

# IRAN



## GEOGRAPHY AND POPULATION

The Islamic Republic of Iran covers a total area of about 1.65 million km<sup>2</sup> and is bordered by Azerbaijan, Armenia, the Caspian Sea and Turkmenistan to the north, Afghanistan and Pakistan to the east, the Oman sea and the Persian Gulf to the south, and Iraq and Turkey to the west. About 52 % of the country area consists of mountains and deserts and some 16% 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 north-western Iran first southwards to the shores of the Persian Gulf and then continues eastwards till the most south-eastern province. Other mountain ranges run from the north-west to the east along the southern edge of the Caspian Sea. Finally, along the eastern frontier of Iran several scattered mountain chains exist. The Central or Interior Plateau is located in between these mountain chains and covers over 50% 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 31% of the total area. In 1993 about 18.5 million ha, or 36% of the cultivable area, were considered usable for agriculture, while 14.4 million ha were actually cultivated. Of this area, 12.8 million ha consisted of annual crops and 1.6 million ha of permanent crops. About 70 % of the landholders possess less than 5.5 ha (of which on average 2.13 ha irrigated and 3.25 ha rainfed).

Table 1 - Basic statistics and population

<b>Physical areas:</b>			
Area of the country	-----	164 800 000	ha
Cultivable area	-----	51 000 000	ha
Cultivated area	1997	13 793 263	ha
- annual crops	1997	12 106 644	ha
- permanent crops	1997	1 686 619	ha
Population:			
Total population	1996	60 050 000	inhabitants
Population density	1996	36.4	inhab./km <sup>2</sup>
Rural population	1996	38.3	%
Water supply coverage:			
Urban population	1996	95	%
Rural population	1996	86	%

The total population is about 60.05 million (1996), of which 38.3% is rural. The average population density is 36.4 inhabitants/km, but it ranges from less than 10 in the eastern part of the country up to more than 150 in the Gilan province, located in the Caspian Plain in the north, which is by far the most densely populated region in the country. In the Tehran province, where the capital is located, the population density reaches 400 inhabitants/ km<sup>2</sup>. The annual demographic growth rate was estimated at 3.9% over the period 1976-1986 and at 2.46% over the period 1986-1991 and 1.47 over the period 1991-1996.

TABLE 2 - Water: sources and use

Renewable water resources:			
Average precipitation		252	mm/r
		415.3	km <sup>3</sup> /yr
Internal renewable water resources		121	km <sup>3</sup> /yr
Total (actual) renewable water resources	1996	130	km <sup>3</sup> /yr
Dependency ratio	1996	7	%
Total (actual! Renewable water resources per inhabitant	1996	2165	m <sup>3</sup> /yr
Total dam capacity	1993	39200	10 <sup>6</sup> m <sup>3</sup>
Water withdrawal:			
- agricultural	1996	81400	10 <sup>6</sup> m <sup>3</sup> /yr
- domestic	1996	4 500	10 <sup>6</sup> m <sup>3</sup> /yr
- industrial	1996	900	10 <sup>6</sup> m <sup>3</sup> /yr
Total water withdrawal		86800	10 <sup>6</sup> m <sup>3</sup> /yr
per inhabitant	1996	1445	m <sup>3</sup> /yr
as % of total (actual) renewable water resources		66.7	%
Other water withdrawal	1996	16000	10 <sup>6</sup> m <sup>3</sup> /yr
Average groundwater depletion	1993	3 795	10 <sup>6</sup> m <sup>3</sup> /yr
Wastewater - Non-conventional water sources:			
Wastewater:			
- produced wastewater (Agricultural , urban & Industrial)	1996	29000	10 <sup>6</sup> m <sup>3</sup> /yr
- treated wastewater	1996	250	10 <sup>6</sup> m <sup>3</sup> /yr
- reused treated wastewater		-	10 <sup>6</sup> m <sup>3</sup> /yr
Desalinated water	1991	2.9	10 <sup>6</sup> m <sup>3</sup> /yr

## CLIMATE AND WATER RESOURCES

### Climate

The climate 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 30°C can be recorded in the north-west and minus 20°C is common in many places.

Annual rainfall ranges from less than 50 mm in the deserts to more than 1600 mm on the Caspian Plain. The average annual rainfall is 252 mm and approximately 90% of the country is arid or semiarid. Overall, about two-thirds of the country receives less than 250 mm of rainfall per year.

