

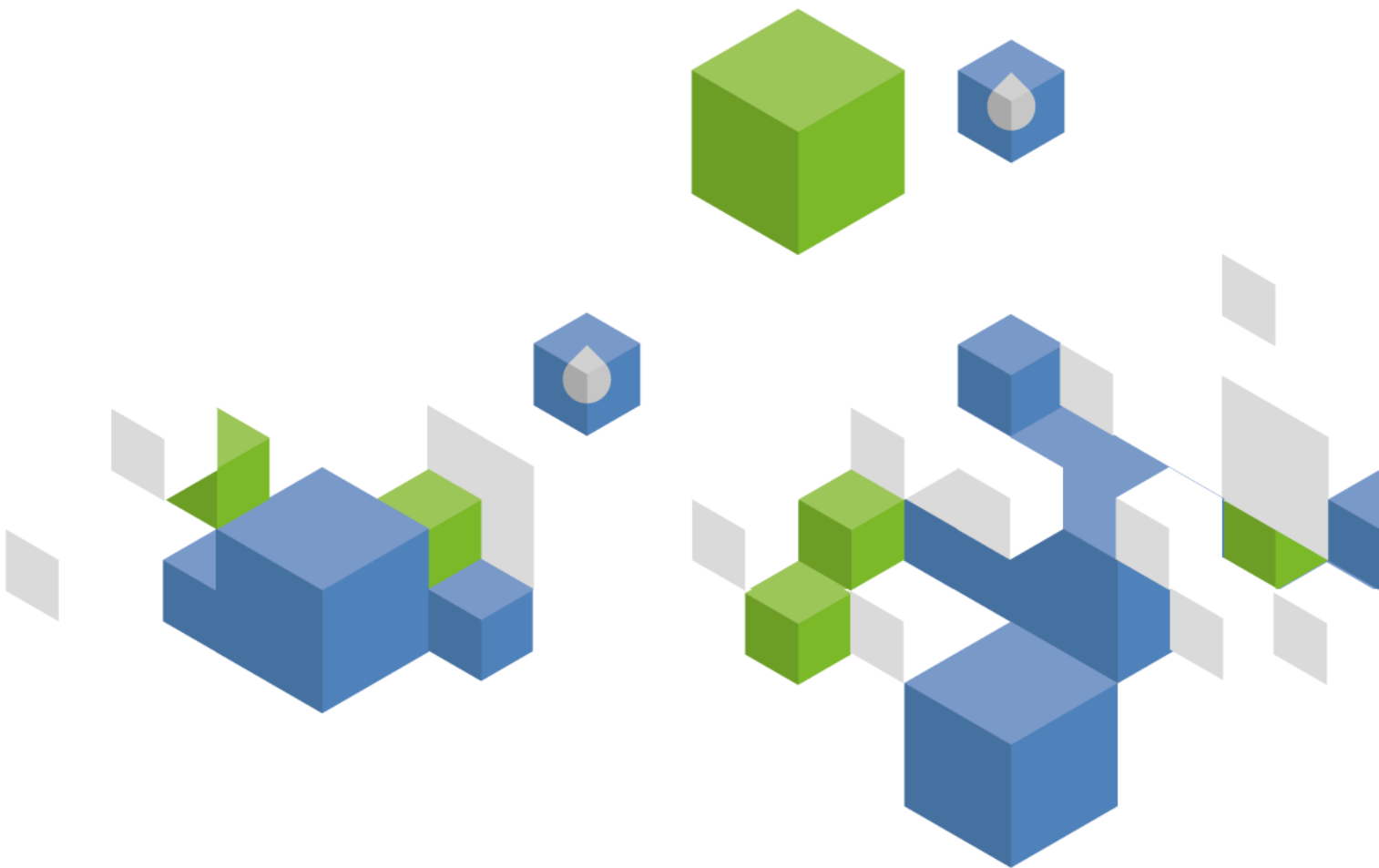


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Uzbekistan

GEOGRAPHY, CLIMATE AND POPULATION

Geography

Uzbekistan is a landlocked country in Central Asia, with a total area of 447 400 km². It is bordered in the west by Kazakhstan, in the northeast by the Aral Sea, in the north by Kazakhstan, in the east by Kyrgyzstan and Tajikistan, and in the south by Afghanistan and Turkmenistan. The country gained its independence from the Union of Soviet Socialist Republics (USSR) in August 1991. For administrative purposes, the country is divided into 12 provinces (vilayats) Andijan, Bukhara, Fergana, Jizzakh, Kashkadarya, Khorezm, Namangan, Navoiy, Samarkand, Sirdaryo, Surkhandarya and Tashkent (which includes the capital city of Tashkent), plus one autonomous republic: Karakalpakstan in the far west near the Aral Sea.

Physiographically the country can be divided into three zones:

- the desert (Kyzylkum), steppe and semi-arid region covering 60 percent of the country, mainly the central and western parts;
- the fertile valleys (including the Fergana valley) that skirt the Amu Darya and Syr Darya rivers;
- the mountainous areas in the east with peaks of about 4 500 m above sea level (Tien Shan and Gissaro-Alay mountain ranges).

In 2009, the cultivated area was an estimated 4.65 million ha, of which 92.5 percent was under temporary crops and 7.5 percent under permanent (Table 1). Only 18 percent of the cultivable area, an estimated 25.4 million ha, is cultivated because of the water shortage.

In 1994, the agriculture area was divided into:

- kolkhoz (collective farms) and sovkhoz (state farms), occupy 89.7 percent;
- land managed by forest enterprises, occupy 8.1 percent;
- ‘citizens’ land’, corresponding to gardens and individual plots cultivated by their owners, occupy 1.9 percent;
- land leased to farmers for agricultural production on a long-term period (arenda), occupy 0.3 percent.

