Food and Agriculture Organization of the United Nations

FAO AQUASTAT Reports

Country profile – Iran (Islamic Republic of)

Version 2008

Recommended citation: FAO. 2008. AQUASTAT Country Profile – Iran (Islamic Republic of). Food and Agriculture Organization of the United Nations (FAO). Rome, Italy

Iran (Islamic Republic of)

GEOGRAPHY, CLIMATE AND POPULATION

Geography

The Islamic Republic of Iran covers a total area of about 1.75 million km^2. The country is bordered by Armenia, Azerbaijan, the Caspian Sea and Turkmenistan to the north, Afghanistan and Pakistan to the east, the Gulf of Oman, the Strait of Hormuz and the Persian Gulf to the south, and Iraq and Turkey to the west. About 52 percent of the country consists of mountains and deserts and some 16 percent of the country has an elevation of more than 2 000 m above sea level. The largest mountain massif is that of the Zagros, which runs from the northwest of the country southwards first to the shores of the Persian Gulf and then continues eastwards till the most south-eastern province. Other mountain ranges run from the northwest to the east along the southern edge of the Caspian Sea. Finally, there are several scattered mountain chains along the eastern frontier of the country. The Central or Interior Plateau is located in between these mountain chains and covers over 50 percent of the country. It is partly covered by a remarkable salt swamp (kavir) and partly by areas of loose sand or stones with stretches of better land near the foothills of the surrounding mountains.

The cultivable area is estimated at about 51 million ha, which is 29 percent of the total area. In 2005 18.1 million ha were cultivated. Of this area, 16.5 million ha consisted of annual crops and 1.6 million ha of permanent crops (Table 1). In 2003, 72.5 percent of the landholders cultivated less than 5 ha, 22.5 percent between 5 and 20 ha, and only 5 percent more than 20 ha.

Climate

The climate of the Islamic Republic of Iran is one of great extremes due to its geographic location and varied topography. The summer is extremely hot with temperatures in the interior rising possibly higher than anywhere else in the world; certainly over 55°C has been recorded. In winter, however, the great altitude of much of the country and its continental situation result in far lower temperatures than one would expect to find in a country in such low latitudes. Minus Temperatures of –30°C can be recorded in the northwest and –20°C is common in many places.

Annual rainfall ranges from less than 50 mm in the deserts to 2 275 mm in Rasht near the Caspian Sea. The average annual rainfall is 228 mm and approximately 90 percent of the country is arid or semi-arid. About 23 percent of the rain falls in spring, 4 percent in summer, 23 percent in autumn and 50 percent in winter.

Population

Total population is about 69.5 million (2005), of which 32 percent are living in rural areas (Table 1). This means that the ratio between urban and rural population has been reversed over the last 50 years, the urban population being around 31 percent in 1955 (Mahmoodian, 2001). Average population density is 40 inhabitants/km^2, but ranges from less than 10 in the eastern part of the country up to more than 150 in the Gilan province, located on the Caspian Plain in the north, which is by far the most densely populated region in the country after Tehran province where the capital is located and where the population density reaches 400 inhabitants/km^2. The annual demographic growth rate was estimated at 3.7 percent over the period 1980–1990 and decreased to 0.9 percent over the period 2000–2005.

FIGURE 1
Map of Iran (Islamic Republic of)

ISLAMIC REPUBLIC OF IRAN

FAO - AQUASTAT, 2008

TABLE 1
Basic statistics and population

Physical areas			
Area of the country	2005	174 515 000	ha
Cultivated area (arable land and area under permanent crops)	2005	18 107 000	ha
• as % of the total area of the country	2005	10.4	%
• arable land (annual crops + temp. fallow + temp. meadows)	2005	16 533 000	ha
• area under permanent crops	2005	1 574 000	ha
Population			
Total population	2005	69 515 000	inhabitants
• of which rural	2005	31.9	%
Population density	2005	39.8	inhabitants/km^2
Economically active population	2005	27 594 000	inhabitants
• as % of total population	2005	39.0	%
• female	2005	30.3	%
• male	2005	69.7	%
Population economically active in agriculture	2005	6 689 000	inhabitants
• as % of total economically active population	2005	24.2	%
• female	2005	44.3	%
• male	2005	55.7	%
Economy and development			
Gross Domestic Product (GDP) (current US$)	2007	270 940	million US$/yr
• value added by agriculture (% of GDP)	2007	9	%
• GDP per capita	2005	3 207	US$/yr
Human Development Index (highest = 1)	2005	0.759	
Access to improved drinking water sources			
Total population	2000	94	%
Urban population	2006	99	%
Rural population	2000	84	%

In 2006, 99 percent of the urban population had access to safe drinking water. In 2000, 84 percent of the rural population had access to safe drinking water. In 2000, 86 and 78 percent of the urban and rural populations respectively had access to improved sanitation.

ECONOMY, AGRICULTURE AND FOOD SECURITY

In 2007 the Gross Domestic Product (GDP) was US$270.9 billion. Agriculture accounted for around 9 percent of GDP, while in 1992 it accounted for 23 percent. The economically active population is about 27.6 million (2005) of which 70 percent is male and 30 percent female. In agriculture, 6.7 million inhabitants are economically active of which 56 percent male and 44 percent female.

Agriculture is mostly practiced on small farming units. From 1960 to 1993 the number of farming units increased from 1.8 to 2.8 million units, with the average area per unit decreasing from just over 6 ha to less than 5.5 ha. More than 80 percent of these farming units have a total size of less than 10 ha and even these 10 ha are on average scattered over five different locations. About 5 percent of the agricultural land is used by cooperative companies, consisting of both traditional and modern systems. Usually each cooperative has 8 members with an average size of 40 ha. Commercial companies cover around 14 percent of the agricultural land, mostly located in Khozestan province in the southwest of the country.

