Iraq

GEOGRAPHY, CLIMATE AND POPULATION

Geography

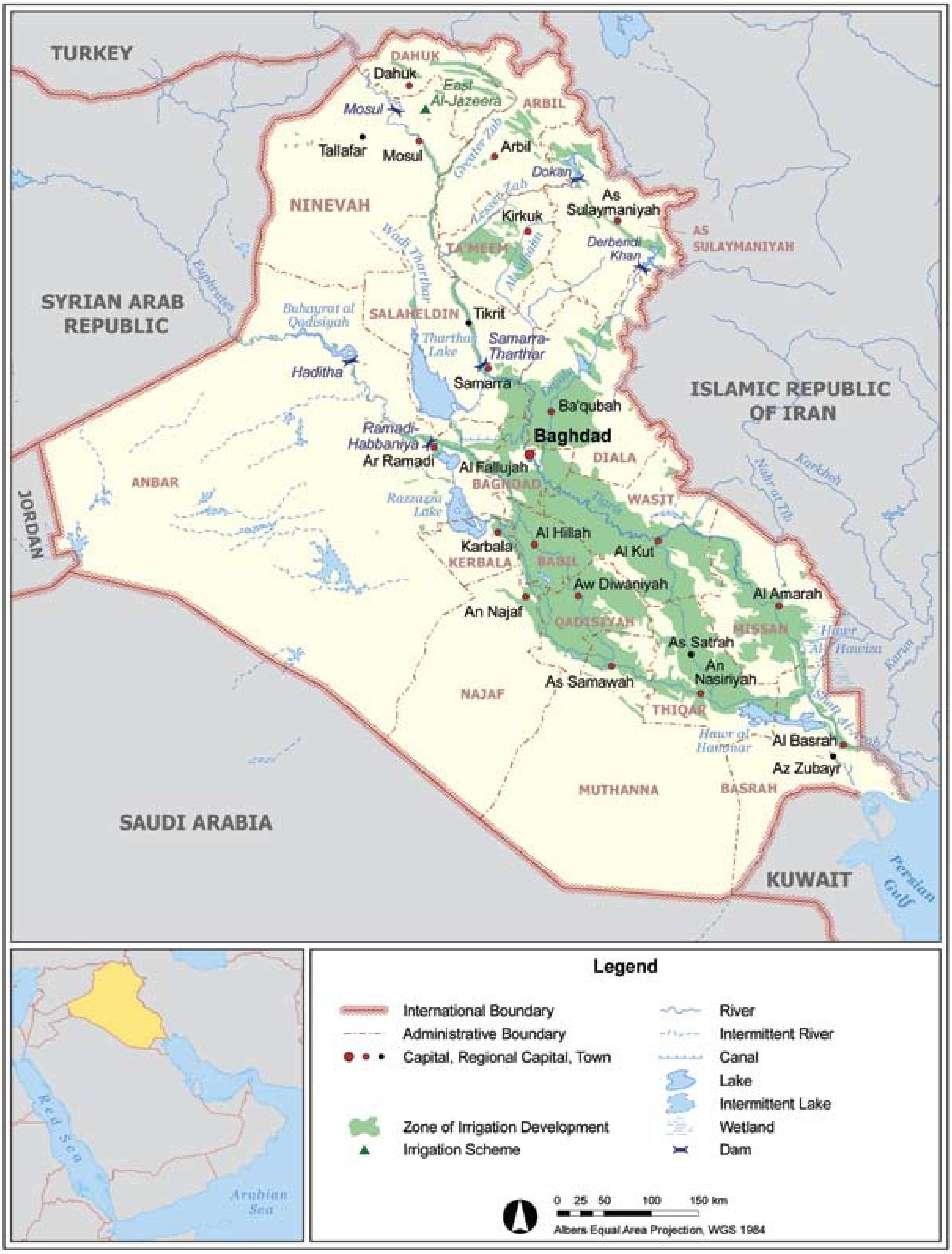
Iraq, with a total area of 438 320 km², is bordered by Turkey to the north, the Islamic Republic of Iran to the east, the Persian Gulf to the southeast, Saudi Arabia and Kuwait to the south, and Jordan and the Syrian Arab Republic to the west. Topographically, Iraq is shaped like a basin, consisting of the Great Mesopotamian alluvial plain of the Tigris and the Euphrates rivers (Mesopotamia means, literally, the land between two rivers). This plain is surrounded by mountains in the north and the east, which can reach altitudes of 3 550 m above sea level, and by desert areas in the south and west, which account for over 40 percent of the land area. For administrative purposes, the country is divided into eighteen governorates, of which three (Arbil, Dahuk, and As Sulaymaniyah) are gathered in an autonomous region in the north and the other fifteen governorates are in central and southern Iraq. This division corresponds roughly to the rainfed northern agricultural zone and the irrigated central and southern zone.

It is estimated that about 11.5 million ha, or 26 percent of the total area of the country, are cultivable. The remaining part is not viable for agricultural use under current conditions and only a small strip situated along the extreme northern border with Turkey and the Islamic Republic of Iran is under forest and woodlands. The total cultivated area is estimated at about 6 million ha, of which almost 50 percent in northern Iraq under rainfed conditions. Less than 5 percent is occupied by permanent crops (Table 1). Permanent pasture covers around 4 million ha. Livestock grazing occurs throughout all agricultural zones, but is more widespread in the north where hillside grazing prevails. Small ruminants (mainly sheep and goats) are the main livestock species. However, beef cattle have been the traditional source of dietary protein for most Iraqis. Poultry production occurs in close proximity to urban centres.