Climate

The climate is continental; arid/deserts cover over 60 percent of the territory. Average annual rainfall is 264 mm, ranging from less than 97 mm in the northwest to 425 mm in the mountainous regions in the centre and south. In the Fergana valley, average annual rainfall varies between 98 and 502 mm, while in the Tashkent vilayat, it varies between 295 and 878 mm. Rainfall occurs during the winter, mainly between October and April. There are high temperatures 42–47°C on the plains and 25–30°C in the mountainous regions in July, and low temperatures in winter, minus 11°C in the north and 2–3°C in the south in January. Because of frequent frosts, between late September and April, only one crop a year can be grown. In favourable years, however, double-cropping of vegetables with a short growing period is possible.

FIGURE 1
Map of Uzbekistan

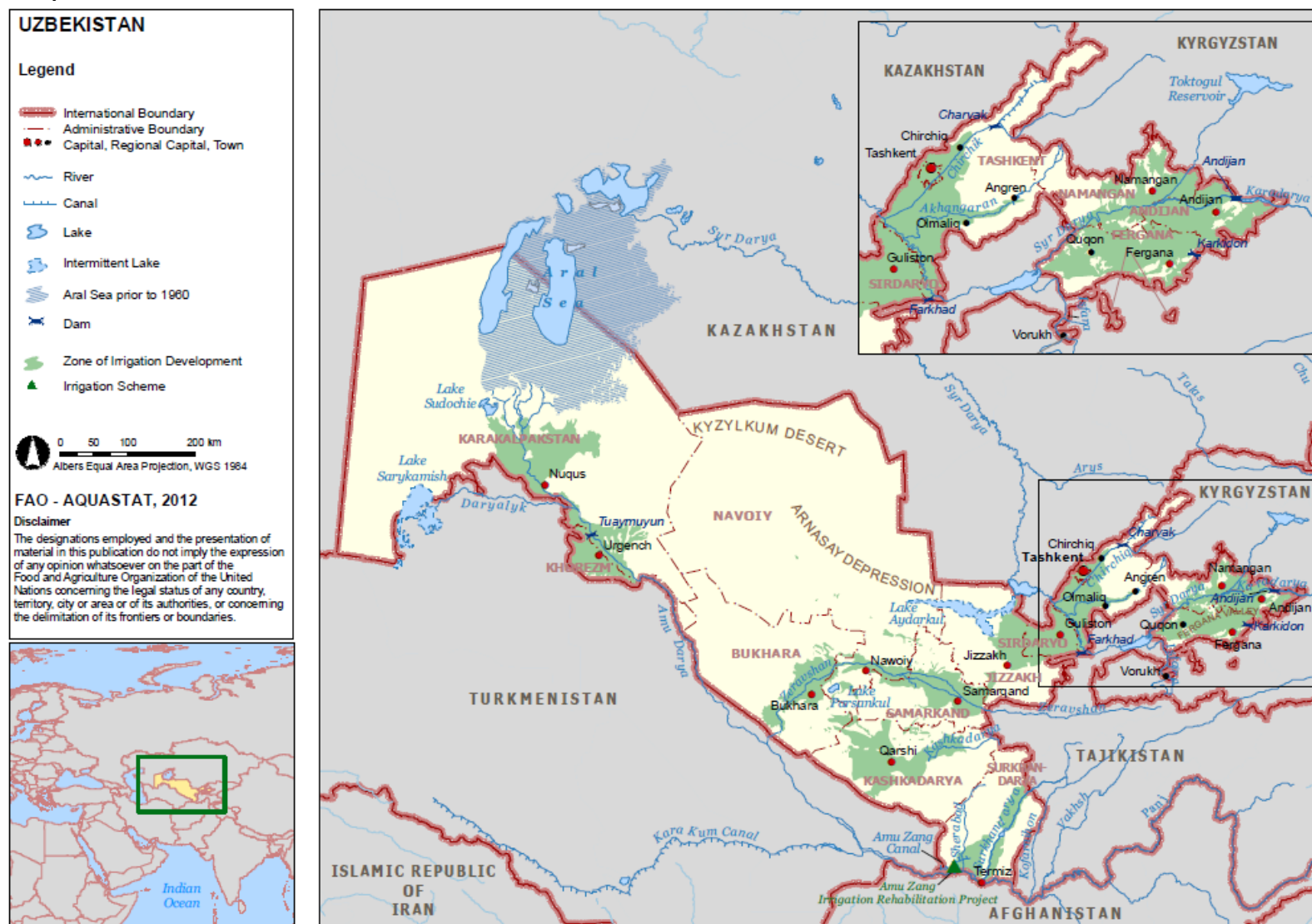


TABLE 1
Basic statistics and population

Physical areas:			
Area of the country	2009	44 740 000	ha
Cultivated area (arable land and area under permanent crops)	2009	4 651 000	ha
• as % of the total area of the country	2009	10	%
• arable land (temporary crops + temp fallow + temp. meadows)	2009	4 301 000	ha
• area under permanent crops	2009	350 000	ha
Population:			
Total population	2011	27 760 000	inhabitants
• of which rural	2011	64	%
Population density	2011	62	inhabitants/km ²
Economically active population	2011	12 916 000	inhabitants
• as % of total population	2011	47	%
• female	2011	46	%
• male	2011	54	%
Population economically active in agriculture	2011	2 695 000	inhabitants
• as % of total economically active population	2011	21	%
• female	2011	43	%
• male	2011	57	%
Economy and development:			
Gross Domestic Product (GDP) (current US\$)	2010	38 982	million US\$/yr
• value added in agriculture (% of GDP)	2010	20	%
• GDP per capita	2010	1 420	US\$/yr
Human Development Index (highest = 1)	2011	0.641	
Access to improved drinking water sources:			
Total population	2010	87	%
Urban population	2010	98	%
Rural population	2010	81	%

Population

The total population was an estimated 27.8 million inhabitants in 2011 (of which 64 percent rural) (Table 1). During the period 2001–2011 annual population growth rate was an estimated 1 percent. Population density is about 62 inhabitants/km², which is the highest of the five former Soviet Central Asian republics. Population ranges from more than 464 inhabitants/km² in Andijan province in the Fergana valley in the east to only eight inhabitants/km² in Karakalpakstan.

