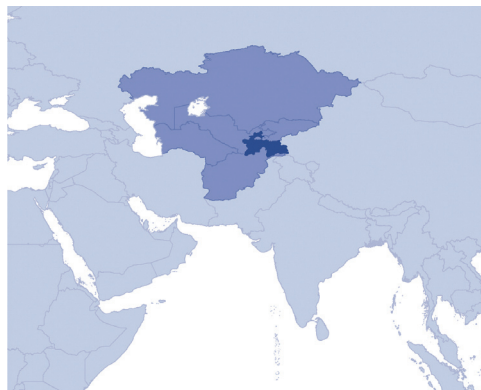


# Tajikistan



## GEOGRAPHY, CLIMATE AND POPULATION

### Geography

Tajikistan is a mountainous, landlocked country in southeastern Central Asia. It has a total area of about 142 550 km<sup>2</sup> (Table 1). It is bordered in the west and northwest by Uzbekistan (910 km borderline), in the northeast by the Kyrgyzstan (630 km), in the east by China (430 km) and in the south by Afghanistan (1 030 km). The country became independent in September 1991. The mountainous landscape covers 93 percent of the country. Administratively, the country is divided into four provinces: Badakhshan (64 200 km<sup>2</sup>), Khatlon (24 800 km<sup>2</sup>), Sughd (25 400 km<sup>2</sup>) and Regions (*Raions*) of Republican Subordination (28 154 km<sup>2</sup>).

The north Sughd and east Badakhshan regions are separated by high mountain ranges and are often isolated from the centre and south during winter. The Fergana valley, which is a major agricultural area, covers part of the north. A few valleys in the centre are between several mountain chains; most of the country is over 3 000 m above sea level. In the east are the Pamir mountains, which form part of the Himalayan mountain chain and are among the highest and most inaccessible mountains in the world. The highest mountain in the country, as well as in the Former Soviet Union (FSU), is the Ismoil Somoni peak, which rises to 7 495 m. Tunnels are being constructed through two mountain ranges to connect the capital Dushanbe with north Sughd province and China to the east of the Pamir mountains. A bridge, built over the Panj (upstream Amu Darya) river in the south connects the country with Afghanistan.

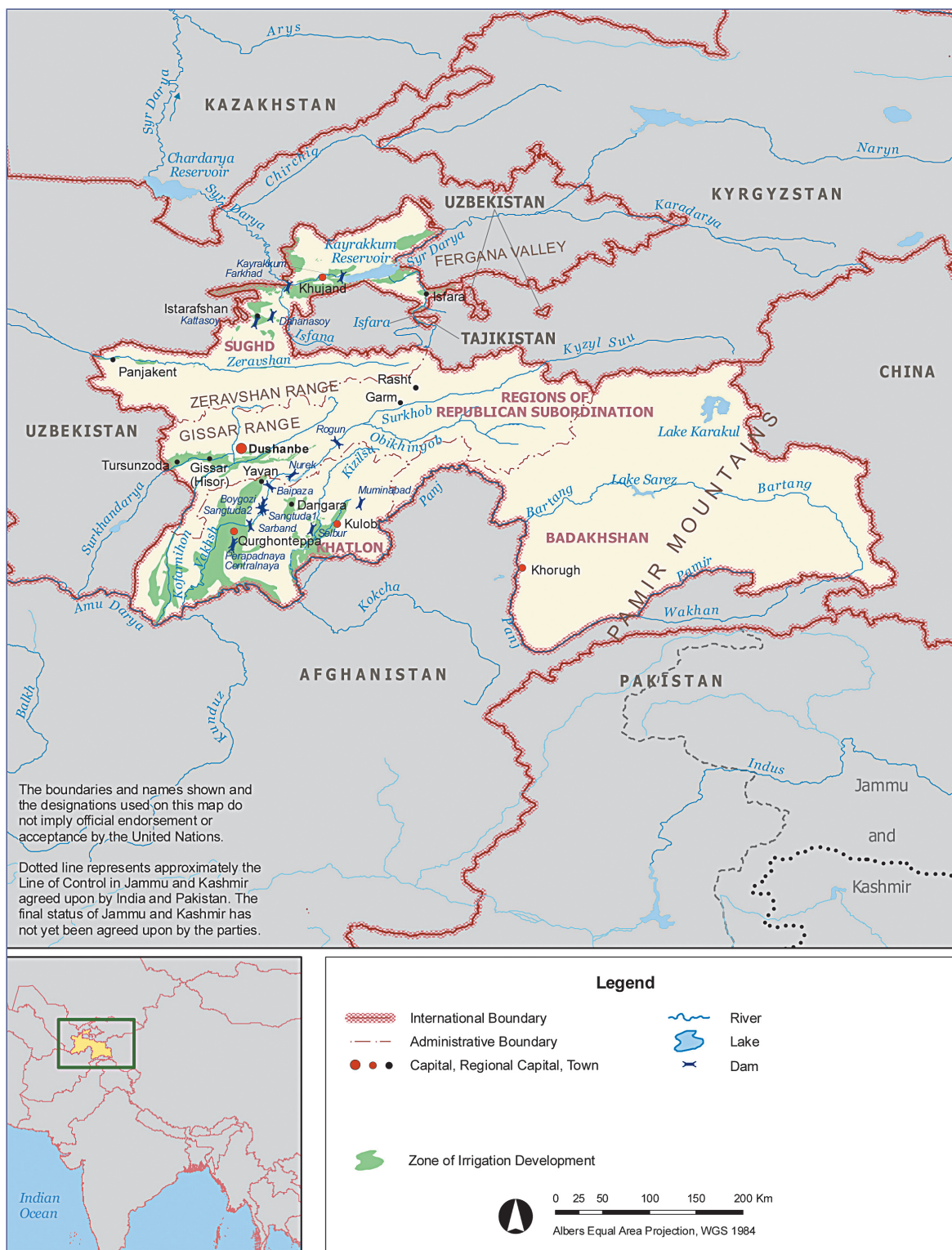
In 2009, total cultivated area was an estimated 875 000 ha. About 742 000 ha under temporary crops and 133 000 ha permanent.

### Climate

The climate is continental, but the country's mountainous terrain gives rise to wide variations. In areas cultivation takes place, mainly on the river floodplains, the climate is hot and dry in summer and mild and warm in winter. Average annual precipitation is 691 mm, ranging from less than 100 mm in the southeast and up to 2 400 mm on the Fedchenko glacier in the centre. Precipitation occurs during the winter, between September and April. Average temperature is 16–17 °C and absolute maximum temperature recorded is 48 °C in July; absolute minimum is minus 49 °C in January. The daily temperature is about 7 °C in winter and 18 °C in summer. Evapotranspiration varies from 300 mm/year to 1 200 mm/year, for stony soils and can be as much as 1 500 mm/year.

### Population

Total population in 2011 was an estimated 7 million inhabitants, of which 74 percent rural. During the period 2001–2011, the annual population growth rate was an estimated 1.1 percent, while during the 1980s it was 3.3 percent. The main reasons for the decline were emigration and lower birth rates as a result of deteriorating socio-economic conditions. The population density is about 49 inhabitants/km<sup>2</sup>, ranging from three inhabitants/km<sup>2</sup> in the southeast to



TAJIKISTAN

FAO - AQUASTAT, 2012

**Disclaimer**  
The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Food and Agriculture Organization of the United Nations concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries.