WATER RESOURCES

Of the average rainfall volume of 376 km^3/year an estimated 66 percent evaporates before reaching the rivers. The total long-term total renewable water resources are estimated at 137.5 km^3 of which about 9 km^3/year are external water resources (Table 2). Internal renewable water resources are estimated at

128.5 km^3/year. Surface runoff represents a total of 97.3 km^3/year, of which 5.4 km^3/year come from drainage of the aquifers, and groundwater recharge is estimated at about 49.3 km^3/year, of which 12.7 km^3/year are obtained from infiltration in the river bed, giving an overlap of 18.1 km^3/year. The Islamic Republic of Iran receives 6.7 km^3/year of surface water from Afghanistan through the Helmand River. The flow of the Araks River, at the border with Azerbaijan, is estimated at 4.63 km^3/year. The surface runoff to the sea and to other countries is estimated at 55.9 km^3/year, of which 7.5 km^3/year to Azerbaijan (Araks) and 10 km^3/year from affluents of the Tigris to Iraq. About 24.7 km^3/year flows from the Karun into Iraq, but since this is just before it discharges into the sea, it does not count as inflow into Iraq.

TABLE 2
Water resources

Renewable freshwater resources			
Precipitation (long-term average)	-	228	mm/yr
	-	397.9	10^9 m^3/yr
Internal renewable water resources (long-term average)	-	128.5	10^9 m^3/yr
Total actual renewable water resources	-	137.5	10^9 m^3/yr
Dependency ratio	-	6.6	%
Total actual renewable water resources per inhabitant	2005	1 978	m^3/yr
Total dam capacity	2006	31 610	10^6 m^3

The Islamic Republic of Iran is divided into 6 main and 31 secondary catchment areas. The 6 major basins are: the Central Plateau in the centre (Markazi), the Lake Oroomieh basin in the northwest, the Persian Gulf and the Gulf of Oman basin in the west and south, the Lake Hamoon basin in the east (Mashkil Hirmand), the Kara-Kum basin in the northeast (Sarakhs) and the Caspian Sea basin in the north (Khazar) (Figure 2). All these basins, except the Persian Gulf and the Gulf of Oman basin, are interior basins. Almost half of the country's renewable water resources are located in the Persian Gulf and the Gulf of Oman basin, which only covers one fourth of the country (Table 3). On the other hand the Markazi basin, covering over half of the country, has less than one third of the total renewable water resources. With an area of 424 240 km^2, the Caspian Sea is the largest landlocked water body in the world and its surface lies about 22 metres below sea level.

FIGURE 2
Major basins in Iran

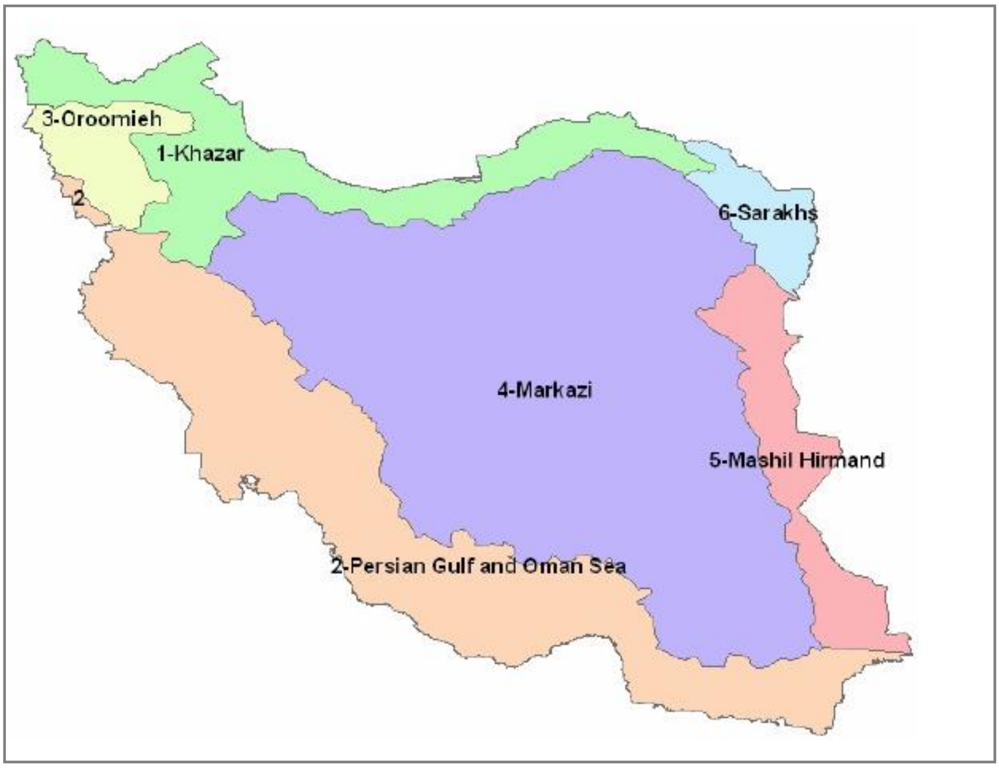


TABLE 3
Water resources in major basins

Name of basin	Percentage of total area of the country	Percentage of renewable water resources
Khazar	10	15
Persian Gulf and Gulf of Oman	25	46
Lake Oroomieh	3	5
Markazi	52	29
Hamoon	7	2
Sarakhs	3	3
Total for country	**100**	**100**

There are several large rivers, but the only navigable one is the Karun, the others being too steep and irregular. The Karun River, with a total length of 890 km, flows in the southwest of the country to the Shatt al Arab, which is formed by the Euphrates and the Tigris in Iraq after their confluence. The few streams that empty into the Central Plateau dissipate into the saline marshes. All streams are seasonable and variable. Spring floods do enormous damage, while there is little water flow in summer when most streams disappear. Water is however stored naturally underground, finding its outlet in subterranean water canals (qanats) and in springs. It can also be tapped by wells.