### Water resources

Iran can be divided into the following major river basins: the Central Plateau in the middle, the Lake Orumieh basin in the north-west, the Persian Gulf and the Oman sea basin in the west and south, the Lake Hamoun basin in the east, the Kara-Kum basin in the north-east and the Caspian Sea basin in the north. With an area of 424 240 km<sup>2</sup>, the Caspian Sea is the largest landlocked water body in the world and its surface lies about 22 metres below sea level. The rainfall characteristics of the above basins are summarized in Table 4.

TABLE 3 - Irrigation and drainage

Irrigation potential	1995	15000000	ha
Irrigation:			
1. Full or partial control irrigation: equipped area	1993	7 264 194	ha
- surface irrigation	1993	7 173 494	ha
- sprinkler irrigation	1993	47 200	ha
- micro-irrigation	1993	43 500	ha
% of area irrigated from groundwater	1993	50.1	%
% of area irrigated from surface water	1993	49.9	%
% of area irrigated from non-conventional sources	1993	0.0	%
% of equipped area actually irrigated	1993	100	%
2. Spate irrigation area		-	ha
3. Equipped wetland and inland valley bottoms (i.v.b.)		-	ha
Total irrigation (1 + 2 + 3)	1993	7 264 194	ha
- as % of cultivated area		51	%
4. Flood recession cropping area	1993	10 000	ha
Total water managed area (1 +2+3+4)	1993	7 274 194	ha
- as % of cultivated area		51	%
- increase over last 10 years	1983-93	30	%
- power irrigated area as % of water managed area	1993	36.0	%
Full or partial control irrigation schemes: Criteria			
Large-scale schemes > 50 ha	1991	708 260	ha
Medium-scale schemes	1991	3 159 924	ha
Small-scale schemes < 10 ha	1991	3 396 010	ha
Total number of households in irrigation	1991	2 620 000	
Irrigated crops:			
Total irrigated grain production	1993	10000000	tons
as % of total grain production	1993	61	%

Harvested crops under irrigation (full or partial control)	1993	7 264 194	ha
- permanent crops: total	1993	1 564 884	ha
- annual crops: total	1993	5 699 310	ha
. wheat	1993	2 340 676	ha
. other cereals (barley and rice)	1993	1 256 310	ha
. fodder crops	1993	790 063	ha
. vegetables	1993	425 116	ha
. other annual crops	1993	887 145	ha
Drainage - Environment:			
Drained area	1995	40 000	ha
as % of cultivated area		0.3	%
- drained areas in full or partial control irrigated areas	1995	40 000	ha
- drained areas in equipped wetland and i.v.b		-	ha
- other drained areas		-	ha
- total drained area with subsurface drains	1995	40 000	ha
- total drained area with surface drains		-	ha
Flood-protected area		-	ha
Area salinized by irrigation	1993	2 100 000	ha
Population affected by water-borne diseases		-	inhabitants

TABLE 4 - Rainfall in the major basins in Iran

Basin	Total area (km <sup>2</sup> )	As % of total area	Rainfall (mm/year)	Rainfall (km <sup>3</sup> /year)	As % of total rainfall
Central Plateau	832 000	51	165	138	33
Persian Gulf and Gulf of Oman	431 000	26	366	158	38
Caspian Sea	178 000	11	430	77	19
Lake Hamoun and Kara-Kum	150 000	9	142	21	5
Lake Orumie	57 000	3	370	21	5
Total	1 648 000	100	252	415	100

All these basins, except the Persian Gulf and Oman sea, are interior basins. There are several large rivers, the only navigable one of which is Karun, the others being too steep and irregular. The Karun river, with a total length of 890 km, flows in the south-west of the country to Arvand Rud, which is formed by the Euphrates and the Tigris 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 springs. It can also be tapped by wells.