TABLE 1  
Basic statistics and population

Physical areas			
Area of the country	2009	14 255 000	ha
Cultivated area (arable land and area under permanent crops)	2009	875 000	ha
• as % of the total area of the country	2009	6	%
• arable land (temporary crops + temp fallow + temp meadows)	2009	742 000	ha
• area under permanent crops	2009	133 000	ha
Population			
Total population	2011	6 977 000	inhabitants
• of which rural	2011	74	%
Population density	2011	49	inhabitants/km <sup>2</sup>
Economically active population	2011	2 901 000	inhabitants
• as % of total population	2011	42	%
• female	2011	47	%
• male	2011	53	%
Population economically active in agriculture	2011	778 000	inhabitants
• as % of total economically active population	2011	27	%
• female	2011	53	%
• male	2011	47	%
Economy and development			
Gross Domestic Product (GDP) (current US\$)	2010	5 640	million US\$/yr
• value added in agriculture (% of GDP)	2010	21	%
• GDP per capita	2010	820	US\$/yr
Human Development Index (highest = 1)	2011	0.607	
Access to improved drinking water sources			
Total population	2010	64	%
Urban population	2010	92	%
Rural population	2010	54	%

186–243 inhabitants/km<sup>2</sup> in the districts around Dushanbe; 221–359 inhabitants/km<sup>2</sup> in the districts around Qurghonteppa and 223–377 inhabitants/km<sup>2</sup> in the districts around Khujand.

In 2010, 64 percent of the population had access to improved water sources (92 and 54 percent in urban and rural areas respectively). Sanitation coverage accounted for 94 percent (95 and 94 percent in urban and rural areas respectively).

## ECONOMY, AGRICULTURE AND FOOD SECURITY

In 2010, Tajikistan's gross domestic product (GDP) was US\$5 640 million of which the agriculture sector accounted for 21 percent (Table 1).

In 2011, the total economically active population was 2.9 million, or 42 percent of the total population. The economically active population in agriculture was an estimated 0.8 million (27 percent of total active population), of which 53 percent is female.

According to the World Bank poverty assessment, the poverty rate decreased from 82 percent in 1999 to 64 percent in 2003. Over the past two decades, unemployment has become a problem, aggravated by the world financial crisis. More than 600 000 Tajiks work in other countries, mainly in the Russian Federation.

Tajikistan cities import about 50 percent of wheat, meat, milk, eggs, fruit including melons and watermelons. The main reason is lack of irrigated land, and another is under-developed

agricultural production. The main export goods are aluminum and cotton. In 2008, the export of cotton fibre fell by 30 percent as compared to 2007.

About 95 percent of crop production is from irrigated land. Rainfed agriculture in arid Tajikistan is not guaranteed because of low precipitation. Rainfed land is used to grow cereals and for pastures. Cereal yields on irrigated areas are 2–3 times higher than on rainfed land.

Climate conditions allow for cultivation of a wide variety of crops, such as cereals, legumes, vegetables, orchards (apricots, grapes, apples, pears, pomegranates, figs, walnuts, pistachio, peaches, cherries, plums, cucurbitaceous, citrus), watermelons, melons, pumpkins, non-food crops (cotton, including fine fibre, tobacco, geranium), medicinal herbs.

## WATER RESOURCES AND USE

### Water resources

Tajikistan can be divided into four major river basin groups (Table 2):

1. Amu Darya river basin: About 76 percent of the flow of the Amu Darya river is generated in Tajikistan. The Panj river, the largest tributary of the Amu Darya river originates in the Pamir mountainous ranges and forms the border between Tajikistan and Afghanistan for almost its entire length flowing from east to west. The Bartang river is the first large tributary of the Panj river. Before the confluence with the Vakhsh river, the annual average flow of the Panj river is 33.4 km<sup>3</sup>/year. During the Soviet era, based on an agreement in 1946, entitled Afghanistan use of up to 9 km<sup>3</sup>/year of water from the Panj river. The Vakhsh river is the largest river in Tajikistan, crossing the country from the northeast to the southwest. Originating in Kyrgyzstan, where it is called the Kyzyl Suu river, it enters Tajikistan, where it is called the Surkhob river. After the confluence of the Surkhob and Obikhingob rivers, it becomes the Vakhsh river. Its catchment area lies in the highest part of Tajikistan, at over 3 500 m. After the confluence of the Vakhsh and Panj rivers, at the border with Afghanistan, it becomes the Amu Darya river. The Kofarnihon river is another large tributary of the Amu Darya river. Originating in Tajikistan, it becomes the border between Tajikistan and Uzbekistan for several tens of kilometres, then it re-enters Tajikistan, after which it flows into the Amu Darya river, which is about 36 km downstream of the confluence

TABLE 2

Renewable surface water resources (RSWR) by river basin in Tajikistan

River basin	Part of total area of the country	Internal RSWR	Inflow			Outflow			Actual RSWR
			Total	Secured by agreements		Total	Secured by agreements		
			km <sup>3</sup> /year	From:		km <sup>3</sup> /year	To:		
Amu Darya (including Surkhandarya and Zeravshan, which join further downstream)	88	59.45	1.93	1.51	Kyrgyzstan	61.38 <sup>b</sup>	22.00 21.32 <sup>c</sup>	Uzbekistan Turkmenistan (through Uzb.)	17.64
Syr Darya	11	1.01	32.26 <sup>a</sup>	11.80	Uzbekistan	33.27 <sup>d</sup>	11.54	Uzbekistan	1.27
Northeast	1	-		-			-	China	-
Total	100	60.46	34.19	13.31		94.65	54.86		18.91

a Equal to the flow from Kyrgyzstan through Uzbekistan (27.42) and flow from Uzbekistan (4.84=IRSWR Uzbekistan)

b Equal to IRSWR (59.45) and inflow from Kyrgyzstan (1.93)

c Share for Turkmenistan is 22, including the IRSWR of Turkmenistan (0.68). Therefore secured is 21.32 (=22.00-0.68)

d Equal to IRSWR (1.01) and inflow from Kyrgyzstan through Uzbekistan (27.42) and inflow from Uzbekistan (4.84)

of the Panj and Vakhsh rivers, at the border between Tajikistan and Afghanistan. About 65 km further downstream, the Amu Darya leaves the Tajikistan border to become the border between Afghanistan and Uzbekistan. The Surkhandarya river also originates in Tajikistan, then enters Uzbekistan and joins the Amu Darya river at the border between Uzbekistan and Afghanistan. The Zeravshan river originates between the mountain ranges of Zeravshan and Gissar in Tajikistan, and the total flow generated within Tajikistan is an estimated 3.09 km<sup>3</sup>/year. The river then enters Uzbekistan and joins the Amu Darya river at the border between Uzbekistan and Turkmenistan. However, while the Zeravshan river was once the largest tributary of the Amu Darya river, before it began to be tapped to irrigate land in Uzbekistan, the flow no longer reaches the city of Bukhara in Uzbekistan. Total water generated within Tajikistan in the Amu Darya river basin is an estimated 59.45 km<sup>3</sup>/year.