In 2010, 87 percent of the population had access to improved water sources (98 and 81 percent in urban and rural areas respectively). Sanitation coverage accounted for 100 percent of the population.

ECONOMY, AGRICULTURE AND FOOD SECURITY

In 2010, Uzbekistan's gross domestic product (GDP) was US\$38 982 million of which the agriculture sector accounted for 20 percent.

In 2011, total economically active population was 12.9 million, or 47 percent of the total population. The economically active population in agriculture is an estimated 2.7 million (21 percent of the total active population) of which 43 percent is female.

Cotton, called 'white gold', was the dominant crop within Uzbekistan's agricultural sector during the Soviet period. Although cotton had been grown in the region for hundreds of years, the crop's expansion in the twentieth century was made possible by two main factors: expansion of irrigated area and Soviet central planning. Irrigation allowed for increased crop production and central planning imposed cotton as the major crop. In exchange for cotton production, central planning provided Uzbekistan with water, energy and food from elsewhere in the integrated national system.

Uzbekistan was the major cotton-growing region in the USSR, accounting for 61 percent of total production. Since the disintegration of the USSR, and Uzbekistan independence in 1991, agricultural policy has been subject to both inertia and change. On the one hand, the government has maintained significant aspects of the central planning system. The state still controls the area and quantity of cotton produced, as well as the purchase prices. In the mid-1990s, the country was the fourth largest producer of cotton in the world and the third largest cotton exporter. Cotton, with vegetables and fruits are the country's principal exports.

On the other hand, the government has allowed a shift towards increased farmer control of many aspects of production, in particular those related to land and water management. At the same time, the country has been forced to develop new trading relationships with other former Soviet states and the rest of the world, which has led to the mandated expansion of the wheat area to meet local food needs. The government mandated increase of wheat production, means the wheat growing areas are larger and the cotton-growing area smaller, because the wheat and cotton-growing season overlap.

The result has been an expansion of the winter wheat area from 620 000 ha in 1991 to 750 000 ha in 1996 with a similar decline in the cotton area. Wheat production increased substantially, from 1 million tonnes in 1991 to 5.2 million tonnes in 2004, and Uzbekistan has become a wheat exporter of some 500 000 tonnes annually (Abdullaev et al., 2009). The leading export goods and their share in exports are cotton-lint (11 percent), energy resources (25 percent), services (9 percent), non-ferrous and ferrous metals (7 percent), machinery and equipment (6 percent), chemical products (5 percent), food products (10 percent), other (28 percent).

WATER RESOURCES

Two river basins are found in Uzbekistan, which form the Aral Sea basin:

- Amu Darya basin – covers 81.5 percent of the country. The entire main Amu Darya river can be divided into three reaches: the upper reach borders Afghanistan and Tajikistan, where most of the water flow is generated; the middle reach first borders Uzbekistan and Afghanistan and then enters Turkmenistan; and the lower reach, in Uzbekistan, before the river discharges into the Aral Sea. The main tributaries within Uzbekistan are the Surkhandarya, Sherabad, Kashkadarya and Zeravshan rivers. The Surkhandarya and Zeravshan rivers originate in Tajikistan. The Zeravshan was the largest tributary of the Amu Darya before it began to be tapped for irrigation. Even the remaining flow evaporates in the Kyzylkum desert near the city of Bukhara. The total flow produced in the Amu Darya basin is an estimated 78.46 km³/year on average, calculated by adding the internal renewable surface water resources (IRSWR) of the different countries in the basin: Tajikistan 59.45 km³/year, Kyrgyzstan 1.93 km³/year, Afghanistan 11.70 km³/year, Uzbekistan 4.70 km³/year and Turkmenistan 0.68 km³/year, while the 5 and 95 percent probabilities are an estimated 108.4 and 46.9 km³/year respectively. The period April–September accounts for 77–80 percent and the period December–February for 10–13 percent of annual flow. This intra-annual flow distribution is favorable for irrigated agriculture. Because of significant losses when the river flows through the desert, and because of major water withdrawal by agriculture, the flow reaching the Aral Sea is limited to less than 10 percent of this figure in the driest years. About 4.7 km³/year, or 6 percent of the average total surface water resources of the Amu Darya river basin, are generated within Uzbekistan.
- Syr Darya basin – covers 13.5 percent of the country. The entire main Syr Darya river can be divided into three reaches: the upper is in Kyrgyzstan, where most of the water flow is generated; the middle in Uzbekistan and Tajikistan; and the lower reach in Kazakhstan, before it discharges into the Aral Sea. The main tributaries within Uzbekistan are the Chirchik and Akhangaran rivers, which rise in Kyrgyzstan. The total flow produced in the Syr Darya basin is an estimated 36.57 km³/year, calculated by adding the IRSWR of the different countries in the basin: Kyrgyzstan 27.42 km³/year, Tajikistan 1.01 km³/year, Uzbekistan 4.84 km³/year and Kazakhstan 3.3 km³/year, while the 5 and 95 percent probabilities are an estimated 54.1 and

21.4 km³/year respectively. Because of significant losses in the desert areas of its course, and because of major water withdrawal by agriculture, the flow reaching the Aral Sea is limited to less than 5 percent of this figure in the driest years. About 4.84 km³/year, or 13 percent of the average surface water resources of the Syr Darya river basin are generated within Uzbekistan.

Uzbekistan has thousands of small streams that disappear in the desert, many having been emptied by irrigation (OrexCA, 2011).

The total river flow generated inside Uzbekistan is thus estimated at 9.54 km³/year of which 49 percent from the Amu Darya river basin and 51 percent from the Syr Darya river basin.