Dams have always played an important role in harnessing precious Iranian water reserves and the long-term objective of the Islamic Republic of Iran's water resources development plan is based on the control and regulation of water resources through dams. In 2006, 94 large storage dams with a total capacity of 31.6 km^3 were operating and 85 large dams with a capacity of 10 km^3 were under construction. Aside from hydropower, dams also play an important role in flood control through the routing of floods. Several reservoirs behind the dams would seem to offer good sailing and water-skiing facilities, but have not been used for recreation so far.

In 2001, there were 39 wastewater treatment plants with a total capacity of 712 000 m^3/day, treating the wastewater produced by a population of 3.8 million. The wastewater actually treated was around 130 million m^3/year (Mahmoodian, 2001). Some 79 treatment plants with a total capacity of 1.917 million m^3/day were under construction and 112 treatment plants with a total capacity of 1.590 million m^3/day were being studied for completion by the year 2010.

In 2002, the total installed gross desalination capacity (design capacity) in the Islamic Republic of Iran was 590 521 m^3/day or almost 215.5 million m^3/year (Wangnick Consulting, 2002). The desalinated water produced was around 200 million m^3 in 2004.

INTERNATIONAL WATER ISSUES

Prior to the Taliban regime in Afghanistan there was an agreed flow of 27 m^3/s (850 million m^3/year) of the Helmand River entering the Islamic Republic of Iran. However during the Taliban regime in Afghanistan (1995–2001), this agreement ceased completely and this caused an economic and environmental disaster in the provinces of Sistan and Baluchistan bordering Afghanistan and Pakistan (Bybordi, 2002). The Helmand River is the longest river in Afghanistan. It stretches 1 150 km from the Hindu Kush mountains about 80 km west of Kabul and crosses southwest through the desert to the Seistan marshes and the Hamun-i-Helmand lake region around Zabol on the Afghan-Iranian border.

WATER USE

In 2004, the total agricultural, municipal and industrial water withdrawal was estimated at about 93.3 km^3, of which 40.0 km^3 from surface water, 53.1 km^3 from groundwater (qanats and wells) and 0.2 km^3 desalinated water (Table 4, Table 5 and Figure 3). Groundwater depletion is estimated at 3.8 km^3/year. Most of the overexploitation happens in the central basins where less surface water is available. Total surface water and groundwater withdrawal represents almost 68 percent of the total actual renewable water resources. Use of non-conventional sources of water is minimal. The treated wastewater is said to be indirectly used in agriculture. In some towns, albeit in a limited form, raw wastewater is used directly for irrigation, resulting in some health-related problems (Mahmoodian, 2001). Agriculture is the main water withdrawal sector, with 86 km^3 in 2004 (Figure 4). Its part of the total water withdrawn remains identical compared to 1993 (around 92 percent). Municipal and industrial water withdrawal amount to 6.2 and 1.1 km^3 respectively. About 16 km^3 of water was used for electrical power generation in 1999.

TABLE 4
Water use

Water withdrawal			
Total water withdrawal	2004	93 300	10^6 m^3/yr
- irrigation + livestock	2004	86 000	10^6 m^3/yr
- municipalities	2004	6 200	10^6 m^3/yr
- industry	2004	1 100	10^6 m^3/yr
• per inhabitant	2004	1 356	m^3/yr
Surface water and groundwater withdrawal	2004	93 100	10^6 m^3/yr
• as % of total actual renewable water resources	2004	67.7	%
Non-conventional sources of water			
Produced wastewater	2001	3 075	10^6 m^3/yr
Treated wastewater	2001	130	10^6 m^3/yr
Reused treated wastewater		-	10^6 m^3/yr
Desalinated water produced	2004	200	10^6 m^3/yr
Reused agricultural drainage water		-	10^6 m^3/yr

TABLE 5
Groundwater discharges in major sub-basins (2001)

name of basin	Wells		Qanats		Springs		Total
	Quantity	Discharge (km^3/year)	Quantity	Discharge (km^3/year)	Quantity	Discharge (km^3/year)	Discharge (km^3/year)
Khazar	130 267	4.39	2 611	0.45	25 404	3.00	7.83
Persian Gulf and Gulf of Oman	97 376	10.08	3 950	1.06	13 529	15.24	26.38
Lake Oroomieh	72 019	1.97	1 540	0.23	943	0.12	2.32
Markazi	155 415	25.93	22 017	5.79	13 681	2.47	34.18
Hamoon	3 873	0.80	2 606	0.40	1 140	0.06	1.26
Sarakhs	9 099	1.73	1 631	0.29	1 215	0.35	2.36
Total	**468 049**	**44.89**	**34 355**	**8.23**	**55 912**	**21.24**	**74.35**