2. Syr Darya river basin: The northwest of the country forms part of the Syr Darya basin. Only 1 percent of the total flow of the Syr Darya river is generated within Tajikistan by the shallow rivers Khodzhabakirgan, Isfara and Isfana, with a total flow of 1.01 km<sup>3</sup>/year.
3. In the extreme northeast of the country a small river, the Marcansy, drains towards China. No figures on flows are available.
4. Small closed basins: There are a few small closed basins, such as those formed by the small Kattasoy and Basmandasoy rivers, but the annual flow is negligible compared to the total renewable flow generated in Tajikistan.

Total internal renewable surface water resources (IRSWR) are an estimated 60.46 km<sup>3</sup>/year (Table 2). During the Soviet period, water resources were shared among the five Central Asia republics based on master plans for water resources development in the Amu Darya and Syr Darya river basins. With the establishment of the Interstate Commission for Water Coordination (ICWC) in 1992, the newly independent states prepared a regional water strategy (Agreement of 18 February 1992), but continued to respect existing principles until the adoption of a new water-sharing agreement. Surface water resources allocated to Tajikistan are thus calculated every year, depending on existing flows. On average, however, incoming surface water resources that are available to Tajikistan are thought to be 13.31 km<sup>3</sup>/year (1.51 Amu Darya and 11.8 Syr Darya). Considering an outflow of 54.86 km<sup>3</sup>/year, secured by agreements, this means that the total renewable surface water resources (TRSWR) for Tajikistan are 18.91 km<sup>3</sup>/year (60.46+13.31-54.86) (Table 2).

Internally generated renewable groundwater resources are an estimated 6 km<sup>3</sup>/year, of which 3 km<sup>3</sup>/year overlap with surface water resources. In 1999, the portion of groundwater resources for which abstraction equipment exists was an estimated 2.2 km<sup>3</sup>/year.

Tajikistan's total actual renewable water resources (TARWR) may thus be estimated at 21.91 km<sup>3</sup>/year (Table 2 and Table 3).

In 1994, the return flow within Tajikistan amounted to 4.36 km<sup>3</sup>/year, including 3.78 km<sup>3</sup>/year of collector-drainage flow from irrigation and about 0.58 km<sup>3</sup>/year of municipal and industrial wastewater. The main portion of the return flow, about 3.94 km<sup>3</sup>/year, flowed back to rivers, of which 2.85 km<sup>3</sup> into the Amu Darya river and 1.09 km<sup>3</sup> into the Syr Darya river. Around 0.35 km<sup>3</sup>/year (8 percent of total return water) were directly used for irrigation. The remaining 0.06 km<sup>3</sup>/year of return flow were directed to natural depressions. Since 2000, the average return flow has decreased to 3.5 km<sup>3</sup>/year, because water intake from rivers for irrigation and other water sector needs has been reduced. The main portion of the return flow, about 3 km<sup>3</sup>/year, flows back to the Amu Darya and Syr Darya rivers. Around 0.3 km<sup>3</sup>/year is directly reused for irrigation. In 2008, wastewater produced accounted for 92 million m<sup>3</sup> of which 89 million m<sup>3</sup> were treated.

There are 1 300 natural lakes in Tajikistan with a total water surface area of 705 km<sup>2</sup> and a total capacity of about 50 km<sup>3</sup>. About 78 percent of the lakes are in the mountain area over 3 500 m



TABLE 3

**Water: sources and use**

<b>Renewable freshwater resources</b>			
Precipitation (long-term average)	-	691	mm/yr
	-	98 500	million m <sup>3</sup> /yr
Internal renewable water resources (long-term average)	-	63 460	million m <sup>3</sup> /yr
Total actual renewable water resources	-	21 910	million m <sup>3</sup> /yr
Dependency ratio	-	17.3	%
Total actual renewable water resources per inhabitant	2011	3 140	m <sup>3</sup> /yr
Total dam capacity	2010	29 500	million m <sup>3</sup>
<b>Water withdrawal</b>			
Total water withdrawal by sector	2006	11 496	million m <sup>3</sup> /yr
- agriculture	2006	10 441	million m <sup>3</sup> /yr
- municipalities	2006	647	million m <sup>3</sup> /yr
- industry	2006	408	million m <sup>3</sup> /yr
• per inhabitant	2006	1 762	m <sup>3</sup> /yr
Surface water and groundwater withdrawal (primary and secondary)	2006	11 196	million m <sup>3</sup> /yr
• as % of total actual renewable water resources	2006	51	%
<b>Non-conventional sources of water</b>			
Produced municipal wastewater	2008	92	million m <sup>3</sup> /yr
Treated municipal wastewater	2008	89	million m <sup>3</sup> /yr
Direct use of treated municipal wastewater		-	million m <sup>3</sup> /yr
Desalinated water produced		-	million m <sup>3</sup> /yr
Direct use of agricultural drainage water	2000	300	million m <sup>3</sup> /yr

above sea level. The largest lake in the country, lake Karakul, is in the northeast at 3 914 m, with a surface area of 380 km<sup>2</sup> and a volume of 26.5 km<sup>3</sup>. Sarez lake with 86.5 km<sup>2</sup> surface area and a volume of 17.5 km<sup>3</sup> is the second largest lake.

Water regulation is implemented by hundreds of hydraulic headworks, canals, pump stations and reservoirs. Reservoirs play the main role in water regulation for Tajikistan and downstream countries.

In 2010, there were 17 dams: 4 in the Syr Darya river basin and 13 in the Amu Darya river basin, of which 8 on the Vakhsh river, 2 on the Panj river and 3 on the Kofarnihon river. Their total reservoir capacity is about 29.5 km<sup>3</sup>

Ten reservoirs have a capacity of more than 10 million m<sup>3</sup> each and their total capacity is 29 km<sup>3</sup>. The largest reservoirs are: Nurek on the Vakhsh river (10.5 km<sup>3</sup>), Kayrakkum on the Syr Darya river (4.16 km<sup>3</sup>), Farhod on the Syr Darya river (350 million m<sup>3</sup>), Boygozi on the Vakhsh river (125 million m<sup>3</sup>), Kattasoy on the Kattasoy river (55 million m<sup>3</sup>), Muminabad on the Obi Surkh river (31 million m<sup>3</sup>), Dahanasoy on the Dahanasoy river (28 million m<sup>3</sup>) and Sangtuda 1 on the Vakhsh river (25 million m<sup>3</sup>). Sangtuda 2 reservoir (5 million m<sup>3</sup>) on the Vakhsh river was inaugurated in 2011. The Nurek headwork incorporates a unique rock-filled dam with a central core, 310 m high a power plant with a capacity of 3 000 MW. Nurek and Kayrakkum reservoirs hold water for irrigation in Uzbekistan, Turkmenistan and Kazakhstan. Rogun reservoir on the Vakhsh river (13.3 km<sup>3</sup>) is under construction the first phase of construction was finished in 2012.