Internal renewable water resources are estimated at 121 km<sup>3</sup>/year. Surface runoff represents a total of 97.3 km<sup>3</sup> /year, of which 5.4 km<sup>3</sup>/year comes from drainage of the aquifers, and groundwater recharge is estimated at about 49.3 km<sup>3</sup>/year, of which 12.7 km<sup>3</sup>/year is obtained from infiltration in the river bed. Iran receives 6.7 km<sup>3</sup>/year of surface water from Pakistan and some water from Afghanistan through the Helmand river. The flow of the Arax river, at the border with Azerbaijan, is estimated at 4.63 km<sup>3</sup>/year. The surface runoff to the sea and to other countries is estimated at 55.9 km<sup>3</sup>/year. The total safe yield of groundwater (including non

renewable water or unknown groundwater inflow from other countries) has been estimated at 49.3 km<sup>3</sup>/year. (including return flow from different water uses).

## Dams

Dams have always played an important role in harnessing Iran's precious water reserves and the long-term objective of Iran's water resources development plan is based on the control and regulation of water resources through dams. In 1996, 58 storage dams were in operation with a total regulation capacity of 24.7 km<sup>3</sup>. At the same time, 48 storage dams were under construction with a design regulation capacity of 12.2 km<sup>3</sup>. In 1996, the annual electricity production from dams was 8000 GWH, which is 10 % of the total energy production of the country. Dams also play an important role in flood control through routing of floods. Several reservoirs behind the dams seem to offer good sailing and water-skiing facilities, but have not been used for recreation so far.

## Water use

The total agricultural, domestic and industrial water withdrawal was estimated at about 86.4 km<sup>3</sup> in 1996 (Figure 1). Although this is equal to 66% of the actual available renewable water resources, current annual abstraction from aquifers (from 49 km<sup>3</sup> in 1990 up to 57 km<sup>3</sup> in 1993) is already more than the estimated safe yield (46 km<sup>3</sup>). In some plains of the country there are over abstraction from groundwater which total amount of over abstraction is about 4 km<sup>3</sup> of the same time

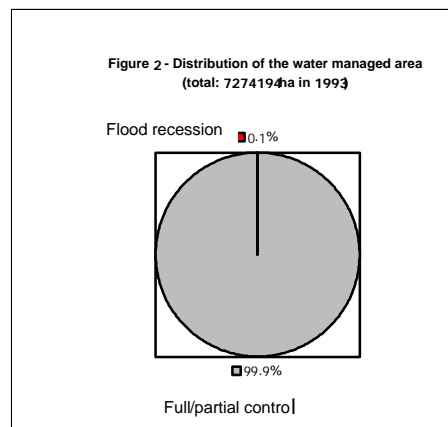
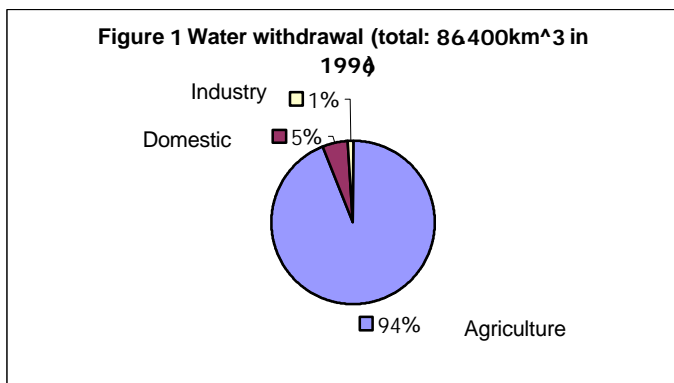
there is some limited possibility for development of groundwater in other aquifers.

## IRRIGATION AND DRAINAGE DEVELOPMENT

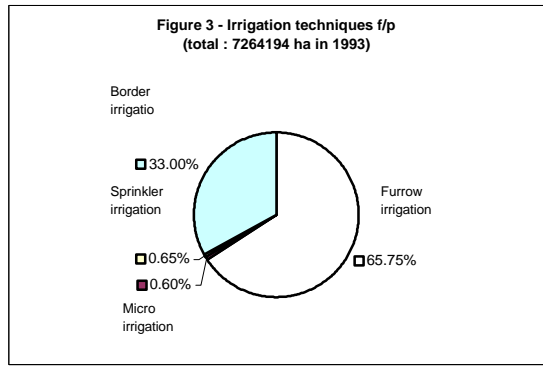
The problem of water supply has been a constant preoccupation in Iran since the beginning of the country's history, thousands of years ago. Its inhabitants learnt to design and implement efficient techniques for harnessing limited water resources and for irrigation. Apart from the qanat, which was a 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 1000 years ago, are still in good condition.