Surface water resources allocated to Uzbekistan are calculated every year, depending on climatic conditions and existing flows. However, the estimated average surface runoff from upstream countries is as follows (Table 2):

- Amu Darya basin: Based on an agreement between Uzbekistan and Turkmenistan signed in January 1996, which supplemented the '1992 Five Central Asia Countries Agreement', half of the water is allocated to Uzbekistan and half to Turkmenistan. Thus, of the average flow of 44 km³/year, 22 km³/year are reserved for Uzbekistan and 22 km³/year for Turkmenistan (of which 0.68 km³/year are Turkmenistan's IRSWR). This means that of the 43.32 km³/year allocated flow from the Amu Darya river basin from Tajikistan into Uzbekistan, 21.32 km³/year (=22–0.68) is transit flow to Turkmenistan.
- Syr Darya basin: 22.33 km³/year from Kyrgyzstan, of which 11.8 km³/year is transit flow to Tajikistan, of which 11.54 km³/year again is transit flow to Uzbekistan, of which finally 10 km³/year is reserved for Kazakhstan;

TABLE 2
Renewable surface water resources (RSWR) by river basin in Uzbekistan

River basin	Internal RSWR	Inflow		Outflow		Actual RSWR
		Total	Secured by agreements	Total	Secured by agreements	
	km ³ /year	km ³ /year	From:	km ³ /year	To:	km ³ /year
Amu Darya	4.7	73.76 ^a	43.32 ^c Tajikistan	66.08 ^d	21.32 Turkmenistan	26.70 ^g
Syr Darya	4.84	28.43 ^b	22.33 Kyrgyzstan	33.27 ^e	11.80 ^f Tajikistan	15.37 ^h
Total	9.54	102.19	65.65	99.35	33.12	42.07

a Equal to inflow from Tajikistan (59.45) and inflow from Kyrgyzstan through Tajikistan (1.93) and inflow from Afghanistan (11.7 through

Turkmenistan) and inflow from Turkmenistan (0.68 IRSWR)

b Equal to inflow from Tajikistan (1.01) and inflow from Kyrgyzstan (27.42)

c Equal to total secured for Uzbekistan (22) and for Turkmenistan (22) minus IRSWR of Turkmenistan (0.68)

d Equal to IRSWR (4.7) and flow from Tajikistan 61.38, of which 59.45 originating in Tajikistan and 1.93 originating in Kyrgyzstan

e Equal to IRSWR (4.84) and flow from Kyrgyzstan and Tajikistan (28.43)

f Outflow to Tajikistan, of which 11.54 again is transit flow to Uzbekistan, of which finally 10 is reserved for Kazakhstan

g Equal to 4.7 (IRSWR) + 43.32 from Tajikistan – 21.32 to Turkmenistan

h Equal to 4.84 (IRSWR) + 22.33 from Kyrgyzstan – 11.8 to Tajikistan

There are 94 major aquifers in Uzbekistan. The renewable groundwater resources are an estimated 8.8 km³/year, of which 2 km³/year are considered an overlap with surface resources. The IRWR are therefore an estimated 16.34 km³/year and total actual renewable water resources (TARWR) are 48.87 km³/year, equal to total actual renewable surface water resources (TARSWR) of 42.07 km³/year, taking into consideration the allocation mechanism between the different countries, plus renewable groundwater resources of 8.8 km³/year minus the overlap of 2 km³/year, (Table 2 and Table 3).

TABLE 3
Water resources

Renewable freshwater resources:			
Precipitation (long-term average)	-	264	mm/yr
	-	92 200	million m ³ /yr
Internal renewable water resources (long-term average)	-	16 340	million m ³ /yr
Total actual renewable water resources	-	48 870	million m ³ /yr
Dependency ratio	-	80	%
Total actual renewable water resources per inhabitant	2011	1 760	m ³ /yr
Total dam capacity	2010	22 162	million m ³

Between 1990 and 1994, return flow on the Uzbekistan territory was an estimated 32.4 km³/year, of which 21.5 km³/year in the Amu Darya river basin and 10.9 km³/year in the Syr Darya river basin. This total comprises 30.9 km³/year of drainage flow from irrigated areas (of which 2.55 km³/year is the result of vertical drainage from pumping) and about 1.5 km³/year of untreated municipal and industrial wastewater. The main portion of the return flow, 49 percent or 15.9 km³/year, returned to rivers: 9.5 km³/year in the Amu Darya basin and 6.4 km³/year in the Syr Darya basin. About 37 percent or 12 km³/year ended up in natural depressions (Arnasay, Parsankul, Sarykamish and lake Sudochie) from which most water evaporates.

More than 4.5 km³/year or 14 percent were used for irrigation: 2.9 km³/year without treatment, mainly for cotton on light soils and 1.6 km³/year after in situ desalting treatment (phytomelioration). Around 2000, direct use of drainage water was an estimated 6.84 km³, of which 4.21 km³ from the Syr Darya and 2.63 km³ from the Amu Darya system. Around 2005, total return flow was an estimated 23 km³ (Abdullaev et al., 2009).

The collector-drainage water outflow has led to the creation of artificial lakes in natural depressions. The largest lakes are: Aydarkul, in the Arnasay depression in the middle reach of Syr Darya, which stored about 30 km³ in 1995; the Sarykamish and Sudochie lakes, both located in the lower reach of the Amu Darya, store 8 and 2 km³ respectively. Several lakes have formed in the centre of the country in the Amu Darya basin, the largest being Parsankul lake close to the Zeravshan river, which stores about 2 km³.

There are at least 50 reservoirs in Uzbekistan with a total capacity of over 22 km³. The largest reservoirs are multipurpose dams used for irrigation, flood control and hydropower production. In the Syr Darya basin, the largest reservoirs are the Charvak and Andijan reservoirs. The Charvak reservoir, which is one of the largest hydropower plants in Central Asia, is on the Chirchik river, near the capital Tashkent and has a capacity of 1.99 km³ and 600 MW. The Andijan reservoir on the Karadarya river in the Fergana valley, has a capacity of 1.9 km³. In the Amu Darya basin, the largest reservoir is the Tuaymuyun, in Khorezm viloyati, with a storage capacity of 7.8 km³, comprising four separate reservoirs. One reservoir in this system (Kaparas) is to provide drinking water for the Karakalpakstan area, which is experiencing severe environmental problems as a result of the shrinking of the Aral Sea. Most reservoirs were built more than 25 years ago. During this period, almost all were exposed to siltation, resulting in almost 20–25 percent loss of useful capacity.