The gross theoretical hydropower potential is an estimated 527 000 Gwh/ year, about half of which would be economically feasible. In 1994, the total installed capacity was about 4 GWh,

generating about 98 percent of the country's electricity. In 1999, Tajikistan ranked third in the world for hydropower development, after the United States and the Russian Federation.

### International water issues

The main rivers in Tajikistan are classified as transboundary, because they cross the boundaries of two countries (Vakhsh, Panj, Kofarnihon and Zeravshan rivers) or four countries (Amu Darya, Syr Darya). The supply of water for irrigation suffers difficulties only in drought years.

During the Soviet era, sharing of water resources among the five Central Asia republics was based on the master plans for the development of water resources in the Amu Darya (1987) and Syr Darya (1984) river basins. A regional water strategy was prepared with the establishment of the ICWC in 1992, by the newly independent states (Agreement of 18 February 1992). Existing principles continue to be respected until the implementation of a new water-sharing agreement. The agreement included the construction of Kambarata 1 reservoir in Kyrgyzstan and Rogun reservoir in Tajikistan. The new agreement 'Agreement on joint actions to address the problem of the Aral Sea and socio-economic development of the Aral Sea basin', was signed by the Heads of the five states in 1996.

Over the years, the main achievement of the ICWC has been the conflict-free supply of water to all water users, despite the complexities and variations of dry and wet years. The ICWC meets twice annually to set surface water withdrawal quotes, taking into account the main rivers water flow prognosis for the October–March and April–September seasons. For Tajikistan the Ministry of Land Reclamation and Water Resources (MLRWR) participates in the ICWC meetings and takes decisions at the interstate level concerning management of the Amu Darya and Syr Darya rivers water resources.

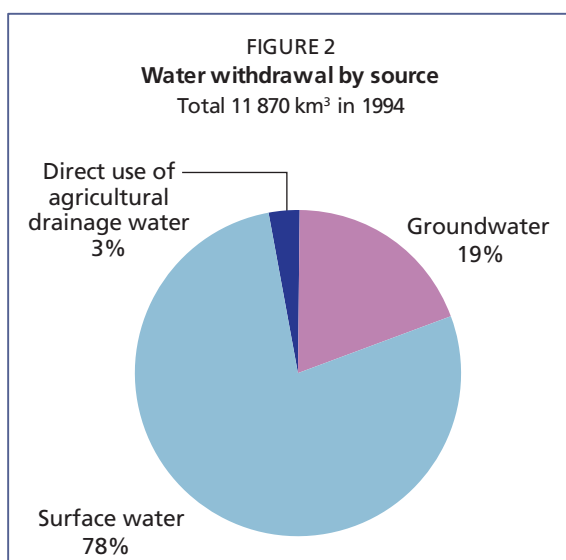
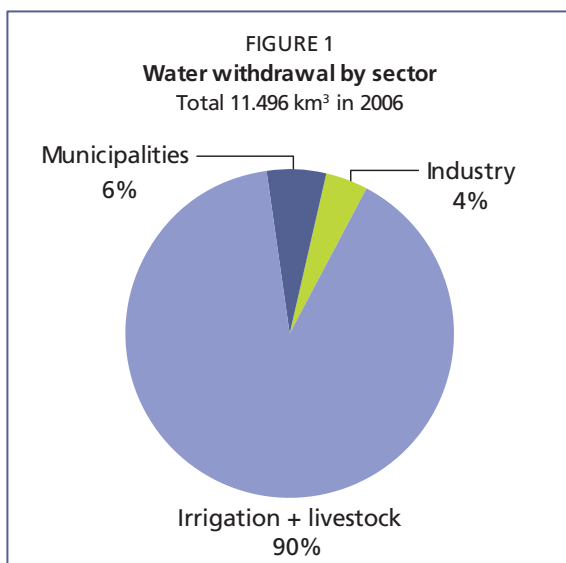
Uzbekistan is not in agreement regarding construction of reservoirs in the mountain areas of Tajikistan and Kyrgyzstan. Disputes between Tajikistan and Uzbekistan regard the management of the Kayrakkum reservoir in Tajikistan (UNDP, 2004). Tajikistan and Kyrgyzstan state that the reduction of the Aral Sea is caused mainly by inefficient water use for irrigation (<30 percent). Afghanistan has notified that it plans to develop irrigation and hydropower in the Amu Darya river basin.

In 1993, with the development of the Aral Sea basin programme, two new organizations emerged: the Interstate Council for the Aral Sea (ICAS) to coordinate implementation of the programme and the International Fund for Saving the Aral Sea (IFAS) to raise and manage its funds. In 1997, the two organizations merged to create IFAS (UNDP, 2004).

The partnership between the European Union Water Initiative (EUWI) and its Eastern Europe, Caucasus and Central Asia (EECCA) programme seeks to improve the management of water resources in the EECCA region. The partnership was established between the European Union and the EECCA countries at the World Summit for Sustainable Development in 2002. A significant component is the 'Integrated water resources management, including transboundary river basin management and regional seas issues' (SIWI, 2010).

In 2002, Central Asian countries and the Caucasus formed the CACENA Regional Water Partnership under the Global Water Partnership (GWP). Within this framework, state departments, local and regional organizations, professional organizations, scientific and research institutes and the private sector and NGOs cooperate to establish a common understanding of the critical issues threatening water security in the region (SIWI, 2010).

In 2004, experts from Kazakhstan, Kyrgyzstan, Tajikistan and Uzbekistan produced a regional water and energy strategy within the framework of the United Nations Special Programme for



the Economies of Central Asia (UN-SPECA). In collaboration with the EUWI and the UNECE is developing integrated water resources management in the Central Asian States. In cooperation with Germany and other EU countries, UNECE may play a role in the implementation of the EU Strategy for Central Asia in the water and energy sectors (SIWI, 2010).

### Water use

On average, annual water withdrawal for the monitoring period 1985–2008 was 10.0–14.5 km<sup>3</sup>/year. In 2006, total water withdrawal was an estimated 11.5 km<sup>3</sup>, of which 91 percent for agricultural, 6 percent for municipal use and 3 percent for industry (Figure 1 and Table 3). The volume of water used to fill fishponds (aquaculture) 2005–2009 was approximately 55 million m<sup>3</sup>/year (State Unitary Department ‘Mohiyi Tojikiston’, 2009). For hydropower about 32–34 km<sup>3</sup>/year of water flows through turbines.

In 1994, total water withdrawal was an estimated 11.9 km<sup>3</sup> (92 percent for agricultural purposes), of which 9.26 km<sup>3</sup> (78 percent) was surface water, 2.26 km<sup>3</sup> (19 percent) groundwater and an estimated 0.35 km<sup>3</sup> (3 percent) direct use of collector-drainage water and wastewater for irrigation (Figure 2). Groundwater is mostly withdrawn by industry.