FIGURE 3
Water withdrawal by source
Total 93.3 km^3 in 2004

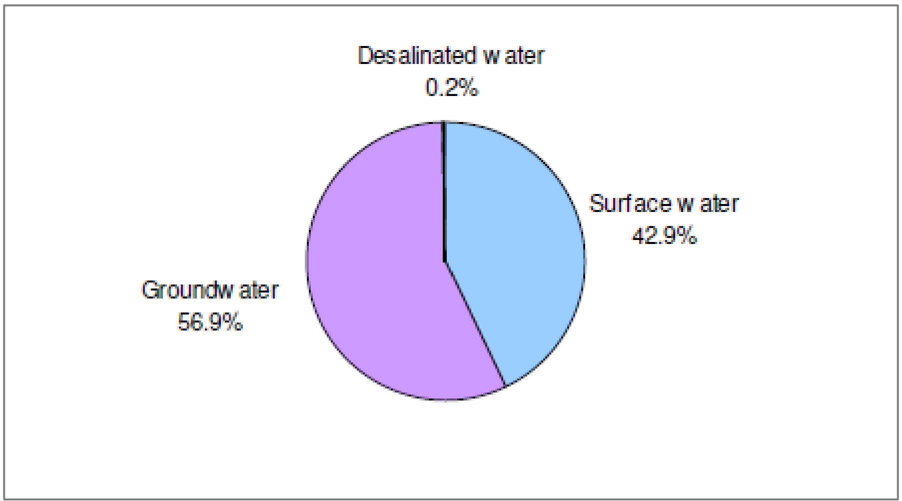
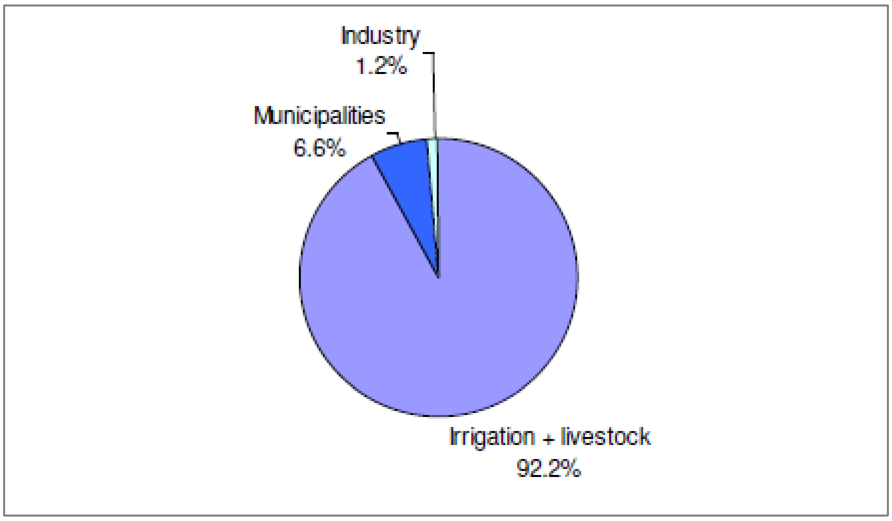


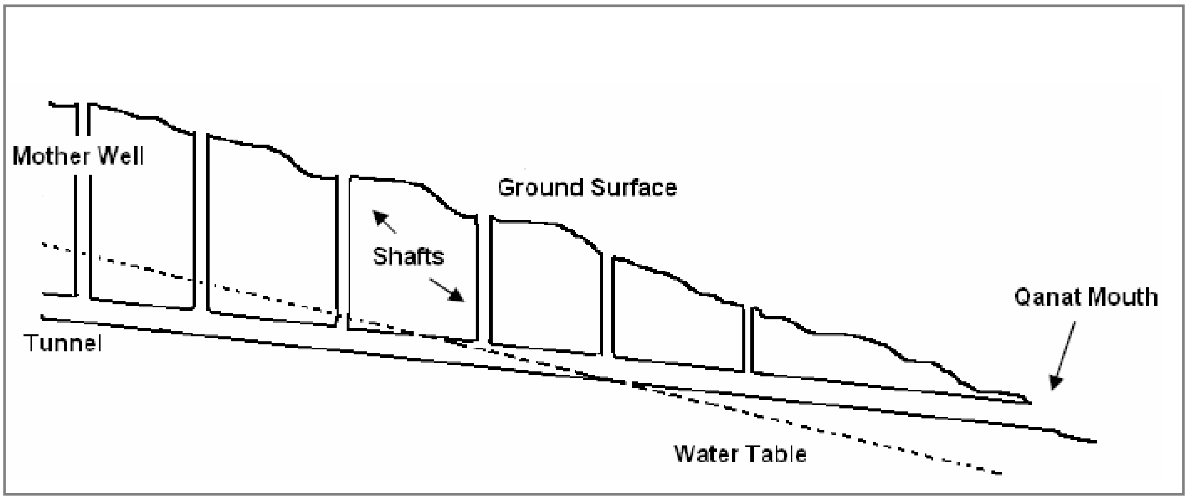
FIGURE 4
Water withdrawal by sector
Total 93.3 km³ in 2004



Groundwater discharge (through wells, qanats and springs) varied from less than 20 km^3/year in the early 1970s to over 74 km^3/year at the beginning of the present millennium (Table 4). The number of wells during that period increased fivefold, from just over 9 000 to almost 45 000.

The qanat is a traditional system in the Islamic Republic of Iran for using groundwater. It is a subterranean water collection and conduction device for bringing water from one place to another. It consists of three parts (Figure 5): (i) the mother well dug at the beginning of the qanat where water is available; (ii) access shafts built along the tunnel to provide ventilation and for the removal of debris, at a distance of 20–50 meters and with the depth depending on the depth of the underground tunnel; (iii) the tunnel per se dug from downstream to upstream with a slope gradient of 1/500 to ½ 500 in order to prevent erosion and siltation, and with a length varying from about 100 metres to 120 km in a qanat in the Yazd region. Its diameter is just enough for a maintenance worker to crawl through.

FIGURE 5
The qanat system



IRRIGATION AND DRAINAGE

Evolution of irrigation development

Water supply has been a constant preoccupation since the beginning of the country's history, thousands of years ago. Its inhabitants learnt to design and implement efficient techniques for harnessing their limited water resources and for irrigation. Apart from the qanat, which was a major source of irrigation and domestic water supply for centuries, Iranians have in the past built dams of various types and weirs. Some of these head control structures, built as long as 1 000 years ago, are still in good condition.

Agricultural land availability is not a major constraint. The major constraint is the availability of water for the development of these lands. The irrigation potential, based on land and water resources, has been estimated at about 15 million ha, or 29 percent of the cultivable area (Table 6). However, this would require optimum storage and water use.