Climate

The climate in Iraq is mainly of the continental, subtropical semi-arid type, with the north and north-eastern mountainous regions having a Mediterranean climate. Rainfall is very seasonal and occurs in the winter from December to February, except in the north and northeast of the country, where the rainy season is from November to April. Average annual rainfall is estimated at 216 mm, but ranges from 1 200 mm in the northeast to less than 100 mm over 60 percent of the country in the south (Table 2). Winters are cool to cold, with a day temperature of about 16 °C dropping at night to 2 °C with a possibility of frost. Summers are dry and hot to extremely hot, with a shade temperature of over 43 °C during July and August, yet dropping at night to 26 °C.

Iraq can be divided into four agro-ecological zones (FAO, 2003):



IRAQ **FAO - AQUASTAT, 2008**

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TABLE 1
Basic statistics and population

Physical areas			
Area of the country	2005	43 832 000	ha
Cultivated area (arable land and area under permanent crops)	2005	6 010 000	ha
• as % of the total area of the country	2005	13.7	%
• arable land (annual crops + temp fallow + temp meadows)	2005	5 750 000	ha
• area under permanent crops	2005	260 000	ha
Population			
Total population	2005	28 807 000	inhabitants
• of which rural	2005	33.2	%
Population density	2005	65.7	inhabitants/km^2
Economically active population	2005	8 189 000	inhabitants
• as % of total population	2005	28.4	%
• female	2005	21.6	%
• male	2005	78.4	%
Population economically active in agriculture	2005	651 000	inhabitants
• as % of total economically active population	2005	7.9	%
• female	2005	55.1	%
• male	2005	44.9	%
Economy and development			
Gross Domestic Product (GDP) (current US$)	2000	25 860	million US$/yr
• value added in agriculture (% of GDP)	2000	5	%
• GDP per capita	2000	1 031	US$/yr
Human Development Index (highest = 1)		-	
Access to improved drinking water sources			
Total population	2006	77	%
Urban population	2006	88	%
Rural population	2006	56	%

TABLE 2
Water: sources and use

Renewable freshwater resources			
Precipitation (long-term average)	-	216	mm/yr
	-	94.68	10^9 m^3/yr
Internal renewable water resources (long-term average)	-	35.2	10^9 m^3/yr
Total actual renewable water resources	-	75.61	10^9 m^3/yr
Dependency ratio	-	53.45	%
Total actual renewable water resources per inhabitant	2005	2 625	m^3/yr
Total dam capacity	2000	139 700	10^6 m^3
Water withdrawal			
Total water withdrawal	2000	66 000	10^6 m^3/yr
- irrigation + livestock	2000	52 000	10^6 m^3/yr
- municipalities	2000	4 300	10^6 m^3/yr
- industry	2000	9 700	10^6 m^3/yr
• per inhabitant	2000	2 632	m^3/yr
Surface water and groundwater withdrawal	2000	64 493	10^6 m^3/yr
• as % of total actual renewable water resources	2000	85.3	%
Non-conventional sources of water			
Produced wastewater		-	10^6 m^3/yr
Treated wastewater		-	10^6 m^3/yr
Reused treated wastewater		-	10^6 m^3/yr
Desalinated water produced	1997	7.4	10^6 m^3/yr
Reused agricultural drainage water	1997	1500	10^6 m^3/yr

- Arid and semi-arid zones with a Mediterranean climate. A growing season of about nine months, over 400 mm of annual winter rainfall, and mild/warm summers prevail. This zone covers mainly the northern governorates of Iraq. Major crops include wheat, barley, rice and chickpea. Other field crops are also produced in smaller quantities. There is some irrigation, mainly from springs, streams and bores.

- Steppes with winter rainfall of 200–400 mm annually. Summers are extremely hot and winters cold. This zone is located between the Mediterranean zone and the desert zone. It includes the feed barley production areas, limited wheat production, and it has limited irrigation.
- The desert zone with extreme summer temperatures and less than 200 mm of rainfall annually. It extends from just north of Baghdad to the Saudi Arabian and Jordanian borders. It is sparsely populated and cultivated with just a few crops in some irrigated spots.
- The irrigated area which extends between the Tigris and Euphrates rivers from the north of Baghdad to Basra in the south. Serious hazards for this area are poor drainage and salinity. The majority of the country's vegetables, sunflower and rice are produced in this zone.

Population

Total population is about 28.8 million (2005), of which 33 percent is rural (Table 1). Average population density is estimated at 66 inhabitants/km^2, but varies greatly from the almost uninhabited Anwar province in the desert in the western part of the country to the most inhabited Babylon province in the centre of the country. Average population growth was estimated at 3.6 percent during 1980–90, but emigration of foreign workers, severe economic hardships and war have since reduced this growth rate.

In 1991 safe water supplies reached 100 percent in urban areas but only 54 percent in rural areas. The water supply and sanitation situation has deteriorated as a result of the wars, among other things owing to shortages of chlorine imports for water treatment. In 2006 access to improved drinking water sources reached 77 percent of the population (88 and 56 percent of urban and rural population respectively). The sanitation coverage was 76 percent (80 and 69 percent respectively).

ECONOMY, AGRICULTURE AND FOOD SECURITY

In 2000 the Gross Domestic Product (GDP) was US$25.9 billion, with an annul rate growth of -4.3 percent. In 1989 the agriculture sector contributed only 5 percent to GDP, which was dominated by oil (61 percent); in 2000 the agriculture sector accounted for 5 percent of GDP (Table 1).

The economically active population is about 8.2 million (2005) of which 78 percent is male and 22 percent female. In agriculture, 0.7 million inhabitants are economically active, of which 45 percent male and 55 percent female. While the agricultural labour force represented 31 percent of the economically active population in 1975, it decreased to about 8 percent in 2004, partly due to the introduction of agricultural mechanization, the development of education and health services in the urban areas and increased job opportunities encouraging rural–urban migration. However, after public service and the trade sector, agriculture still is the main provider of employment in Iraq (FAO, 2003). A large portion of Iraq's population lives in poverty, with many people engaged in subsistence agriculture.