## IRRIGATION AND DRAINAGE DEVELOPMENT

### Evolution of irrigation development

Irrigation in Tajikistan is important for the development of agriculture and the national economy. Large-scale irrigation development in southern Tajikistan started in 1931 with the construction of the Vakhsh main canal in the Vakhsh valley. This canal is 11.7 km long with a capacity of 150 m<sup>3</sup>/s, diverting water from the Vakhsh river for the irrigation of 120 000 ha. The Vakhsh main canal was later reconstructed, its capacity increased to 200 m<sup>3</sup>/s and the canal extended to irrigate the Akgazy plateau.

During the Soviet era, significant irrigation development took place in the Kofarnihon river basin, in southern Tajikistan. Together with Uzbekistan, Tajikistan built the Large Gissar canal in 1940, which carries water from the Kofarnihon river to the Surkhandarya river basin in Uzbekistan. In 1994, the irrigated area in the Kofarnihon river basin in Tajikistan was about 29 000 ha.

Further irrigation development in southern Tajikistan took place with the construction of the Nurek and Baipaza dams on the Vakhsh river. Water is provided through a 13.7 km irrigation tunnel to irrigate 76 000 ha in the Dangara valley. In the Vakhsh basin, a large irrigation system (40 000 ha), located in the Yavan and Obikiik valleys, which is extremely short of water, is supplied with water from the Baipaza reservoir through a 7.3 km long tunnel.



Recently, the irrigation potential area has been estimated as 1.58 million ha, which is about 11 percent of the total area of the country. In 1960, the total area equipped for irrigation was an estimated 408 000 ha. In 1994 it was 719 200 ha, which was 74 percent of the total cultivated area. About 33 percent of the total irrigated area (240 200 ha) is in the Syr Darya river basin and 67 percent (479 000 ha) in the Amu Darya river basin, of which 20 000 ha in the Zeravshan basin, 49 000 ha in the Kofarnihon basin, 18 000 ha in the Panj basin and 392 000 ha in the Vakhsh basin. In 2009, total area equipped for irrigation was 742 051 ha (Table 4). The area equipped for irrigation is mainly in north Sughd (Syr Darya basin), 282 374 ha, and south Khatlon (Amu Darya basin), 336 158 ha. Because of the lack of investment the country annually develops only 700–1 200 ha, which is around ten times less than necessary according to the ‘Water sector development strategy for 2010–2025’ (MLRWR and OSCE, 2009). In 2008, the area actually irrigated was an estimated 674 416 ha, or approximately 91 percent of the equipped area.

In northern Tajikistan, where irrigation is mainly based on the water resources of the Syr Darya river, water is (80 percent) delivered by pumping stations. The Tajik part of the Hunger steppe is bordered in the northwest by Uzbekistan. This region belongs to a semi-arid zone and the irrigated area is about 39 000 ha and mainly used for cotton. Water is taken from the Farkhad power plant diversion canal in two stages by remote-controlled pumping stations, which lift the water to 170 m. In 1994, the total power irrigated area was an estimated 318 000 ha.

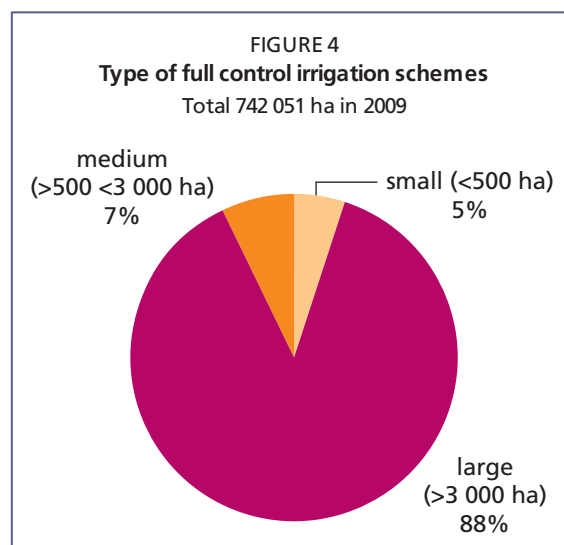
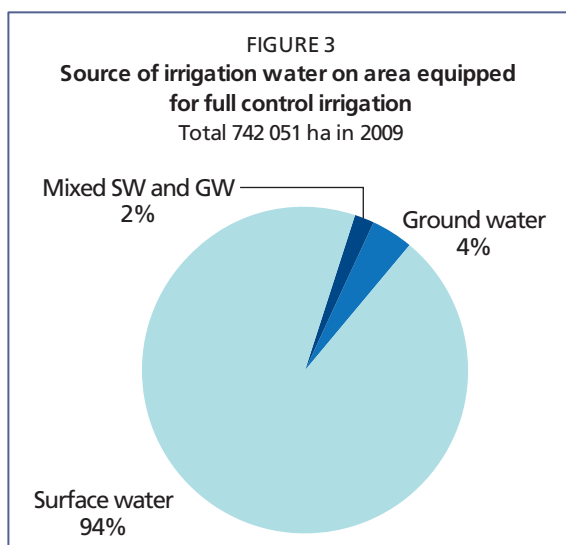
Surface irrigation is the only irrigation technique used in Tajikistan. Drip, sprinkler and micro-sprinkler irrigation technologies have been used in a small area only at the experimental level. It is expected, however, that increased power tariffs will accelerate the spread of modern and water-saving technologies in pump-fed irrigation areas. In 1994, furrow irrigation was practised on over 96.3 percent of the equipped area and borderstrip irrigation on about 1.7 percent. On hill slopes the irrigation delivery network for gardens and grapes was comprised of pipes (2 percent). The irrigation technique used on fields is also surface irrigation. Cascade irrigation is practised on around 14 000 ha for rice cultivation.

All irrigation is full control irrigation. In 1994, out of a total area equipped for irrigation 719 200 ha, about 68 000 ha (or 9.4 percent) were irrigated with groundwater and about 25 000 ha (3.5 percent) agricultural drainage water and wastewater was used. Water pumped from rivers provided some 250 000 ha (34.8 percent); elsewhere water was gravity fed from river diversions (24.5 percent) or reservoirs (27.8).

In 2009, surface water irrigated about 696 476 ha (or 93.9 percent of total full control irrigation area), groundwater about 32 500 ha (4.4 percent) and about 13 075 ha (1.8 percent) mixed surface water and groundwater (Figure 3) was used. Monitoring of direct use of agricultural drainage water and treated wastewater is difficult. Water pumped from rivers irrigates 298 500 ha.

In 1994, the total length of the irrigation canal network was about 33 250 km. The length of the main canals and the inter-farm network was 27 991 km, of which 38 percent were concrete canals. On-farm canal networks totalled 5 259 km, with 13.3 percent concrete canals, 21.9 percent pipes and the remaining 64.8 percent unlined earthen canals. Water losses between the source and the fields depend on canal conditions and vary from 50 to 65 percent; field water use efficiency varies from 55 to 70 percent. Total water use efficiency ranges from 27 to 46 percent.

In Tajikistan, as with other Central Asia countries, large-scale irrigation schemes prevail. Large-scale schemes (>3 000 ha) cover 652 000 ha (88 percent), medium-scale irrigation schemes (500–3 000 ha) cover 50 000 ha (7 percent) and small-scale schemes (<500 ha) in mountainous areas, cover the remaining 40 000 ha (5 percent) (Figure 4). In 2009, approximately 62 percent of farms were privatized, 16 percent were family farms and 22 percent public.