The total area equipped for irrigation is about 8.13 million ha in 2003, compared to 7.26 million ha in 1993. About 62 percent of that area is irrigated by groundwater (Figure 6). Surface irrigation is the main irrigation technology used in the Islamic Republic of Iran, covering 91.4 percent of the area equipped for irrigation (Figure 7). Localized and sprinkler irrigation cover 5.2 and 3.4 percent respectively, compared to only 0.6 percent each in 1993. Almost all pressurized irrigation systems are manufactured in the country. The water in the surface irrigation schemes arrives through a combination of gravity and water lifting systems. Most of the dams constructed in the Islamic Republic of Iran are for irrigation purposes with main and secondary canals built downstream, covering a total area of 1.56 million ha and which are called modern systems. The rest of the irrigated areas have traditional canals built by farmers that in many cases have to be rebuilt every year. Small schemes (< 10 ha) cover 50 percent of the total equipped area for irrigation, medium size schemes (10–50 ha) 40 percent and large schemes (>50 ha) 10 percent (Figure 8). Among the holdings practicing irrigation, the average irrigated area is 2.9 ha.

TABLE 6
Irrigation and drainage

Irrigation potential		-	15 000 000	ha
Irrigation				
1. Full or partial control irrigation: equipped area		2003	8 131 564	ha
- surface irrigation		2003	7 431 564	ha
- sprinkler irrigation		2003	280 000	ha
- localized irrigation		2003	420 000	ha
• % of area irrigated from surface water		2003	37.9	%
• % of area irrigated from groundwater		2003	62.1	%
• % of area irrigated from mixed surface water and groundwater			-	%
• % of area irrigated from non-conventional sources of water			-	%
• area equipped for full or partial control irrigation actually irrigated			-	ha
- as % of full/partial control area equipped			-	%
2. Equipped lowlands (wetland, ivb, flood plains, mangroves)			-	ha
3. Spate irrigation			-	ha
Total area equipped for irrigation (1+2+3)		**2003**	**8 131 564**	**ha**
• as % of cultivated area		2003	46.0	%
• % of total area equipped for irrigation actually irrigated			-	%
• average increase per year over the last 10 years		1993-2003	1.13	%
• power irrigated area as % of total area equipped		1993	32.2	%
4. Non-equipped cultivated wetlands and inland valley bottoms		1993	0	ha
5. Non-equipped flood recession cropping area		1993	10 000	ha
Total water-managed area (1+2+3+4+5)		**2003**	**8 141 564**	**ha**
• as % of cultivated area		2003	46.1	%
Full or partial control irrigation schemes	**Criteria**			
Small-scale schemes	< 10 ha	2003	4 000 000	ha
Medium-scale schemes		2003	3 281 564	ha
large-scale schemes	> 50 ha	2003	850 000	ha
Total number of households in irrigation		2004	2 828 646	

TABLE 6 *(continued)*
Irrigation and drainage

Irrigated crops in full or partial control irrigation schemes			
Total irrigated grain production	1993	10 000 000	metric tons
• as % of total grain production	1993	61	%
Harvested crops			
Total harvested irrigated cropped area	2003	8 592 554	ha
• Annual crops: total	2003	7 258 899	ha
- Wheat	2003	2 634 106	ha
- Rice	2003	628 105	ha
- Barley	2003	607 485	ha
- Maize	2003	275 941	ha
- Other cereals	2003	65	ha
- Sweet potatoes	2003	186 671	ha
- Other roots and tubers	2003	48 758	ha
- Sugar beet	2003	152 875	ha
- Vegetables	2003	563 011	ha
- Pulses	2003	159 716	ha
- Tea	2003	2 934	ha
- Tobacco	2003	10 142	ha
- Cotton	2003	143 233	ha
- Soybeans	2003	56 586	ha
- Groundnuts	2003	647 852	ha
- Fodder	2003	878 181	ha
- Sunflowers	2003	77 781	ha
- Flowers	2003	61 860	ha
- Other annual crops	2003	123 597	ha
• Permanent crops: total	2003	1 333 655	ha
- Sugar cane	2003	63 385	ha
- Bananas	2003	2 889	ha
- Citrus fruit	2003	213 348	ha
- Other perennial crops	2003	1 054 033	ha
Irrigated cropping intensity (on equipped area)	2003	106	%
Drainage - Environment			
Total drained area	2002	1 508 000	ha
- part of the area equipped for irrigation drained	2002	1 508 000	ha
- other drained area (non-irrigated)		-	ha
• drained area as % of cultivated area	2002	8.6	%
Flood-protected areas		-	ha
Area salinized by irrigation	1993	2 100 000	ha
Population affected by water-related diseases		-	inhabitants

In 1993 non-equipped flood recession cropping was practiced in an area of about 10 000 ha in the southwest of the country.