The nation-wide rationing system set up by the Government of Iraq in 1991 prevented famine but with the decline in the energy content of the ration and the reduction in food available outside the rationing system, malnutrition and mortality of young children increased dramatically. In April 1995 the Oil-for-Food Programme was established under Security Council Resolution 986 (SRC 986), according to which the distribution of humanitarian supplies to the population is undertaken by the government in the centre and south and by the UN Inter-Agency Humanitarian

Programme on behalf of the government in the three northern governorates. This arrested further decline in nutrition (FAO, 2000).

However, despite substantial increases in the food ration since SCR 986, the following has occurred:

- child malnutrition rates in the centre and south of the country do not appear to have improved significantly and nutritional problems remain serious and widespread
- existing food rations do not provide a nutritionally adequate and varied diet
- the monthly food basket lasts up to three weeks, depending on the type of ration
- despite shortfalls in the ration, some segments of the population can supplement their diet with market purchases, albeit at considerable cost.

WATER RESOURCES AND USE

Water resources

Both the Tigris and the Euphrates are transboundary rivers, originating in Turkey. Before their confluence, the Euphrates flows for about 1 000 km and the Tigris for about 1 300 km within the territory of Iraq.

The area of the Tigris River Basin in Iraq is 253 000 km², which is 54 percent of the total river basin area. The average annual runoff is estimated at 21.33 km^3 as it enters Iraq. All the Tigris tributaries are on the left bank. From upstream to downstream:

- the Greater Zab, which originates in Turkey. It generates 13.18 km^3 at its confluence with the Tigris; 62 percent of the total area of this river basin of 25 810 km^2 is in Iraq;
- the Lesser Zab, which originates in the Islamic Republic of Iran and which is equipped with the Dokan Dam (6.8 km^3). The river basin of 21 475 km^2 (of which 74 percent is in Iraqi territory) generates about 7.17 km^3, of which 5.07 km^3 of annual safe yield after construction of the Dokan Dam;
- the Al-Adhaim (or Nahr Al Uzaym), which drains about 13 000 km^2 entirely in Iraq. It generates about 0.79 km^3 at its confluence with the Tigris. It is an intermittent stream subject to flash floods;
- the Diyala, which originates in the Islamic Republic of Iran and drains about 31 896 km^2, 75 percent of which in Iraqi territory. It is equipped with the Derbendi Khan Dam and generates about 5.74 km^3 at its confluence with the Tigris;
- the Nahr at Tib, Dewarege (Doveyrich) and Shehabi rivers, draining together more than 8 000 km^2. They originate in Iranian territory and bring together about 1 km^3 of highly saline waters in the Tigris;
- the Karkheh, the main course of which is in the Islamic Republic of Iran and which, from a drainage area of 46 000 km^2, brings around 6.3 km^3 yearly into Iraq, namely into the Hawr Al Hawiza during the flood season and into the Tigris River during the dry season.

The average annual flow of the Euphrates as it enters Iraq is estimated at 30 km^3, with a fluctuating annual value of between 10 and 40 km^3. Unlike the Tigris, the Euphrates receives no tributaries during its passage in Iraq. About 10 km^3 per year are drained into the Hawr al Harnmar (a marsh in the south of the country). The Shatt Al-Arab is the river formed by the confluence downstream of the Euphrates and the Tigris; it flows into the Gulf after a course of only 190 km. The Karun River, originating in Iranian territory, has a mean annual flow of 24.7 km^3 and flows into the Shatt Al-Arab, to which it brings a large amount of fresh water just before reaching the sea.

It is difficult to determine the average annual discharge of the Euphrates and Tigris rivers together due to the large yearly fluctuation. According to the records for 1938–1980, there have been years in the mid-1960s when 68 km^3 were recorded in the two rivers and years in the mid-1970s when the amount reached over 84 km^3. On the other hand, there was the critical drought year with less than 30 km^3 at the beginning of the 1960s. Such variations in annual discharge make it difficult to develop an adequate water allocation plan for competing water demand from each sector as well as to ensure fair sharing of water among neighbouring countries (UNDG, 2005).

This yearly fluctuation in the annual discharge has also caused large and possibly disastrous floods as well as periodic severe droughts. The level of water in the Tigris can rise at a rate of over 30 cm/hour. In the southern part of the country, immense areas are regularly inundated, levees often collapse, and villages and roads must be built on high embankments. The Tharthar Reservoir was planned in the 1950s among other to protect Baghdad from the ravages of the periodic flooding of the Tigris by storing extra water upstream of the Samarra Barrage.

The major part of the river flow occurs during the spring flood period, which is from February through June on the Tigris River and from March through July on the Euphrates River. On the Tigris the natural flow during this period makes up 60–80 percent of the total annual flow and on the Euphrates 45–80 percent. During the low water period (July through September) the natural flow does not exceed 10 percent of the annual amount under normal conditions.

In order to increase water transport efficiency, minimize losses and waterlogging, and improve water quality, a number of new watercourses were constructed, especially in the southern part of the country. The Third River (also called Saddam River), which was completed in 1992, functions as a main outfall drain collecting drainage waters from more than 1.5 million ha of agricultural land from the north of Baghdad to the Gulf between the Euphrates and the Tigris. The length of the watercourse, completed in December 1992, is 565 km, with a total discharge of 210 m^3/s. In 1995 an estimated 17 million tons of salt was said to have been transported to the Gulf through the Third River. Other watercourses were also constructed to reclaim new lands or to reduce waterlogging.