### Role of irrigation in agricultural production, economy and society

In 2009, total harvested irrigated cropped area was an estimated 729 283 ha. The main irrigated crop in Tajikistan is cotton, accounting for 237 130 ha or 33 percent of total irrigated harvested area. Around one million rural people are involved in cotton production and processing. The area has decreased since 1990, when it accounted for 300 000 ha. During the Soviet era, Tajikistan had the highest cotton yield in Central Asia, with a national average yield of 3 tonnes/ha. During the last 5 years, however, the yield barely achieves 1.6–1.7 tonnes/ha. The second largest area is irrigated wheat with 179 742 ha (25 percent). After harvesting of wheat in June–July, farmers sow maize for forage, vegetables and legumes as a second crop. In the mountainous Badakhshan region, and other districts over 1 500 m, wheat harvesting months are July and August. Temporary and permanent fodder and permanent meadows and pastures account for 83 234 ha or 11 percent of the harvested irrigated cropped area, vegetables represent 37 162 ha (5 percent) and other perennial crops 98 957 ha (14 percent) (Figure 5 and Table 4). Cotton, fruits and grapes were the most important export crops during the 1990s.

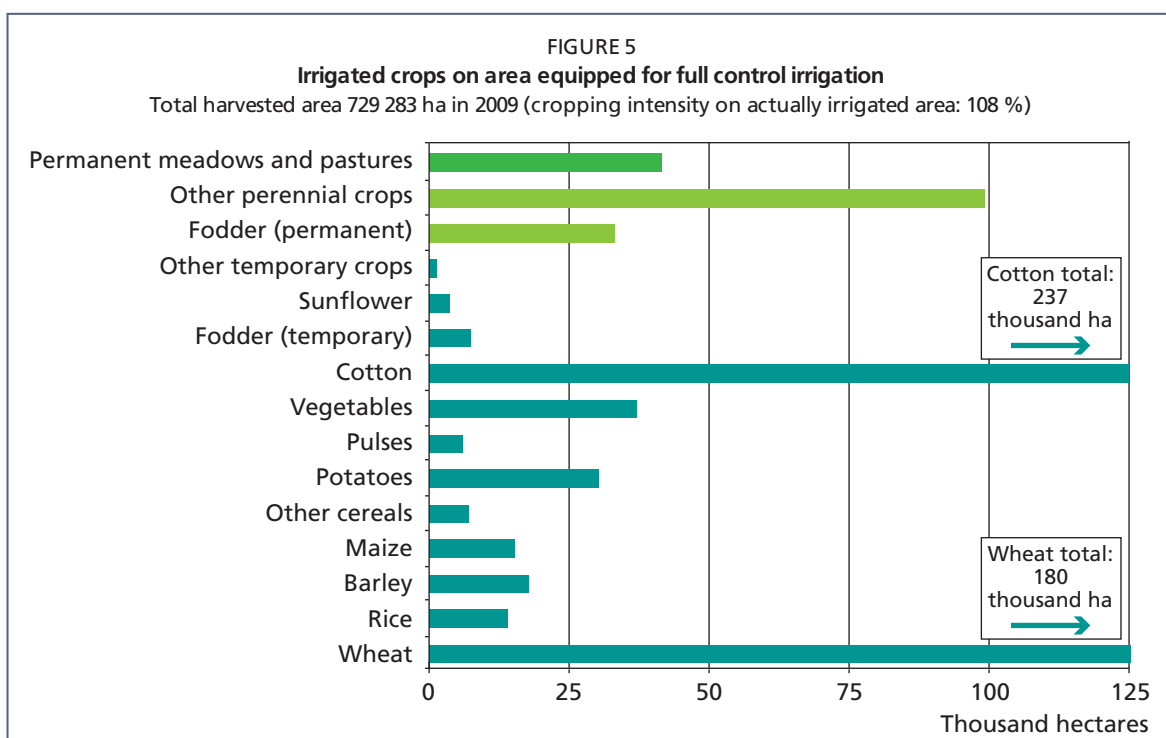


TABLE 4  
Irrigation and drainage

Irrigation potential		1 580 000	ha
Irrigation			
1. Full control irrigation: equipped area	2009	742 051	ha
- surface irrigation	2009	742 051	ha
- sprinkler irrigation		-	ha
- localized irrigation		-	ha
• % of area irrigated from surface water	2009	93.9	%
• % of area irrigated from groundwater	2009	4.4	%
• % of area irrigated from mixed surface water and groundwater	2009	1.8	%
• % of area irrigated from mixed non-conventional sources of water		-	%
• area equipped for full control irrigation actually irrigated	2008	674 416	ha
- as % of full control area equipped	2008	91	%
2. Equipped lowlands (wetland, ivb, flood plains, mangroves)		-	ha
3. Spate irrigation		-	ha
Total area equipped for irrigation (1+2+3)	2009	742 051	ha
• as % of cultivated area	2009	85	%
• % of total area equipped for irrigation actually irrigated	2008	91	%
• average increase per year over the last 14 years	1994-2009	0.2	%
• power irrigated area as % of total area equipped	2009	40	%
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)	2009	742 051	ha
• as % of cultivated area	2009	85	%
Full control irrigation schemes		Criteria	
Small-scale schemes	< 500 ha	2009	40 000 ha
Medium-scale schemes	> 500 and < 3 000 ha	2009	50 000 ha
Large-scale schemes	> 3 000 ha	2009	652 051 ha
Total number of households in irrigation		-	
Irrigated crops in full control irrigation schemes			
Total irrigated grain production (wheat and barley)		-	metric tons
• as % of total grain production		-	%
Harvested crops			
Total harvested irrigated cropped area	2009	729 283	ha
• Temporary crops: total	2009	555 415	ha
- Wheat	2009	179 742	ha
- Rice	2009	14 126	ha
- Barley	2009	18 017	ha
- Maize	2009	14 743	ha
- Millet	2009	237	ha
- Other cereals	2009	6 988	ha
- Potatoes	2009	29 901	ha
- Sugar beet	2009	53	ha
- Pulses	2009	4 667	ha
- Vegetables	2009	37 162	ha
- Tobacco	2009	210	ha
- Cotton	2009	237 130	ha
- Fodder (temporary)	2009	8 323	ha
- Soyabeans	2009	7	ha
- Sunflower	2009	3 493	ha
- Sesame	2009	616	ha
• Permanent crops: total	2009	133 000	ha
- Fodder (alfalfa)	2009	34 043	ha
- Other perennial crops	2009	98 957	ha
• Permanent meadows and pastures: total	2009	40 868	ha
Irrigated cropping intensity (on full control area actually irrigated)	2009	108	%
Drainage - Environment			
Total drained area	2009	345 200	ha
- part of the area equipped for irrigation drained	2009	345 200	ha
- other drained area (non-irrigated)		-	ha
• drained area as % of cultivated area	2009	39	%
Flood-protected areas		-	ha
Area salinized by irrigation	2009	23 235	ha
Population affected by water-related diseases		-	inhabitant

Around 95 percent of agriculture production comes from irrigated areas. Rainfed land is mainly located upland where wheat is grown and there are pastures. The wheat yield in rainfed areas is very low, 1.2–1.8 tonnes/ha.