FIGURE 6
Source of irrigation water
Total 8 131 564 ha in 2003

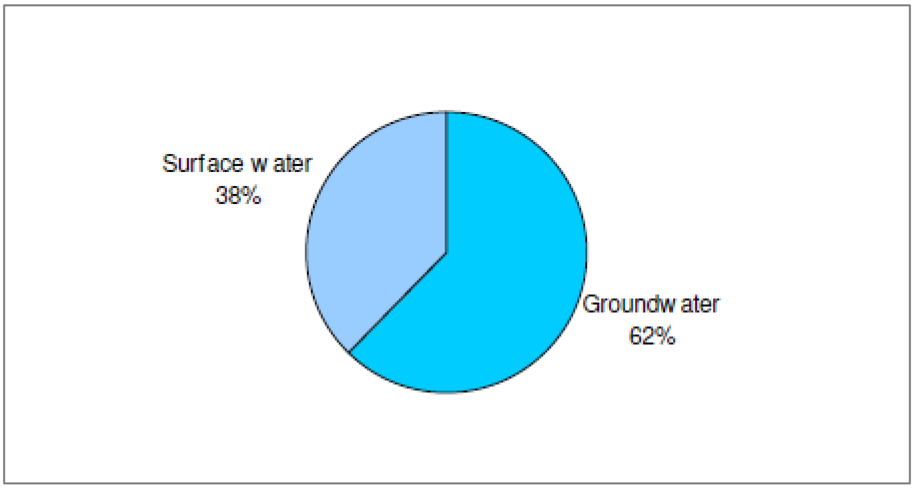


FIGURE 7
Irrigation techniques
Total 8 131 564 ha in 2003

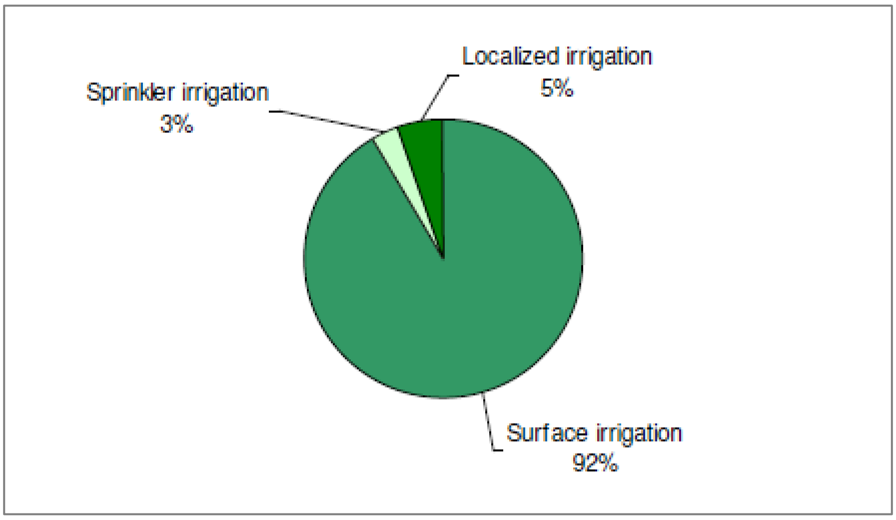
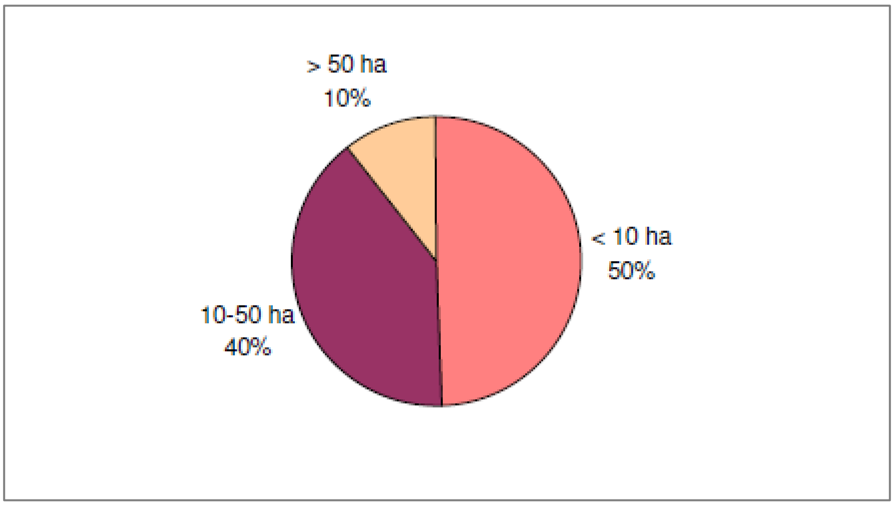


FIGURE 8
Type of irrigation schemes
Total 8 131 564 ha in 2003

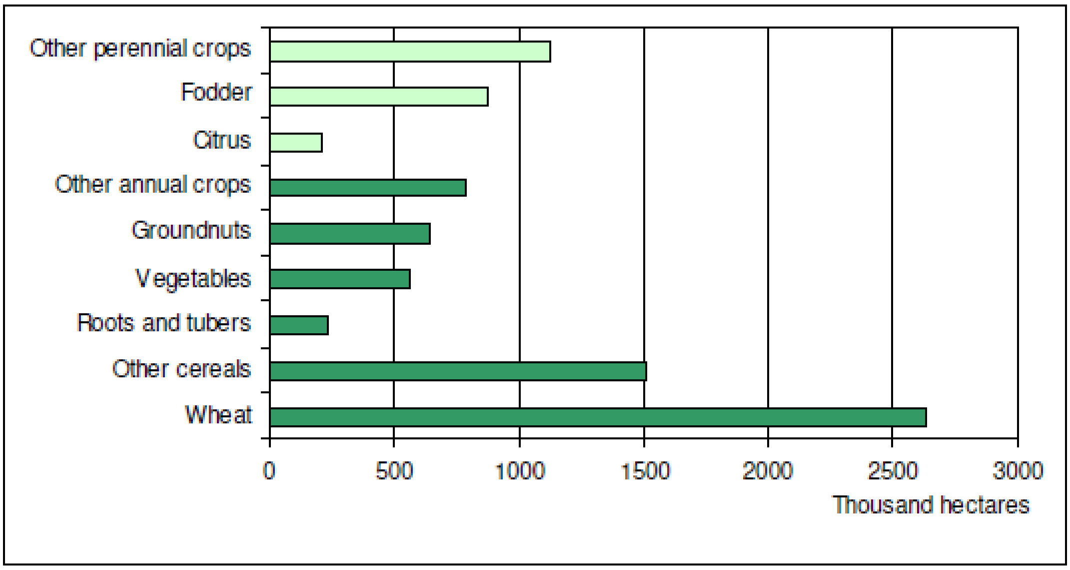


Role of irrigation in agricultural production, the economy and society

About 98.5 percent of the agricultural land in the Islamic Republic of Iran is under private ownership. Rainfed cultivation is possible in the higher rainfall areas in the northwest, the west and in the littoral zone along the Caspian Sea. About 89 percent of the total agricultural products in the last 5 years have come from the irrigated land.