Groundwater aquifers in Iraq consist of extensive alluvial deposits of the Tigris and Euphrates rivers, and are composed of Mesopotamian-clastic and carbonate formations. The alluvial aquifers have limited potential because of poor water quality. The Mesopotamian-clastic aquifers in the northwestern foothills consist of Fars, Bakhtiari and alluvial sediments. The Fars formation is made up of anhydrite and gypsum inter-bedded with limestone and covers a large area of Iraq. The Bakhtiari and alluvial formations consist of a variety of material, including silt, sand, gravel, conglomerate and boulders, with a thickness of up to 6 000 metres. Water quality ranges from 300 to 1 000 ppm. Another major aquifer system is contained in the carbonate layers of the Zagros Mountains. Two main aquifers are found in the limestone and dolomite layers, as well as in the Quaternary alluvium deposits. The limestone aquifer contributes large volumes of water through a number of springs. The alluvial aquifers contain large volume reservoirs and annual recharge is estimated at 620 million m^3 from direct infiltration of rainfall and surface water runoff. Water quality is good, ranging from 150 to 1 400 ppm (ESCWA, 2001).

Good quality subterranean water has been found in the foothills of the mountains in the northeast of the country and in the area on the right bank of the Euphrates. The aquifer in the northeast of Iraq has an estimated safe yield of between 10 and 40 m^3/sec at depths of 5–50 metres. Its salinity increases towards the southeast of the area until it reaches between 0.5 and 1 mg/l. The aquifers on the right bank of the Euphrates River, trapped between gypsum and dolomite at depths increasing towards the west where water is found at 300 m (at Abu-Aljeer), have an estimated safe yield of 13 m^3/sec. In the western part of that area the salinity of the water is only 0.3 mg/l compared with 0.5–1 mg/l in the eastern section. In other areas of the country good quality water is fairly limited because of high levels of salinity (Ministry of Irrigation, 1986). An estimated 0.08 km^3/year of water from the Umm er Radhuma aquifer enters Iraq from Saudi Arabia. Internal renewable water resources are estimated at 35.2 km^3/year (Table 2).

Total gross dam capacity of the major dams in the Tigris Basin is estimated at 102.2 km³, of which on-river dam capacity is 29.4 km³ (7 dams). The off-river storage Samarra-Tharthar Dam, constructed in 1954, has a capacity of 72.8 km³. It is filled with Wadi Tharthar waters and, since 1985, also with Euphrates water.

Total gross capacity of the major dams in the Euphrates Basin is estimated at 37.5 km³, of which on-river dam capacity is 34.2 km³. The off-river Ramadi-Habbaniya Dam, constructed in 1951, has a capacity of 3.3 km³; it can be filled with upstream Euphrates waters and drains into the Euphrates downstream (UNEP, 2001a).

There are eleven major wastewater treatment plants in Iraq, three of which are in Baghdad. All the treatment plants are located near rivers (three near the Euphrates, two near the Tigris, two near the Diala, and one each near the Kahla, the Aw Diwaniyah, the Husseinya and the Shatt Basrah). The total treatment capacity of these plants is 650 000 m³/day. The technologies used are: primary sedimentation, aeration and secondary sedimentation (chlorination) at five plants; primary sedimentation, trickling filtering and chlorination at three plants; primary sedimentation, extended aeration and chlorination at two plants; aeration lagoons and secondary sedimentation at one plant (UNEP, 2001b). Until now, the majority of wastewater after treatment has been discharged into rivers and drainage canals by gravity and there is no definite canal network for wastewater collection.

The two largest wastewater treatment plants were built in Baghdad County (Salih, 2001). The first, Al-Rustumia, was designed to handle an average flow of 204 million m³/year and the second, Al-Karkh, handles an average flow of 150 million m³/year. Baghdad city is generally supplied by less saline drinking water (0.8–1.2 dS/m) and this salinity increases 2–3 times in the wastewater. It can therefore be used without creating any salinity and alkalinity problems except for very sensitive crops. The sodium concentration is rather low, resulting in a sodium adsorption ratio (SAR) ranging between 2.68 and 3.12 for the Al-Rustumia station and between 4.38 and 5.24 for the Al-Karkh station. The chloride content of wastewater of the Al-Karkh station is fairly high for surface irrigation and not recommended for sprinkler irrigation, while the chloride content of the Al-Rustomia station is appropriate for surface irrigation but generally inadequate for sprinkler irrigation. The bicarbonate content of wastewater from both stations is adequate for surface irrigation but inappropriate for sprinkler irrigation. The phosphorus and potassium contents of wastewater from both stations are fairly low. Contents of iron, magnesium, chromium, zinc, cobalt and boron in wastewater of both stations are generally within acceptable limits.

In 2002, the total installed desalination capacity was 384 513 m³/day. This refers to the installed gross capacity (design capacity) (Wangnick Consulting, 2002).

Water use

In 2000, total water withdrawal was estimated at 66 km³, of which 79 percent for agricultural purposes, 6.5 percent for domestic supplies and 14.5 percent for industrial use (ESCWA, 2005) (Table 2, Figure 1 and Figure 2).

Hydroelectric power generation is about 17 percent of current electrical energy production in Iraq. Existing power plants have been neglected

FIGURE 1
Water withdrawal by sector
Total: 66 km³ in 2000

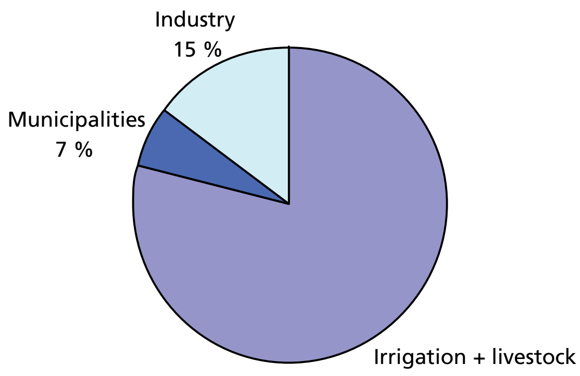
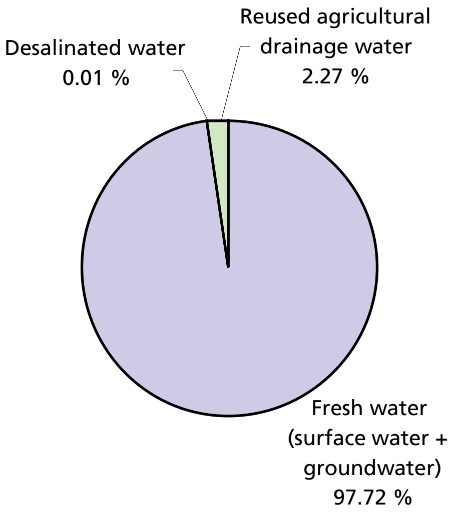