Agricultural land availability is not a major constraint in the development of Iranian agriculture. 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% of the cultivable area. However, this would require optimum storage and water use.

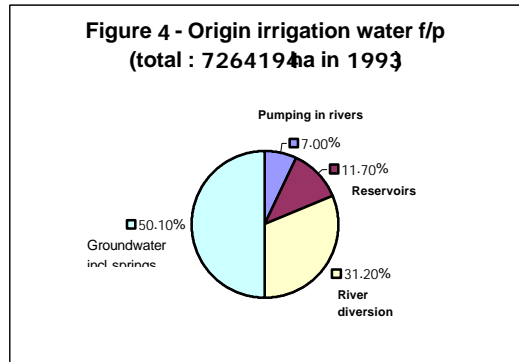
In 1993 out of 14382 million ha of cultivated land 7264 million ha, or 51 %, were equipped for full or partial control irrigation. Annual irrigated crops covered 5 699 million ha and permanent irrigated trees covered 1565 million ha. In addition, flood recession cropping is practiced on an area of about 10000 ha in the southwest (Figure2).



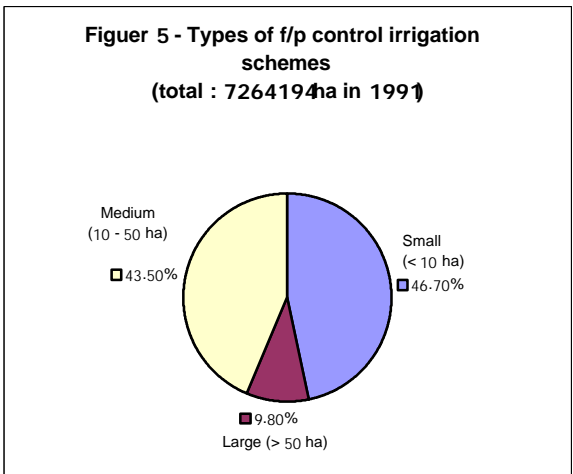
Surface irrigation techniques are used on 98.75 % of the area equipped for irrigation and 1.25 % benefits from a pressurized irrigation system (Figure 3). About half the area is irrigated from groundwater, including spring water (Figure 4). According to the landholding and technologies which are used, the farming systems are grouped as: small farms (< 10 ha) 47%, medium size farms (10-50 ha) 43%, and large farms (>50 ha) 10% (Figure 5) .



The cost of surface irrigation development varies from \$US 2 300/ha for large to \$US 2500/ ha for medium and \$US 2 600/ha for small schemes. Average operation and maintenance costs are estimated at \$US 130, 175 and 60 per ha and per year respectively. The cost of micro-irrigation and sprinkler irrigation development is estimated at about \$US2200 and 1 200/ha. The average price of water delivered to farmers by government is \$US 0.2 to 0.8/ 1000m<sup>3</sup>, while the cost of withdrawal of groundwater by the farmer is \$US 5 to 9/1 000 m<sup>3</sup> and the cost for regulating surface water in existing projects is \$US 3 to 5 per 1 000 m<sup>3</sup>. These figures are subjected to change according to different rate of exchange of foreign currencies. This means that the government heavily subsidizes delivered water, which is probably one of the main reasons for the low irrigation efficiency throughout the country.