If water is available in winter, farmers irrigate to improve soil conditions. In pump irrigation areas winter irrigation is not practiced.

Annual expenditure for operation and maintenance (O&M) of irrigation and drainage systems is an estimated US\$68.8 million. The costs of irrigation development and rehabilitation are higher in Tajikistan than in downstream countries, mainly because of the need for pumping and erosion control. In 1999, the average cost of irrigation development was an estimated US\$10 000–18 000/ha for large-scale surface irrigation schemes using standard modern technologies, including agricultural development. Estimated cost of implementation would be US\$2 500–5 000/ha if localized irrigation were to be developed on existing irrigated land.

### Status and evolution of drainage systems

Total area equipped for irrigation, also equipped with a drainage system, amounts to 345 200 ha, including 69 200 ha of subsurface drainage (20 percent) (Table 4). Because O&M is inadequate, a substantial portion of subsurface drainage is currently not used. In 2008, 19 364 ha of medium salinization and 3 871 ha of high salinization (toxic ions exceeding 0.5 percent of total soil weight) were monitored. Unsatisfactory land conditions for agricultural use were estimated on 43 474 ha, of which 54 percent is the result of waterlogging.

According to MLRWR data new drainage systems need to be constructed on 7 000 ha, existing drainage systems rehabilitated on 23 400 ha and soils leached on 14 200 ha. The water table has risen because of water losses from the irrigation network. Modernization and rehabilitation of the on-farm irrigation network on 449 600 ha can lower the water table considerably and increase agriculture production efficiency.

Because of increased fuel prices over the last 5 years, the cost of excavation work has increased and, accordingly, there has been a three-fold increase in the cost of drainage construction and rehabilitation. The average cost of surface drainage development is an estimated US\$1 500–1 800/ha and that of subsurface drainage development US\$1 500–2 000/ha.

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

### Institutions

Interdepartmental coordination of water resources management is carried out by the government. Water management involves many government organizations: Ministry of Land Reclamation and Water Resources (MLRWR), Ministry of Energy and Industry, Ministry of Foreign Affairs, Ministry of Agriculture, Ministry of Economical Development and Trade, Ministry of Health, Ministry of Justice, State Unitary Organization on Water Supply, State Inspectorate on Mining and Technical Supervision, State Committee on Environmental Protection, State Committee on Land Management and Geodesy, National Geological Agency, Committee on Emergency Situation and Civil Protection.

Institutionally, water management follows a hierarchy: state, province, district, farm or water user association (WUA). The first three levels fall under the MLRWR, which is responsible for the planning and management of water resources for agriculture, water distribution and delivery to the farm inlet, assistance to the water users for implementation of advanced technology and control of water use and water quality. The special reclamation services at provincial level are

the responsibility of the MLRWR, which monitors irrigated land (groundwater level, drainage discharge, soil salinity) and plans maintenance and improvement of soil conditions, including leaching, repair and cleaning of collectors and drainage network and rehabilitation. O&M, rehabilitation and modernization and construction of new irrigation schemes, inter-farm level irrigation and drainage networks have been implemented by the Ministry and its subdivisions in *viloyats* (provinces).

MLRWR is a member of the ICWC of Central Asia countries.

The Ministry of Agriculture is in charge of agricultural research and extension, as well as farm-level agricultural and land reclamation development, and operation and maintenance of the irrigation network.

The State Unitary Enterprise *Khojagii Manziliu Kommunal* is responsible for domestic water supply and the treatment of wastewater. The Committee on Nature Protection is responsible for the protection of water resources.

## Water management

WUAs in Tajikistan are a new initiative to manage water structures on irrigated areas belonging to the former *kolkhoz* (collective farms) and *sovkhos* (state [Soviet] farms). In 1994, there were 297 000 households on 262 *kolkhoz*, occupying 48.4 percent of the cultivated area, and 199 700 households on 393 *sovkhos*, occupying 44.3 percent of the cultivated area. Private plots and land leased to state-farm employees (about 33 000 households) totaled about 7.3 percent of the cultivated area. During land reform (1996–2000) *kolkhoz* and *sovkhos* were privatized and divided into a number of small, private (*dehkan*) farms. There are WUAs on irrigation schemes of 1–500 ha each. Currently, WUAs cover almost 35 percent of the irrigated area, but they remain weak. District-level state water management organizations supply water to WUAs gates on a contract basis and these implement on-farm water management. In some areas, several WUAs have established a federation of WUAs. Because agriculture is inefficient and low incomes, often farmers are unable to pay water fees to the state water management organizations.

The MLRWR established the Support Unit to assist WUAs. A number of international and local NGOs conduct training and provide technical assistance to increase the capacity of the WUAs.

## Finances

A water fee system has been in place since 1996 for the supply of irrigation water services from state water management organizations. The current financial mechanism has shortcomings and will be settled during upcoming irrigation reform.

MLRWR accords actual expenditures of O&M, including electricity price, and estimates the water fee, which is provided to the Ministry of Economy Development and Trade for its approval. The water fee is rated 2–6 times less than required to ensure adequate O&M of the irrigation and drainage systems, especially for pump irrigation. Some of these lift irrigation systems are not economically viable under current energy costs and economic conditions. These systems, built in the Soviet period without any economic considerations, pump in what is called a cascade system consisting of 4, 5 and up to 6 stages of pumping. The current water fee for gravity irrigation is US\$4.13/1 000 m<sup>3</sup> and US\$6.58/1 000 m<sup>3</sup> for pump irrigation (including 20 percent VAT). The recent increase in the price of electricity will influence changes to the water fee for irrigation services.

The government annually subsidises construction of irrigation infrastructure on 700–1 000 ha.



Since 2000, rehabilitation of irrigation and drainage facilities, pump stations and pressure pipes has cost more than US\$200 million, funded mainly by the Asian Development Bank (ADB) and World Bank investments and grants.

## Policies and legislation

The current legal basis for water management is the 'Water Code of Tajikistan', adopted in 2000. The main target of water legislation is to ensure water supply to users. A previous 'Water Code of Tajikistan' was signed in 1993.

The WUAs Law was adopted in 2007, which provided a legal basis for the establishment and development of WUAs to improve on-farm water management within the bounds of privatized former *kolkhoz* and *sovkhoz*.

There are almost 50 laws linked to water management.

## ENVIRONMENT AND HEALTH

The environmental problems in Tajikistan are the result of its climate, natural conditions (steep slopes), land-use change and the structure of the national economy. Erosion affects 97 percent of agricultural land and is a major threat to sustainable agriculture, particularly in hilly areas. In the löss zone, steep slope grazing land has been converted to cultivated agriculture over the last 15 years resulting in significant loss of sediments, which has caused damage downstream.