FIGURE 2
Water withdrawal by source
Total: 66 km³ in 2000



for over a decade and a number of new projects were suspended in the aftermath of the Gulf War. The volume and timing of water entering Iraq from neighbouring countries is a significant factor in hydropower production (UNDG, 2005).

International water issues

The water resources of Iraq depend largely on the surface water of the Tigris and Euphrates rivers and most of the natural renewable water resources of Iraq come from outside the country.

The protocol concerning the regulation of water use of the Euphrates and Tigris rivers dates back to 1946 when Turkey and Iraq agreed that the rivers' control and management depended to a large extent on the regulation of flow in Turkish source areas. At that time, Turkey agreed to begin monitoring the two rivers and to share related data with Iraq. In 1980 Turkey and Iraq further specified the nature of the earlier protocol by establishing a Joint Technical Committee on Regional Waters. After a bilateral agreement in 1982, the Syrian Arab Republic joined the committee. Turkey has unilaterally guaranteed to allow 15.75 km³/year (500 m³/s) of water of the Euphrates across the border to the Syrian Arab Republic, but no formal agreement has been reached so far on the sharing of the Euphrates water. According to an agreement between the Syrian Arab Republic and Iraq (1990), Syria agrees to share the Euphrates water with Iraq on a 58 percent (Iraq) and 42 percent (Syria) basis, which corresponds to a flow of 9 km³/year at the border with Iraq when using the figure of 15.75 km³/year from Turkey. Up to now, there has been no global agreement between the three countries concerning the Euphrates waters (FAO, 2004).

The construction of the Ataturk Dam, one of the projects of GAP completed in 1992, has been widely portrayed in the Arab media as a belligerent act, since Turkey began the process of filling the Ataturk Dam by shutting off the river flow for a month (Akanda *et al*, 2007). Both the Syrian Arab Republic and Iraq accused Turkey of not informing them about the cut-off, thereby causing considerable harm. Iraq even threatened to bomb the Euphrates dams. Turkey countered that its co-riparians "had been informed in time that river flow would be interrupted for a period of one month, due to technical necessity" (Kaya, 1998). Turkey returned to previous flow-sharing agreements after the dam became operational, but the conflicts were never fully resolved as downstream demands had increased in the meantime (Akanda *et al*, 2007).

Turkey contributes about 90 percent of the total annual flow of the Euphrates, while the remaining part originates in the Syrian Arab Republic and very little is added in Iraq. Turkey also contributes 38 percent directly to the main Tigris River and another 11 percent to its tributaries, which join the main stream of the Tigris further downstream in Iraq. Most of the remainder comes from three tributaries originating in the Islamic Republic of Iran (FAO, 2004).

As shown, a number of crises have occurred in the Euphrates-Tigris Basin, partly due to lack of communication, conflicting approaches, unilateral development, and inefficient water management practices. The Arab countries have long accused Turkey of violating international water laws with regard to the Euphrates and the Tigris rivers. Iraq and the

Syrian Arab Republic consider these rivers to be international and thus claim a share of their waters. Turkey, in contrast, refuses to concede the international character of the two rivers and only speaks of the rational utilization of transboundary waters. According to Turkey, the Euphrates becomes an international river only after it joins the Tigris in lower Iraq to form the Shatt al-Arab, which then serves as the border between Iraq and the Islamic Republic of Iran until it reaches the Gulf only 193 km further downstream. Furthermore, Turkey is the only country in the Euphrates Basin to have voted against the United Nations Convention on the Law of Non-navigational Uses of International Watercourses. According to Turkey, if signed, the law would give the lower riparians "a veto right" over Turkey's development plans. Consequently, Turkey maintains that the Convention does not apply to it and is therefore not legally binding (Akanda *et al*, 2007). Problems regarding sharing water might arise between Turkey, the Syrian Arab Republic and Iraq, since according to different scenarios full irrigation development by the countries in the Euphrates-Tigris river basins would lead to water shortages and solutions will have to be found at basin level through regional cooperation.

In 2002, a bilateral agreement between the Syrian Arab Republic and Iraq was signed concerning the installation of a Syrian pump station on the Tigris River for irrigation purposes. The quantity of water drawn annually from the Tigris River, when the flow of water is within the average, will be 1.25 km^3 with a drainage capacity proportional to the projected surface of 150 000 ha (FAO, 2002)

In April 2008, Turkey, the Syrian Arab Republic and Iraq decided to cooperate on water issues by establishing a water institute consisting of 18 water experts from each country to work towards the solution of water-related problems among the three countries. The institute will conduct its studies at the facilities of the Atatürk Dam, the biggest dam in Turkey, and plans to develop projects for the fair and effective use of transboundary water resources (Yavuz, 2008).

IRRIGATION AND DRAINAGE DEVELOPMENT

Evolution of irrigation development

The oldest and most deeply rooted hydraulic civilization of the world started in Mesopotamia, from which agricultural and agro-ecological systems developed that are strongly related to the presence of water. The history of irrigation started about 7 500 years ago when the Sumerians built a canal to irrigate wheat and barley in Mesopotamia.