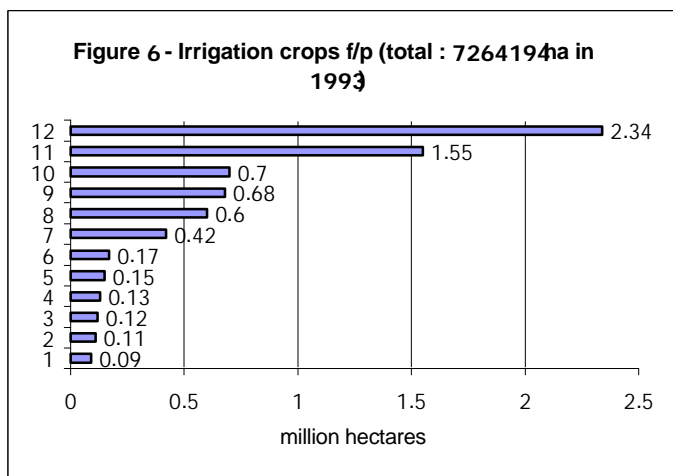


On-farm application rates in the country are rather high and in general irrigation has a low efficiency, 32% on average at national level. Major causes of inefficiency include: careless operation, poor maintenance, negligible water prices, fragmentation of responsibilities among different governmental agencies and inadequate training of farmers. Low irrigation efficiency causes waterlogging and salinization in the irrigated areas, which are a major problem in Iran. No comprehensive study has been undertaken regarding the extent of irrigation-induced salinity, but according to an estimate (ICID, 1977) for the year 1974 about 38% of the irrigated area in Iran had soils with considerable salinity and drainage problems. Over 2 million ha are estimated to be salt-affected and/or waterlogged at present.



By far the most important irrigated crop is wheat covering almost one-third of the total irrigated area, followed by irrigated fruit trees, covering one fifth of the total area (Figure 6). Other major irrigated crops are barley, rice, vegetables and pulses Wheat is also by far the most important rainfed crop covering 4.47 million ha, or almost two-thirds of the rainfed area. The yield for irrigated wheat was estimated at 2.78 tons/ha in 1993 against 0.95 tons/ha for rainfed wheat.

1-Wheat	2- Fruit trees	3- Fodder	4-Barley
5-Rice	6- Vegetables	7-Pulses	8-Sugar beet
9-Potatoes	10-Oil crops	11-Cotton	12- Other



## INSTITUTIONAL ENVIRONMENT

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

- The Ministry of Energy (MOE) has two responsibilities: energy supplies and water resources. In the field of irrigation, 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 MOE, the Water Affairs Department (WAD) is responsible for overseeing and coordinating planning, development, management and conservation of water resources. Fourteen publicly owned Regional Water Authorities (RWA), reporting directly to MOE, are responsible for feasibility studies, project execution and subsequent management of water resources. The Operation and Maintenance of primary and secondary irrigation and drainage canals are operated by operation and maintenance corporations affiliated to MOE.

- 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 on 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 Ministry of Jihad-e-Sazandagi (MOJ) deals with watershed management and rural development.

## TRENDS IN WATER RESOURCES MANAGEMENT

Agriculture is one of the main priorities in national development plans. The annual increase in irrigated land over 15 years (1978-1993) was 3.8% along with a 4.4% annual increase for agricultural water supply. An increase of 500 000 ha of irrigated land and an increase of 10 km<sup>3</sup>/year of agricultural water supply was planned in the second national five-year plan (1995 - 2000).

At present, a big gap exists between water delivery from the main canals and water application in the field. Compared to the large investments for water resources development, little has been done to improve irrigation water use at farm level. Water is delivered to old traditional irrigation canals and on-farm conveyance and the use of irrigation water is generally rudimentary and wasteful. The use of earth bunds, unlined canals and poor levelling combined with low water charges have resulted in very low levels of water conveyance and use efficiencies (32% as a national average) and caused the emergence of serious drainage problems.

A fundamental review of the organizational chart and institutional changes were made to improve this situation. Since 1992, the Deputy Ministry for Infrastructure Affairs of the Ministry of

Agriculture created five departments: farm development, pressurized irrigation systems, water supply, hydraulic constructions and operation and maintenance.

The government policy includes:

- An increase in irrigation efficiency by changing the surface irrigation techniques to pressurized irrigation.
- The establishment of a land Bank to facilitate the on-farm development and hand over the structures to the farmers groups.
- A change in water pricing and delivery methods;
- large-scale privatization.

## **MAIN SOURCES OF INFORMATION**

Bureau of Information and Statistics. 1994. Agricultural Statistics Yearbook 1993. Deputy Ministry of Plan and Project, Ministry of Agriculture.

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.

Deputy Ministry for Infrastructure Affairs. 1991. Summary of the social and agricultural economy of Iran. Ministry of Agriculture.

Keshavarz, M.A. 1993. Improvement of farm level infrastructures. Deputy Ministry for Infrastructure Affairs. Ministry of Agriculture.

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

Statistical Centre. 1994. Yearly Statistical Book 1993. Plan and Budget Organization.

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

World Bank. 1993. Staff appraisal report: Irrigation improvement project. Report No. 11393-IRN.

Yekom Consulting Engineers. 1995. Cost of Irrigation and Drainage Projects - Tender Documents.