Gross theoretical hydropower potential is an estimated 88 000 GWh/year and the economically feasible potential 15 000 GWh/year. In 1993 total installed capacity was 1.7 GW, and in 1995 provided about 12 percent of the country's electricity.

Extensive canal systems, such as the Amu-Bukhara canal and many others built during the Soviet period, have greatly altered water-flow patterns (OrexCA, 2011).

INTERNATIONAL WATER ISSUES

During the Soviet period, sharing of water resources among the five Central Asian republics was based on the master plans for water resources development in the Amu Darya (1987) and Syr Darya (1984) river basins. In 1992, the Interstate Commission for Water Coordination (ICWC) was established and the newly independent republics decided, with the Agreement of 18 February 1992, to prepare a regional water strategy and continue to respect the existing principles until the adoption of a new water sharing agreement. This new agreement was confirmed by the 'Agreement on joint actions to address the problem of the Aral Sea and socio-economic development of the Aral Sea basin', which was signed by the Heads of the five states in 1996. Over the years, the ICWC has achieved the conflict-free supply of water to all water users, despite the complexities and variations of dry and wet years.

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).

Uzbekistan and Turkmenistan have signed agreements about basic water allocation principles. These principles proved viable and both countries gained experience in the joint management of the Amu Darya river. ICWC played and still plays a positive role in this respect. In 1996 a permanent agreement was reached between Turkmenistan and Uzbekistan on cooperation concerning water management issues. This agreement is based on the principles that the Parties:

- recognize the necessity of joint use of interstate rivers and other water sources;
- refuse to apply economic and other ways of pressure when solving water issues;
- acknowledge the interdependence of water problems and the responsibility for rational water use;
- focus on the increase of water inflow to the Aral Sea;
- understand the necessity of respecting mutual interests and settling water-related issues through consensus.

The above-mentioned agreement was signed in Türkmenabat, in eastern Turkmenistan, on 15 January 1996 and set out that the:

- land used by Uzbekistan and located within the borders of Turkmenistan is the sole property of Turkmenistan;
- waterworks and water management organizations on the Karshi and Amu-Bukhara canals and at the Tuyamuin reservoir, located in Turkmenistan, are the property of Uzbekistan;
- land for the Karshi and Amu-Bukhara canals and Tuyamuin hydro-unit are placed at the disposal of Uzbekistan's on a chargeable basis;
- Parties will make all necessary attempts to provide normal operation of the interstate waterworks located within their territories;
- companies and organizations, including those dealing with the operation of interstate waterworks located on the territory of the other Party, act according to international rules and the laws of that Party;
- flow of the Amu Darya river at Kerki gauging station is divided into equal shares (50/50);
- Parties should allocate a portion of their shares to the Aral Sea;
- Parties should stop disposal of drainage water into the Amu Darya river, independently of the quality of the drainage water;
- Parties jointly implement measures on land reclamation, on reconstruction and operation of interstate collectors and irrigation systems, and on construction of water disposal canals;
- Parties will prevent channel deformations and flooding of adjacent areas, caused by the operation of the Amu-Bukhara, Karshi, Sovetyab, Dashoguz, Tashsaka, Kylychbay, and Shabat-Gazavat water systems;

- Parties will make the necessary attempts to prevent flooding of land located along the Daryalyk and Ozerny collectors crossing Turkmenistan and will bear the costs of the collectors reconstruction and operation proportional to drainage flow;
- ICWC will define the reduced limits for water withdrawal during the driest years, which includes ministries of water economies in all five Central Asian countries.

In a meeting in 2004, the presidents of Uzbekistan and Turkmenistan reiterated the importance of observing mutual understanding of all questions of water allocation from the Amu Darya.

The most acute disagreement in the Syr Darya basin relates to the operation of the Toktogul reservoir in Kyrgyzstan, leading to a conflict of interest between Kyrgyzstan, Uzbekistan and Kazakhstan. The two downstream countries are interested in maintaining storage for summertime irrigation from the Toktogul reservoir, whereas winter energy generation from the reservoir is beneficial to Kyrgyzstan. A similar set of issues may be observed between Tajikistan and Uzbekistan regarding the management of the Kayrakkum reservoir in Tajikistan (UNDP, 2004).

Kazakhstan, Kyrgyzstan and Uzbekistan signed an agreement concerning dams in the upper Syr Darya river basin in 1998, which includes provisions for Kazakhstan and Uzbekistan to share equally in the purchasing of summer hydropower from Kyrgyzstan (SIWI, 2010).

Relations with upstream Kyrgyzstan and Tajikistan are not good. If a reasonable agreement on water usage and water management could be reached, Uzbekistan could avoid many of the current problems. However, the minimum requirements of such an agreement would be for Uzbekistan to commit to the delivery of much needed fossil energy, especially natural gas, to Kyrgyzstan and Tajikistan, so that they do not use hydropower during periods of water shortage. Currently Uzbekistan fails to do so, thus facing the consequences of water shortages (Akhmadov, 2008).

Most of the year, residents of Vorukh in eastern Uzbekistan and Ravot in northern Tajikistan have access to the Isfara river. Once the growing season begins however farmers from upstream Ravot irrigate their fields and unintentionally cut off access to water in Vorukh. Through the United States Agency for International Development (USAID) programme, residents of Vorukh were given the opportunity to address issues that served as sources of tension in their community. Water was, naturally, the first priority. The 3-year project, operating in the Fergana valley portions of Kyrgyzstan, Tajikistan and Uzbekistan, aims to reduce interethnic and transboundary conflicts through a combination of social and infrastructure initiatives.

The Community Initiative Group, a council of active citizens from all walks of life, undertook the design and implementation of the project, which required the repair and rehabilitation of three wells, in addition to the construction of a 3.5 km water pipeline. The total cost of the project was approximately US\$17 000, with roughly half coming from the community itself. More importantly, this group stressed long-term management. In the end, the project has not only benefited the 1 235 residents of Vorukh, as they gain improved access to drinking water, it has improved relations between two Fergana valley neighbours (USAID, 2012).