Irrigation potential is estimated at over 5.55 million ha, of which 63 percent in the Tigris Basin, 35 percent in the Euphrates Basin, and 2 percent in the Shatt Al-Arab Basin. Considering the soil resources, it is estimated that about 6 million ha are classified as excellent, good or moderately suitable for flood irrigation. With the development of water storage facilities, the regulated flow has increased and significantly changed the irrigation potential, which was estimated at 4.25 million ha only in 1976. However, irrigation development depends to a large extent on the volume of water released by the upstream countries.

The total managed water area was estimated at 3.5 million ha in 1990, all of it equipped for full or partial control irrigation (Table 3). The areas irrigated by surface water were estimated at 3 305 000 ha, of which 105 000 ha (3 percent) in the Shatt Al-Arab River Basin, 2 200 000 ha (67 percent) in the Tigris River Basin, and 1 000 000 ha (30 percent) in the Euphrates River Basin. However, not all these areas are actually irrigated, since a large part has been abandoned due to waterlogging and salinity. The areas irrigated from groundwater were estimated at 220 000 ha in 1990, with some 18 000 wells (Figure 3). About 8 000 ha were reported to be equipped for localized irrigation, but these techniques were not used. Water use efficiency at the farm level is reported to be poor.

In 1997, the total irrigated area was estimated at 3.4 million ha, of which 87.5 percent obtained water from river diversion, 9.2 percent from rivers using irrigation pumps,

TABLE 3
Irrigation and drainage

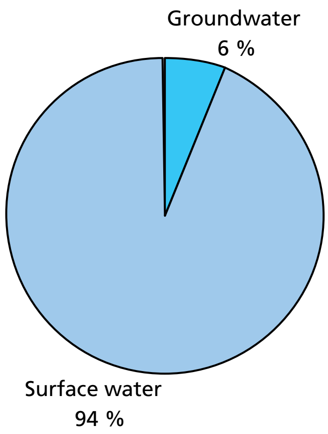
Irrigation potential	2007	5 554 000	ha
Irrigation			
1. Full or partial control irrigation: equipped area	1990	3 525 000	ha
- surface irrigation		-	ha
- sprinkler irrigation		-	ha
- localized irrigation	1994	8 000	ha
• % of area irrigated from surface water	1990	93.8	%
• % of area irrigated from groundwater	1990	6.2	%
• % 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	1997	3 404 000	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)	**1990**	**3 525 000**	**ha**
• as % of cultivated area	1990	59	%
• % of total area equipped for irrigation actually irrigated		-	%
• average increase per year over the last ... years		-	%
• power irrigated area as % of total area equipped		-	%
4. Non-equipped cultivated wetlands and inland valley bottoms		-	ha
5. Non-equipped flood recession cropping area		-	ha
Total water-managed area (1+2+3+4+5)	**1990**	**3 525 000**	**ha**
• as % of cultivated area	1990	59	%
Full or partial control irrigation schemes **Criteria**			
Small-scale schemes < ha		-	ha
Medium-scale schemes		-	ha
large-scale schemes > ha		-	ha
Total number of households in irrigation		-	
Irrigated crops in full or partial control irrigation schemes			
Total irrigated grain production		-	metric tons
• as % of total grain production		-	%
Harvested crops			
Total harvested irrigated cropped area	1998	2 428 000	ha
Annual crops: total	1998	2 068 000	ha
- Wheat	1998	717 000	ha
- Rice	1998	126 000	ha
- Barley	1998	785 000	ha
- Maize	1998	60 000	ha
- Millet	1998	3 000	ha
- Sorghum	1998	3 000	ha
- Other cereals	1998	1 000	ha
- Potatoes	1998	26 000	ha
- Pulses	1998	26 000	ha
- Vegetables	1998	226 000	ha
- Tobacco	1998	2 000	ha
- Cotton	1998	19 000	ha
- Soybean	1998	1 000	ha
- Sunflower	1998	49 000	ha
- Sesame	1998	23 000	ha
- Other annual crops	1998	1 000	ha
Permanent crops: total	1998	360 000	ha
- Sugar cane	1998	3 000	ha
- Citrus	1998	72 000	ha
- Other perennial crops	1998	285 000	ha
Irrigated cropping intensity (on full/partial control area actually irrigated)	1998	71	%

TABLE 3
Irrigation and drainage (continued)

Drainage - Environment		
Total drained area	-	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

3.1 percent from artesian wells and 1.2 percent from spring sources (FAO, 2003).

FIGURE 3
Source of irrigation water
Total: 3 525 000 ha in 1990



In December 1983 the first 87 500 ha stage of the massive Kirkuk Irrigation Project (renamed Saddam) was opened, of which more than 300 000 ha were eventually irrigated. In 1991 a large supplemental irrigation project, the North Al-Jazeera Irrigation Project, was launched in order to serve some 60 000 ha using a linear-move sprinkler irrigation system with water stored by the Mosul Dam (former Saddam Dam). Another irrigation project, the East Al-Jazeera Irrigation Project, involved the installation of irrigation networks on more than 70 000 ha of rainfed land near Mosul. These projects were part of a scheme to irrigate 250 000 ha of the Al-Jazeera plain. To the south of Baghdad, completed land reclamation schemes included Lower Khalis, Diwaniya-Dalmaj, Ishaqi, Dujaila and much of Abu Ghraib. The massive Dujaila project was intended to produce about 22 percent of Iraq's output of crop and animal products. Consultants have designed irrigation schemes for Kifl-Shinafiya, East Gharraf, Saba Nissan, New Rumaitha, Zubair, Bastora, Greater Musayyib and Makhmour. The project's main outfall canal, completed in December 1992, is known as the "Third River". It runs for 565 km from Mahmudiya, south of Baghdad, to Qurnah, north of Basra, and carries saline water to an outlet on the Gulf (Taylor & Francis Group, 2002).