The total harvested irrigated cropped area was 8 592 554 ha in 2003 (Figure 9). By far the most important harvested irrigated crop is wheat (almost 31 percent of the total harvested irrigated area), followed by fodder (10 percent), groundnuts (7.5 percent), rice (7 percent), barley (7 percent) and vegetables (6.5 percent). Wheat is also by far the most important rainfed crop. In 2003, around 40 percent of the area under wheat was irrigated and 60 percent rainfed. In 1993 the yield for irrigated wheat was estimated at 2.78 tonnes/ha against 0.95 tonnes/ha for rainfed wheat.

FIGURE 9
Irrigated crops
Total harvested area 8 592 554 ha in 2003 (cropping intensity on equipped area: 106%)



Crop yields on irrigated land, although generally 2–3 times higher than on rainfed land, are still on the low side by international standards. Water shortage and soil salinity are mentioned among the main causes of this yield gap (Smedema, 2003).

Irrigation efficiency is generally low, 33 percent on average at national level. This causes waterlogging and salinization in the irrigated areas, which are major problems in the Islamic Republic of Iran.

The average cost of surface irrigation development is about $US7 500/ha for public schemes. The cost of sprinkler and localized irrigation for on-farm installations is estimated at $US1 700/ha and US$2 500/ha respectively.

In 1995, the average price of water delivered to farmers by the government was $US0.2 to 0.8 per 1 000 m^3, while the cost of groundwater withdrawal was $US5 to 9 per 1 000 m^3 and the cost for regulating surface water in existing projects was $US 3 to 5 per 1 000 m^3. This means that the government heavily subsidized delivered water, which is probably one of the main reasons for the low irrigation efficiency throughout the country.

Status and evolution of drainage systems

Drainage is not as extensive as irrigation is. Almost all modern irrigation systems have surface drainage systems, which cover about 1.5 million ha (Table 6). Subsurface drainage systems have been constructed on a total of 170 000 – 180 000 ha, of which about half is in Khozestan Province in the southwest of the country.

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

Institutions

According to the water legislation, three ministries are directly in charge of water resources assessment and development:

- The Ministry of Energy (MOE) has two responsibilities: energy supplies and water resources. As far as irrigation is concerned, it is in charge of the construction of large hydraulic works, including dams and primary and secondary irrigation and drainage canals for the distribution of water. Within the MOE, the Water Affairs Department (WAD) is responsible for overseeing and coordinating the planning, development, management and conservation of water resources. The WAD consists of the following sections: Water Resources Management Company (WRMC), Provincial Water Authorities (PWA), Irrigation and Drainage Operation and Maintenance Companies (O&M). WRMC is the mother company that manages all water sectors within the MOE except drinking water distribution for rural and urban areas. PWAs are responsible for the water sector in each province including irrigation and drainage development and operation. Drinking water distribution is the responsibility of provincial water and wastewater companies. O&M companies are responsible for modern irrigation and drainage operation and maintenance. 49 percent of the shares of these companies belong to the MOE and 51 percent belong to private sectors. There are 19 O&M companies working under the supervision of the PWAs.
- The Ministry of Agriculture (MOA) is responsible for supervising rainfed and irrigated crop development. It is in charge of subsurface drains, tertiary and quaternary canals as well as farm development and irrigation techniques, planned and operated by the Provincial Agricultural Organizations and the Deputy Ministry for Infrastructure Affairs of the Ministry of Agriculture.

The Islamic Republic of Iran’s Department of the Environment (DOE) is responsible for the preparation of the environmental protection policy and the laws, directives and systems necessary for evaluating the impacts of social and economic development projects, particularly irrigation and hydropower projects, on the environment and following up their implementation.

The “Farmers’ House” was established in order to protect the rights of the farmers. Its role is to streamline and coordinate the farmers’ activities, including their commitments in the fields of farming, fruit growing, animal husbandry, hunting, poultry production, supportive industries and so on.

Water management

Traditionally, the provision of water has been the responsibility of the government. As far as groundwater is concerned, the private sector invests in well drilling after which it is operated and managed by farmers. In recent years there has been a large increase in private sector financing of water projects, especially irrigation and drainage systems. Between 1994 and 1999 the cumulative new private sector capital expenditures in water projects in the Islamic Republic of Iran came to US$84 million. The construction of a total of about 300 000 ha surface irrigation networks has been financed and/or by farmers and the operation of these systems has been or will be transferred to the water user associations (WUAs) upon completion. In addition, the operation of some parts of the old systems has been transferred to the WUAs as pilot projects. These projects are located in Qazvin, Fomanat, Zabol and Khozestan. Another role of the WUAs is to decrease the number of water delivery points and it is also their responsibility to further distribute the irrigation water and collect the fees.

Irrigation development has always featured quite prominently in the Five Year Plans (FYP). In the first FYP (1989–1994) and second FYP (1995–2000), the area under modern irrigation was expanded and additional water resources were mobilized. The third FYP (2000–2005) marked a shift in the country's irrigation development policy. Since further withdrawal of water will be increasingly costly and in future more water needs to be allocated to other water use sectors (drinking water, industry and environment), more attention must be given to water saving measures than to further expansion of the irrigated area: more demand management as opposed to the current supply management practiced, canal and watercourse lining, sprinkling and other types of pressurized field irrigation, land levelling and so on (Smedema, 2003).

Policies and legislation

According to national law all water bodies (rivers, lakes, seas, etc.) are public property and the government is responsible for their management. The first water law after the revolution in the Islamic Republic of Iran was approved in 1982. Based on this law, allocating and issuing permits to use the water for domestic, agricultural and industrial purposes is the responsibility of the MOE. The MOA is appointed to distribute water for agriculture among farmers and collect the water fees. Water and wastewater companies are responsible for the distribution of water for domestic use in urban and rural areas and for collecting fees.