Uzbekistan, in collaboration with Kazakhstan and the Russian Federation, is exploring the possibility of diverting the Ob and Irtysh rivers. The proposed project consists of building a canal from Siberia across Kazakhstan to Uzbekistan. In theory, the project would solve the problem of limited water resources available to Uzbekistan. The project would enable the Russian Federation to play a greater role in the region, especially in Uzbekistan. There are fears about the salinization of water during transfer, the significant technical issues and the high financial and geopolitical costs to Central Asia (SIWI, 2010).

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 EU and EECCA countries at the World

Summit for Sustainable Development in 2002. One important component is ‘Integrated water resources management, including transboundary river basin management and regional seas issues’ (SIWI, 2010).

In 2002, Central Asian and Caucasus countries formed the CACENA Regional Water Partnership under the Global Water Partnership (GWP). Within this framework state departments; local, regional and 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 EUWI and UNECE, the Programme 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).

In 2007, Uzbekistan joined the ‘International convention on the protection and use of transboundary watercourses and international lakes’ and the ‘Convention on the law of the non-navigational uses of international watercourses’.

WATER USE

In 2005, total water withdrawal was 56.0 km³, of which 50.4 km³ (90 percent) was for agriculture, 4.1 km³ (7 percent) for municipal and 1.5 km³ (3 percent) for industry (Table 4 and Figure 2). Total groundwater withdrawal was 5 km³ or 9 percent of total water withdrawal (Figure 3), of which 49 percent for urban and rural water supply, 34 percent for irrigation and 17 percent for industry. Around 2000, the direct use of drainage water was an estimated 6.84 km³, of which 4.21 km³ from the Syr Darya and 2.63 km³ from the Amu Darya system. In addition, 6.1 km³ of water may be considered environmental flow, which is the average amount annually allowed to the Uzbek portion of the Aral Sea since the early 1990s (Abdullaev et al., 2009). In 1994, total water withdrawal for agricultural, municipal and industrial use was an estimated 58.05 km³, of which 92 percent for irrigation, 2 percent for livestock, 4 percent for municipalities and 2 percent for industries. This amount comprises 50.66 km³ surface water, which included return flow and direct use of agricultural drainage water (the latter about 4.5 km³) and 7.39 km³ groundwater. Requirements for fisheries were an estimated 530 million m³.

TABLE 4
Water use

Water withdrawal:			
Total water withdrawal by sector	2005	56 000	million m ³ /yr
- agriculture	2005	50 400	million m ³ /yr
- municipalities	2005	4 100	million m ³ /yr
- industry	2005	1 500	million m ³ /yr
• per inhabitant	2005	2 158	m ³ /yr
Surface water and groundwater withdrawal (primary and secondary)	2005	49 160	million m ³ /yr
• as % of total actual renewable water resources	2005	101	%
Non-conventional sources of water:			
Produced municipal wastewater	2000	1 083	million m ³ /yr
Treated municipal wastewater		-	million m ³ /yr
Direct use of treated municipal wastewater		-	million m ³ /yr
Desalinated water produced		-	million m ³ /yr
Direct use of agricultural drainage water	2000	6 840	million m ³ /yr

FIGURE 2
Water withdrawal by sector
 Total 56 km³ in 2005

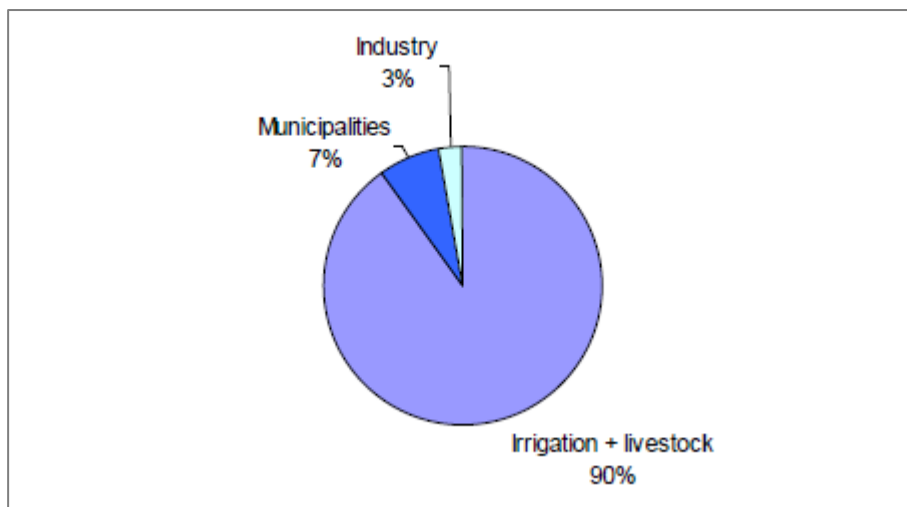
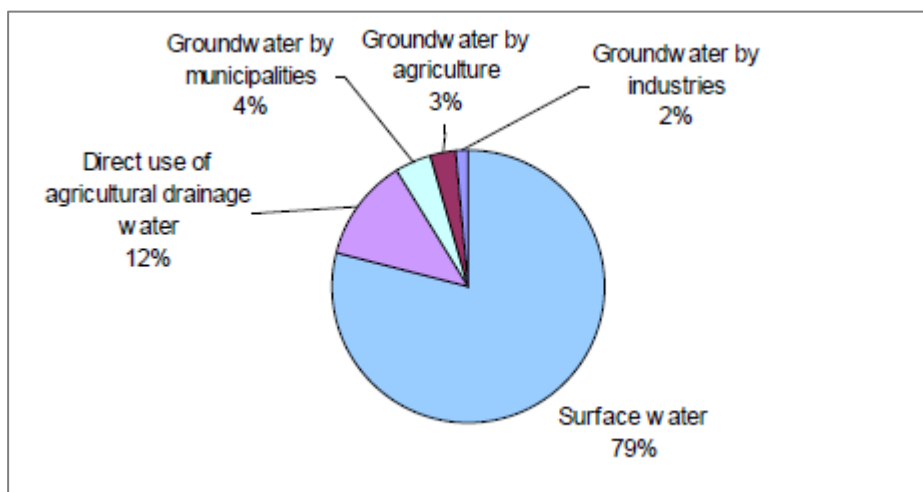