More recently, a new development project on the "Dissemination of improved irrigation technologies" was introduced to increase wheat production. The target was to plant up to 0.5 million ha of wheat under supplemental irrigation by the year 2007. Currently, there are about 3 500 new farms in Mosul Province under supplemental irrigation, with an average size of holding of 25 ha per farm. Wheat is the major winter crop, covering 73 percent of the project area (ESCWA and ICARDA, 2003).

Role of irrigation in agricultural production, economy and society

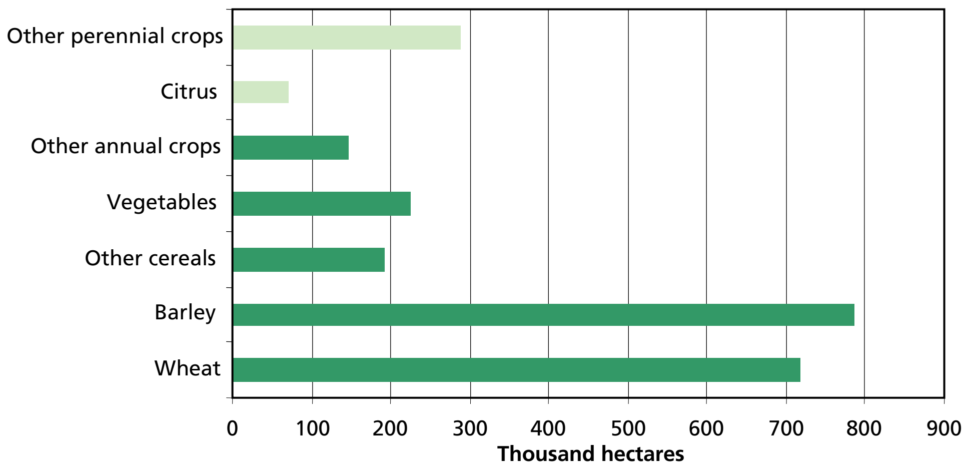
During the 1980s the State attempted to foster private sector investment in Iraq's agriculture. Oil revenues were used to acquire western technology and to lavish government subsidies on the sector. The government distributed high-yielding seeds and invested heavily in the irrigation infrastructure. The 1991 Gulf War resulted in significant damage to the irrigation and transportation infrastructure vital to Iraq's agricultural sector, but it is difficult to evaluate its extent or severity.

Between 75 and 85 percent of crop area is generally planted to grains (mostly wheat and barley). About one-third of Iraq's cereal production is produced under rainfed conditions in the foothills of the northwest in Iraqi-Kurdistan. Winter wheat and barley are planted in the fall (September–November) and harvested in the late spring (May–June). Yields on the rainfed crops are generally poor and vary significantly with rainfall amounts. The remaining two-thirds of Iraq's cereal production occur within the irrigated zone that runs along and between the Tigris and Euphrates rivers.

In 1991, there were 224 490 ha of irrigated wheat, with an average yield of 2.7 tons/ha, while the rainfed wheat area was estimated at 508 620 ha, with an average yield of 1.7 tons/ha. There were 200 770 ha of irrigated barley, with an average yield of 1.8 tons/ha, while the rainfed barley area was estimated at 323 730 ha, with an average yield of 1.3 tons/ha. In 1998 the total area planted with grain crops increased, giving 717 000 ha of irrigated wheat and 785 000 ha of irrigated barley (Table 3 and Figure 4). Other main irrigated crops are rice, maize, vegetables, sunflower, but also date and fruit trees, which are important for the economy of the southern part of the country. For the most part, a single crop is planted per year, although there is some multiple cropping of vegetables where irrigation water is available.

Record cropped areas were achieved in 1992 and again in 1993. However, agricultural productivity suffered from lack of fertilizers, agricultural machinery and the means of spraying planted areas with pesticides. Iraq's irrigation infrastructure fell into disrepair and salinity spread across much of the irrigated fields of central and southern Iraq. Moreover, a severe drought which persisted throughout much of the Middle East from 1999 through 2001 devastated crop output in Iraq. Cereal production in Iraq's rain-dependent northern zone was particularly hard hit, but even the irrigated production of the central and southern region suffered from diminished water availability (down to 43 percent of normal levels). As a result of the drought, Iraq's annual cereal production per capita plummeted from its already low 1999 level of 77 kg to only 39 kg by 2000. Shortage of fodder resulted in forced slaughter of sheep and compounded the impact

FIGURE 4
Irrigated crops
Total harvested area: 2 428 000 ha in 1998 (cropping intensity on equipped area actually irrigated: 71%)



of an outbreak of foot-and-mouth disease in 1998. An estimated one million head of livestock died due to lack of medicines (Schnepf, 2003).

Status and evolution of drainage systems

Throughout history the irrigated agriculture of Iraq's central and southern region has been menaced by salinization. Salinity was already recorded as a cause of crop yield reductions some 3 800 years ago. It spread across much of the irrigated fields as the Government ended its maintenance of the irrigation system. The water table of southern Iraq is saline and so close to the surface that it only takes a little injudicious over-irrigation to bring it up to root level and destroy the crop. High groundwater tables affect more than half of the irrigated land. Once severe salinization has occurred in soil, the rehabilitation process may take several years (Schnepf, 2003).

Half of the irrigated areas in central and southern Iraq were found to be degraded due to waterlogging and salinity in 1970. The absence of drainage facilities and, to a lesser extent, the irrigation practices (flooding) were the major causes of these problems. In 1978 a land rehabilitation programme was undertaken, comprising concrete lining for irrigation canals, and installation of field drains and collector drains. By 1989 a total of 700 000 ha had been reclaimed at a cost of around US$2 000/ha. According to more recent estimates 4 percent of the irrigated areas were severely saline, 50 percent medium saline and 20 percent slightly saline. Irrigation with highly saline waters (more than 1 500 ppm) has been practiced for date palm trees since 1977. The use of brackish groundwater is also reported for tomato irrigation in the south of the country.

