, various water laws are under revision and reformulation to assure institutional compatibility with the new institutional structure. At the same time the MOA is reviewing agricultural policy. Currently there still are grey areas with overlapping responsibilities regarding irrigation and the control and implementation of water reuse for irrigation.

PROSPECTS FOR AGRICULTURAL WATER MANAGEMENT

Irrigated agriculture has reached a stage where it needs a reform that focuses on productivity and sustainability of the investment made by the public sector and private farmers, as well as the rational use of its limited water resources. Irrigated agriculture is leading to the depletion of several aquifers and is putting the sustainability of the investments made at risk. Water productivity is still relatively low despite the introduction of modern irrigation techniques. The Ministry of Agriculture is developing a new agriculture strategy geared towards a greater macro-economic development of the sector, while sustaining the basic resources and increasing their productivity.

A "Future Plan for Agriculture" (draft version of November 2004) was developed in studies carried out by the PARCI (King Saud University). With regard to land and water resources, the plan calls for (FAO, 2007):

- Reducing water demand through a policy of diversification of agricultural production, taking into account the comparative advantages of each region in the country;
- Stopping expansion of high water consuming crops such as dates and forage;
- Concentrating on high added value crops;
- Stopping the distribution of agricultural land except in regions with sufficient renewable water resources;
- Improving irrigation water management and using modern irrigation methods, and stopping any support for well digging or water extraction;
- Estimating crop water requirements;
- Encouraging farmers to make use of tools that help manage irrigation water better, such as soil probes for a better scheduling of irrigation water deliveries;
- Respecting standards set by the MOA for digging wells, in collaboration with well digging companies;
- Taking a decision to solve the situation of open hand-dug wells, either through the use of adequate piping systems or closing these wells and digging others;

- Controlling water consumption through the use of meters for measuring the amount of water flowing out of the wells;
- Water pricing for all water used above the crop water requirements, starting with agricultural companies and specialized farms;
- Intensifying agricultural extension so as to make farmers more aware of the need to conserve water resources and to encourage a new dynamic in the role of agricultural associations and cooperatives in this respect;
- Establishing as a condition for the issuance of permits for agricultural projects the use of water conserving irrigation techniques, as well as an assessment of the relative characteristics of the region and its water potential;
- Expanding the use of treated wastewater in the agriculture and industry sector;
- Orienting and supporting research aimed at producing crop varieties that are resistant to drought, salinity or acid soils.

The next step for the MOA is to create an irrigation strategy that includes all its actions and activities in order to achieve the goals developed in the agriculture plan by 2020.

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