FIGURE 3
Water withdrawal by source
 Total 56 km³ in 2005



Total water withdrawal increased steadily from 45.5 km³ in 1975 to 62.8 km³ in 1985, mainly because of irrigation expansion. Since 1990, when water withdrawal was 62.5 km³, the trend declined, because of agricultural water-saving methods and a recession in the industrial sector. In 2001 total water withdrawal was an estimated 60.6 km³, of which 3.9 km³ groundwater, and in 2005 this was an estimated 56 km³, of which 5 km³ groundwater. Water allocations are regularly reduced to promote savings, satisfy demand from new users and increase water flow to the Aral Sea. Total annual irrigation water withdrawal declined from 58.8 km³ in 1990 to 50.4 km³ in 2005.

The shift towards wheat production appears to have reduced the total quantity of irrigation water consumed. Cotton requires 10 000–12 000 m³/ha, with virtually all water coming from irrigation. Winter wheat is irrigated four to six times during the growing season (October–June) and consumes approximately 8 000–9 000 m³/ha. However, only about 60 percent is delivered by irrigation, with the rest supplied by rainfall. Thus, the shift from cotton to wheat has reduced overall irrigation water requirements (Abdullaev et al., 2009).

IRRIGATION AND DRAINAGE

Evolution of irrigation development

In ancient times (from the fourth century before the common era or until the second century of the common era), the irrigated area in the lower reaches of the Amu Darya, Zeravshan and Kashkadarya rivers in central Asia was 3.5–3.8 million ha. During the feudal system (fourth–sixth centuries) there was a dramatic decrease in the irrigated area in Central Asia. However during the seventh century there was a gradual increase in irrigated farming, beginning in the ninth century there was rapid development. In the Middle Ages, (twelfth–fourteenth centuries) the total area was 2.4 million ha in the lower reaches of Amu Darya and Syr Darya. Medieval irrigation (before the nineteenth century) in Central Asia was characterized by radical redesign of the irrigation systems and construction of monumental waterside structures based on medieval hydraulic solutions. During this period, narrow and deep channels; a variety of water-pressure dams; water dividers; spillways and other water facilities were built. The shallow distribution and irrigation system of this time differs very much from that of the ancient. The irrigation system became a configuration with many branches, instead of channels at right angles to the main channel, as was the case during the ancient period.

The history of irrigation in Uzbekistan began more than 2 500 years ago in the seven natural oases: Tashkent valley in the northeast, Fergana valley in the east, Zeravshan valley in the east-central region, Kashkadarya valley in the southeast, Surkhandarya in the southeast, Khorezm in the west-central region and Karakalpakstan in the northwest. At the beginning of the twentieth century, about 1.2 million ha were irrigated in Uzbekistan. In 1913, during the period of Tsarist Russia, the irrigated area was 1.38 million ha. After the October Revolution in 1917, the irrigated areas were reduced, but in 1928 there was a return to the 1913 area.

Construction of numerous large canals, hydraulic engineering structures and reclamation facilities permitted an irrigated area of 1.85 million ha before the Second World War. In the postwar years, the irrigated area was 2.15 million ha. Large-scale development started in the late 1950s, when the USSR decided that Uzbekistan should specialize in the production of cotton, there was a shift from small- to large-scale irrigation, mainly in the arid and semi-arid regions where land was uninhabited and climatic conditions harsh. Often pump irrigation was used. Waterworks and reservoirs were constructed and irrigation networks reconstructed into engineering networks.

The development of irrigation in the 1970s was accompanied by a broad set of reclamation works – construction of a shallow collector-drainage network and major collector-discharge and drainage wells. Modern irrigation techniques were developed on the Hunger steppe in the centre of the country in the Syr Darya basin and on the Karshi steppe in the southeast in the Amu Darya basin. Strict principles of centralized management of water resources and irrigation by state bodies were introduced during this period, paid for completely out of the state budget. With the reclamation of the Golodnaya, Jizzakh and Karshi prairie, a completely new and powerful irrigation industry was developed and 30 years later, by the end of the 1980s, 100 000 ha of new irrigated areas had been developed, based on advanced technology.

In 1994, irrigation covered 4 280 510 ha, or about 82 percent of cultivated land, and the area actually irrigated was an estimated 4 202 000 ha, or 98 percent of the equipped area. In 2005, an estimated 4 198 000 ha was covered by irrigation (Uzgirovodhoz Institute, 2005), or 89 percent of the cultivated area. The area actually irrigated was an estimated 3 700 000 ha (Abdullaev et al., 2009) (Table 5). The area equipped for irrigation was reduced because the irrigated area had been completely abandoned in part of the area.