The irrigated area is subject to substantial erosion, landslides, sagging and deformation. The area affected is an estimated 45 000 ha. Irrigation development in the foothill zone, especially in the more stony areas, induces increasing groundwater recharge, intensifying waterlogging and salinization of the lower areas and increasing sediment-loaded drainage water runoff. Collector-drainage water is the principal water polluter (common salinization, pesticides and other waste). Environmental pollution is increasing as a consequence of industrial production.

The two major land quality problems are the interrelated issues of salinity and waterlogging, caused by high groundwater levels. Salinization of irrigated land in lowland areas has increased because of inadequate drainage systems, low irrigation efficiency resulting in high water losses. The total area salinized by irrigation is 23 235 ha. The area waterlogged in irrigation areas is 25 742 ha.

Except for some lakes and groundwater sources, the water quality is considered drinkable. General salinity level of water at source is 0.05–0.40 g/litres.

According to research during the Soviet era, around 10–12 percent of irrigation water supplied to fields leaches to aquifers, and around 40 percent returns to rivers. In the Amu Darya river basin Tajikistan withdraws only 10–12 percent of the annual river flow, thus changes to water quality are insignificant.

Mud torrents occur mostly in the Zeravshan river basin on average 150 times/year and in the Vakhsh and Panj river basins on an average of 70 times/year, mostly in April (35 percent) and in May (28 percent). There are 102 mud torrents, hazardous rivers and annual mud torrents and floods result in great damage to the country. Flood damage alone in 2005 amounted to US\$50 million (MLRWR and UNDP, 2006).

The Committee on Emergency and Civil Protection and MLRWR manage floods and mudflows. Lack of equipment, materials and capacity, however, has led to inefficient hazard mitigation measures.

Around 2 012 km of bank protection dykes and mud torrent discharge channels have been constructed to protect social and economic infrastructure. Reservoirs play an important role in protection of property and infrastructure from floods and mud torrents.

## PROSPECTS FOR AGRICULTURAL WATER MANAGEMENT

The objective of water sector reforms is to create an efficiently planned, developed and managed water sector based on sound policies, joint analysis and management of groundwater and surface water. The different water using sectors are balanced, using the basin as the management area, to secure economic benefit to Tajikistan, without compromising ecological integrity. This water sector reform has adopted the guiding principle of integrated water resources management (IWRM).

District-level state water management units will be included in Basin Water Management Organizations (BWMO). The BWMOs will transfer all water management responsibility in stages to WUAs for secondary and tertiary canals. In some cases WUAs will manage water at the primary canal level. Establishing the new tandem management structure BWMO+WUA is fundamental to the introduction of IWRM in Tajikistan. The government expects to create 11 BWMOs: Syr Darya, Istarafshan, Zeravshan, Gissar (Hisor), Rasht, Yavan, Dangara, Kulob, Lower Kofarnihon, Vakhsh and Badakhshan.

Establishment of WUAs has started at the secondary and tertiary canal level, the government aims to cover all irrigated areas with WUAs. The relationship between state BWMOs and non-government WUAs will be based on water supply contracts. The main goal of government irrigation reform is to reduce state budget expenditures for O&M for irrigation and drainage systems. Although the government subsidizes only 10–15 percent of requested expenditures for O&M, efforts are directed to the establishment of self-funding water resources management systems. It seems difficult, however, to cover the highest cost systems (highest lifts) of water supply services. The drought mitigation strategy includes introducing water-saving measures in the summer and limitation of water intake from sources for all economy sectors during drought years. The aim of the ICWC is to reduce the regions water intake quotes by 10–25 percent.

The deteriorating condition of irrigation and drainage, water supply and sanitation infrastructure has forced the government to pursue investment from all accessible sources. State investment and water fees are insufficient to rehabilitate infrastructure.

Several key issues must be addressed for the effective implementation of water sector reforms. These include the formulation of an investment and realistic finance plan for the implementation of water sector reform; application of water related reform laws; inventory of irrigation systems and prioritization of the most viable for modernization/rehabilitation; support to WUAs for the successful O&M of irrigation and drainage systems with the application of a fair and realistic tariff system; and support to alternative high cost systems (high lift systems) to sustain livelihoods in upland areas.

With the participation of international organizations and experts, the government aims to reform the water sector and transfer the centrally planned economy to a real market economy. This will change cropping patterns in irrigated areas. As a result, farmers will become interested in adopting water-saving irrigation technologies for economic reasons and, therefore, contribute to the preservation of the environment.

## MAIN SOURCES OF INFORMATION

- ADB.** 2006. *Country gender assessment*. Republic of Tajikistan, East and Central Asia Regional Department and Regional and Sustainable Development Department. Asian Development Bank.
- CAWaterInfo.** 2012. *The Aral Sea Basin*.
- Dukhovny V.A. & Sorokin G.A.** 2007. *Assessment of impact of the Rogun reservoir to water regime of Amudarya River*. Tashkent, Sepang International Circuit – Interstate Commission for Water Coordination.
- FAO.** 1997. Irrigation in the countries of the former Soviet Union in figures. *FAO Water Report No. 15*. Rome, Food and Agriculture Organization of the United Nations.
- Government of the Republic of Tajikistan in Cooperation with the Development Coordination Council.** 2012. *Report on the results of the agrarian reform of the Republic of Tajikistan*. Dushanbe, September 2012.
- MLRWR.** No year. Annual reports on land reclamation and water use and materials of Collegiums meetings of the MLR&WR, 1980-1994. In Russian and Tajik, Dushanbe. Ministry of Land Reclamation and Water Resources.
- MLRWR & UNDP.** 2006. *Water sector development strategy of Tajikistan*. Tajikistan, Dushanbe, Ministry of Land Reclamation and Water Resources and New York, United Nations Development Programme.
- MLRWR & OSCE** *Water sector development strategy of Tajikistan, MLR&WR and OSCE, Working Group with participation of eight related ministries of Tajikistan, Dushanbe, 2009–2010, Draft*. Ministry of Land Reclamation and Water Resources and the Organization for Security and Cooperation in Europe. (Russian, Tajik, English)
- MLRWR & OCSE.** 2009. *Water sector development strategy for the period 2010–2025*. Ministry of Land Reclamation and Water Resources and the Organization for Security and Cooperation in Europe.
- SIWI.** 2010. *Regional water intelligence report Central Asia*. Stockholm International Water Institute.
- State Unitary Department Mohiyi Tojikiston (Tajik Fish).** 2009. Tajikistan.
- TAJSTAT.** 2009a. *Annual report - economical and social data*. Dushanbe, Tajikistan. State Statistical Committee of Tajikistan.
- TAJSTAT.** 2009b. *Environment protection of the Republic of Tajikistan*. TAJSTAT, Annual report, 2009, Dushanbe, Tajikistan.
- UNDP.** 2004. *Water resources of Kazakhstan in the new millennium*. New York, United Nations Development Programme.
- United Nations.** 2008. *World Population Prospects: The 2008 Revision*. New York, Population Division of the Department of Economic and Social Affairs of the United Nations Secretariat
- USAID.** 2012. *Water project helps reduce ethnic conflict*. Case study. United States Agency for International Development.
- Water Code of the Republic of Tajikistan.** 2000. Dushanbe, Tajikistan.