Due to the relief and the sloping river beds the possibilities of draining the excess irrigation or flood water back to the rivers are few or none. A comprehensive network of sub-surface tile drains and surface drainage canals collects the drainage water from the agricultural fields and eliminates it through the Third River's main out-fall drain to the Shatt Al-Arab in an attempt to keep the irrigated lands free of salinization and waterlogging problems. Drainage water pumping stations are used to lift the effluent water to the main out-fall and onwards by gravity to the Gulf. Almost all land reclamation and development projects contain both irrigation and drainage components (FAO, 2003).

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

Institutions

Governance in Iraq is in a state of flux at present. The Ministry of Water Resources (MWR) is the bulk water supplier for the country and responsible for the whole national water planning, operating twenty-five major dams, hydropower stations and barrages and 275 irrigation pumping stations serving almost the entire irrigated area. The MWR comprises five commissions and eleven companies, employing 12 000 staff. Making the MWR functional again in the aftermath of the wars and collapse of the previous regime is a top priority and measures to achieve this are under way. Other key institutions related to water in Iraq include the Ministry of Agriculture, the Ministry of Energy, the Ministry of Municipalities and Public Works, the Ministry of Environment and other ministries and local governorates concerned with economic and human resources. Higher educational institutions could provide scientific support on water issues and potential human resources for the government. A few NGOs are springing up, such as the Iraq Foundation, which is dedicated to restoring the Mesopotamian marshlands (UNDG, 2005).

Policies and legislation

Water resources development and management plans were drawn up in the 1960s and 1980s. These studies included a comprehensive and detailed analysis of needs, opportunities and plans for the development and management of Iraq's water resources. Investments in water resources development over the years have generally followed the plans outlined in these documents. They have not been updated or revisited since their publication, but the population has grown substantially, much project development has taken place, multiple wars have been conducted, institutions and regimes have changed, and regional and world markets for products have become greatly altered (FAO, 2004).

A Law on Irrigation (No. 12 of 1995) and another on Environment (No. 3 of 1997) have been enacted (ESCWA, 2004).

ENVIRONMENT AND HEALTH

The present quality of water in the Tigris near the Syrian border is presumably good, including water originating in both Turkey and Iraq. Water quality degrades downstream, with major pollution inflows from urban areas such as Baghdad due to poor infrastructure for wastewater treatment. The water quality of the Euphrates entering Iraq is less than that of the Tigris, as it is currently affected by the return flow from irrigation projects in Turkey and the Syrian Arab Republic and is expected to get worse as more lands come under irrigation. The quality is further degraded as flood flows are diverted into off-stream storage in Tharthar and later returned to the river system. Salts in Tharthar are absorbed by the water stored there. The quality of water in both the Euphrates and Tigris is further degraded by return flows from land irrigated in Iraq as well as urban pollution. The amount and quality of water entering southern Iraq from Iranian territory is largely unknown, although it is clear that flows are impacted by irrigation return flow originating in the Islamic Republic of Iran (UNDG, 2005).

The deterioration of water quality and the heavy pollution from many sources are becoming serious threats to Iraq. One problem is the lack of any effective water monitoring network so that it is difficult to take measures to address water quality and pollution as it is impossible to identify the causes. Hence, the rehabilitation and reconstruction of the water monitoring network have becoming urgent to ensure water security.

The Mesopotamian Marshlands in the furthest downstream part of the Tigris and Euphrates Basin have been seriously damaged during the last two decades. Dewatering the marshland areas to foster agricultural production as well as to divert waters away from the marshes for political reasons has caused an adverse impact on the ecosystem and the indigenous populations. The historical marsh area of 17 000 km^2 has now shrunk to about 3 000 km^2 after construction of a number of dams upstream. The potential success of recent restoration efforts depends primarily on the availability of sufficient quantities of satisfactory quality water to the marshland areas.

The quantity and quality of water entering the Gulf is also an issue to be addressed since fisheries are an important food source for the region. Other environmental issues to be taken into account are the impact of water management and changed flow regimes on migrating fishes and terrestrial species and on the viability of riverine and floodplain ecosystems throughout the Tigris and Euphrates basins.

PROSPECTS FOR AGRICULTURAL WATER MANAGEMENT

The development of irrigation as planned in the upstream countries, particularly the southeastern Anatolian (GAP) project in Turkey and the irrigation projects in the Syrian Arab Republic and in the Islamic Republic of Iran on tributaries of the Tigris and on the Dez and Karun, will reduce Iraqi irrigation potential unless an agreement is reached on the sharing of waters between the riparian countries. The regulation capacities on the Euphrates River are already greater than the entire average flow.

It has been pointed out in many quarters that the Tigris and Euphrates rivers are complicated, both politically and hydrologically, and therefore there is need for cooperation among riparian countries to ensure water security and to prevent potential water-related disputes in the future. Iraq is at the furthest downstream point of the Tigris and Euphrates rivers and a large part of the country's water resources originate in Turkey; moreover, almost all of the flow of the Karkheh River that runs through the marshes in southern Iraq before joining the Tigris and Euphrates originates in Iranian territory.

It is thought that between 2020 and 2030 a shortage may arise in the Tigris and Euphrates owing to growing demand in the riparian countries and that an emergency situation will develop already around 2020 because the expected annual 4 km^3 of water remaining as surplus in the two rivers will not be sufficient for the drainage of the Tigris and Euphrates Basin into the sea. Since water shortages are forecast to occur with the development of irrigation, solutions have to be found for an integrated basin-level planning of water resources development.

Undertaking improvement in water management in Iraq will require substantial investment, which must, at least initially, come from outside sources. Needs and opportunities for water-related investments must be identified and prioritized, costs estimated, economic feasibility determined, and financing and repayment plans prepared.

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