In the traditional irrigation systems, farmers receive their share of water based on their water rights, usually in proportion to the land area. This right to water use is usually measured based on the water delivery time. The water rights are attached to the land and when selling the land the water rights are also transferred to the new owner. Water rights can be rented or traded. Groundwater is mainly private property and it is traded between farmers. Wells can be sold with or without the land. Qanats have shared ownerships. Those who have built the qanat or participate in its maintenance are entitled to use its water. The oldest water rights legislation in the country is about how to use and divide the qanats' water among farmers.

ENVIRONMENT AND HEALTH

Salinity is one of the biggest problems in the Islamic Republic of Iran. The total area affected by salinity and waterlogging is estimated to be about 15.5 million ha or 9.4 percent of the total country area. About 7.32 million ha have saline affected soils. Leaching, built into the irrigation network, has proved to be a successful way to treat these soils. Because of the existing high concentration of calcium in soils, it is possible to treat sodic soils with leaching without using any additive materials. No comprehensive study has been undertaken regarding the extent of irrigation-induced salinity, but it is estimated that over 2 million ha are salt-affected and/or waterlogged.

Although the extent is unknown, water-related diseases are prevalent in some irrigated areas where the water is also used for domestic purposes.

PROSPECTS FOR AGRICULTURAL WATER MANAGEMENT

The Water Resources Management Policy emphasizes an integrated approach in water resources development to maximize positive impacts and avoid or minimize any negative effects of irrigation development. Based on the country's perspective on water resources, in order to control the overexploitation of groundwater resources, the surface water withdrawal percentage should change from 43 percent at the present to 55 percent. In addition, the country aims at decreasing the agricultural share from 92 percent to 87 percent by increasing water use efficiency. Water productivity is expected to increase from 0.7 kg/m^3 to 1.4 kg/m^3 over the next 20 years. The country plans to develop irrigation for another 1.76 million ha in the next 20 years.

The increasing water shortage in the country has forced many decision-making bodies to consider the reuse of effluent as an appealing option. Among the recent decisions taken by the Expediency Council were the adoption and implementation of general plans for recycling water nationwide. The proposed policies and strategies are as follows (Mahmoodian, 2001):

- Fully satisfy the drinking water demand potential from freshwater, prior to any other use.
- Guarantee future urban water demands by replacing the agricultural water rights to using freshwater (from brooks, rivers, springs well, etc.) with using treated effluents.
- Avoid the use of high quality urban water to create green spaces, and instead allot low quality water for this purpose.
- Cut off water supply to industries which have not taken practical measures for treating and reusing their wastewater.
- Expand research projects for the establishment of reasonable standards for the safe and reliable reuse of wastewater.

Replacing freshwater with treated effluents in agriculture necessitates introducing farmers to the positive and economic advantages of using wastewater, and consequently convincing them to exchange freshwater with effluents. This in itself requires research and study on the sanitary, economic and environmental impacts of using wastewater for agriculture and the artificial recharging of groundwater resources.

MAIN SOURCES OF INFORMATION

Azari, A. and Akram, M. 2002. *An overview to problems of subsurface drainage studies and implementation in Iran.* Iranian National Committee on Irrigation and Drainage (IRNCID).

Bureau for Agricultural Census and Information. 2005. *Agricultural statistics data.* Ministry of Agriculture.

Bureau for Base Information and Studies. 2005. *Summary of groundwater resources in Iran.* Ministry of Energy.

Bureau for Design and Development and Farmers Participation. 2005. *Annual Report.* Ministry of Energy.

Bureau of Operation and Maintenance of Dams and Irrigation Networks. 1995. *Water utilization in the year 1993.* Deputy Ministry of Water Affairs, Ministry of Agriculture.

Bybordi, M. 2002. *Irrigation and water management in Iran.* A contribution to an FAO sponsored project on: Framework for sustainable agricultural development strategy in Iran. 43 pp.

Jamab Consulting Engineers Company. 1999. *National water master plan.*

Mahmoodian, E.A. 2001. Iran country paper: Water from Water (a review of wastewater reuse in Iran). *In: Proceedings expert consultation for launching the regional network on wastewater reuse in the Near East.* pp 94-104.

Mohammadi, K., Ghodratnama, G. and Najib, R. 2003. Participatory irrigation management in Iran: Development and challenges. *In: Proceedings of workshop on public-private partnership in the water sector for Middle East and North Africa. Nov.* 1-4, Cairo, Egypt.

New Ag International. 2006. *High Tech Ag in Iran: A necessity and many challenges.* pp 58-69.

Shakiebie. 1994. *Seventh Iranian National Seminar on Irrigation and Drainage.* IRNCID, Ministry of Energy.

Siahpoosh, M.T. 1973. *About ancient Iranian weather.* Ebn_Sina Pub., p. 68-70.

Smedema, L.K. 2003. *Irrigated agriculture in Iran: a review of the principal sustainability, reform and efficiency issues.* pp 28.

Statistical Centre of Iran. 2006. *Population and housing census.*

Wangnick Consulting. 2002. *IDA Worldwide desalting plants inventory.* Report No. 17. Sponsored by the International Desalination Association (IDA).

Water and Sewage Engineering Co. 1993. *Situation of water and wastewater in the country in 1992.* Ministry of Energy.

Water Resources Management Company. 2006. *Rainfall, surface water and reservoirs capacities.* Ministry of Energy.

Water Resources Management Company. 2005. *Irrigation networks under operation.* Bureau for Operation and Maintenance of Irrigation networks, Ministry of Energy.

Yekom Consulting Engineers. 1995. *Cost of irrigation and drainage projects - Tender documents.*