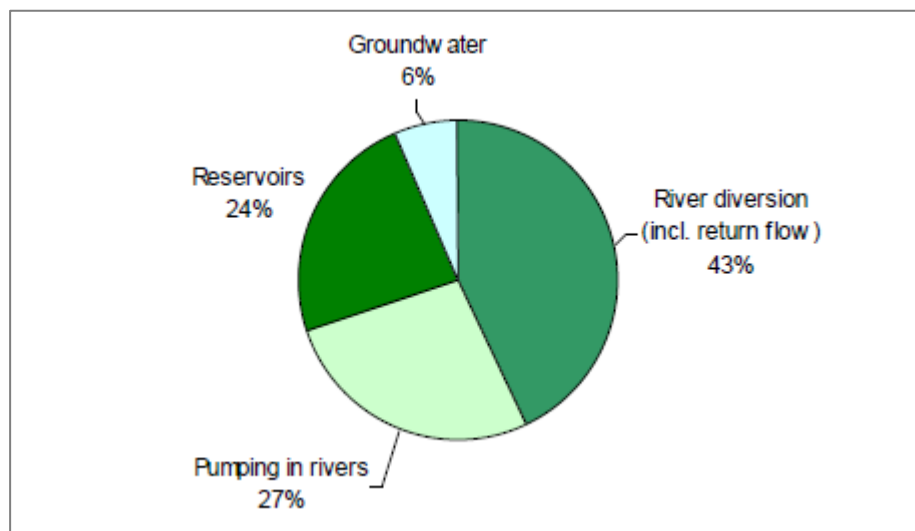
TABLE 5
Irrigation and drainage

Irrigation potential		4 900 000	ha
Irrigation:			
1. Full control irrigation: equipped area	2005	4 198 000	ha
- surface irrigation	1994	4 276 000	ha
- sprinkler irrigation	1994	0	ha
- localized irrigation	1994	4 510	ha
• % of area irrigated from surface water	1994	94	%
• % of area irrigated from groundwater	1994	6	%
• % of area irrigated from mixed surface water and groundwater		-	%
• % of area irrigated from mixed non-conventional sources of water		-	%
• area equipped for full control irrigation actually irrigated	2005	3 700 000	ha
- as % of full control area equipped	2005	88	%
2. Equipped lowlands (wetland, ivb, flood plains, mangroves)		-	ha
3. Spate irrigation		-	ha
Total area equipped for irrigation (1+2+3)	2005	4 198 000	ha
• as % of cultivated area	2005	89	%
• % of total area equipped for irrigation actually irrigated	2005	88	%
• average increase per year over the last 11 years		-	%
• power irrigated area as % of total area equipped	1994	27	%
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)	2005	4 198 000	ha
• as % of cultivated area	2005	89	%
Full control irrigation schemes:		Criteria:	
Small-scale schemes	< 10 000 ha	1994	640 930 ha
Medium-scale schemes	> and <		0 ha
large-scale schemes	> 10 000 ha	1994	3 639 580 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	2005	96	%
Harvested crops:			
Total harvested irrigated cropped area	2005	3 700 000	ha
• Temporary crops: total	2005	3 300 000	ha
- Cotton	2005	1 406 000	ha
- Wheat	2005	1 295 000	ha
- Rice	2005	52 000	ha
- Fodder (alfalfa)	2005	300 000	ha
- Other (maize potatoes, vegetables)	2005	247 000	ha
• Permanent crops: total	2005	300 000	ha
- Fodder	2005	100 000	ha
- Other perennial crops	2005	200 000	ha
• Permanent meadows and pasture	2005	100 000	ha
Irrigated cropping intensity (on actually irrigated area)	2005	100	%
Drainage - Environment:			
Total drained area	1994	2 840 000	ha
- part of the area equipped for irrigation drained	1994	2 840 000	ha
- other drained area (non-irrigated)		-	ha
• drained area as % of cultivated area		59	%
Flood-protected areas		-	ha
Area salinized by irrigation	1994	2 141 000	ha
Population affected by water-related diseases		-	inhabitants

Irrigated land accounts for more than 90 percent of crop production. About 44 percent of the total irrigated area is in the Syr Darya basin and 56 percent in the Amu Darya basin. Considering the area suitable for irrigation and future water saving, irrigation potential is 4.9 million ha, although a figure of 9.7 million ha has been mentioned (Abdullaev, 2001), which may be considered unrealistic considering that withdrawal currently exceeds primary freshwater resources and some return flow is being used.

In 1994, all irrigation was full control irrigation, mainly from surface water (Figure 4). River diversion (including return flow) accounts for 53 percent of the full control equipped area. Wastewater and most drainage water are mixed with surface water before being reused for irrigation. Thus, it is not possible to count them separately. Pumping from rivers, water from reservoirs and groundwater account for 27, 24 and 6 percent respectively.

FIGURE 4
Source of irrigation water on area equipped for full control irrigation
Total 4 280 510 ha in 1994



Irrigation in Uzbekistan relies on a system of pumps and canals, which is among the most complex in the world. In 1994, water was lifted by electric pumps to irrigate 1.17 million ha and there were about 1 500 pumps. For example: the Karshi system lifts 350 m³/s of water from the Amu Darya river over an elevation of 170 m; the Amu-Bukhara pump system discharges 270 m³/s from the Amu Darya river to a canal situated 57 m above the river; the Amu Zang pump system discharges 20 m³/s from the Surkhandarya river to a canal 75 m above the river. The total length of the irrigation network is about 196 000 km. The main canals and inter-farm network extend for about 28 000 km, of which some 33 percent is lined. The on-farm network is about 168 000 km. Most, 79 percent, is unlined earthen canals, 19 percent is concrete canals and 2 percent is pipes.

In 1994, surface irrigation was practised on 99.9 percent of the total area, mainly furrow irrigation (67.9 percent) followed by borderstrip irrigation (26 percent), basin irrigation (4 percent) and other surface irrigation (2 percent). Localized irrigation covered 4 510 ha in 1994, or only 0.1 percent of the total area. Sprinkler irrigation was no longer practised in 1994, although it had covered some 5 000 ha in 1990. Increased energy costs, and a lack of spare parts, meant that this technique was not economically viable. Sprinkler irrigation continues on some pilot demonstration sites (Figure 5).

In 1994, the total area equipped for full control irrigation covered by large irrigation schemes (>10 000 ha) was an estimated 3.64 million ha (85 percent). Small irrigation schemes (<10 000 ha) covered 0.64 million ha (15 percent) (Figure 6).

The average weighted efficiency of the irrigation network, which shows the water losses along the distance between the source and the irrigated field, is 63 percent (1994). Major differences can be observed between old and new irrigated areas. New irrigated areas have been developed since 1960 with lined canals, pipes and flumes in the on-farm network, and a subsurface drainage system, which together enable an efficiency of 75–78 percent.

FIGURE 5
Irrigation techniques on area equipped for full control irrigation
 Total 4 280 510 ha in 1994

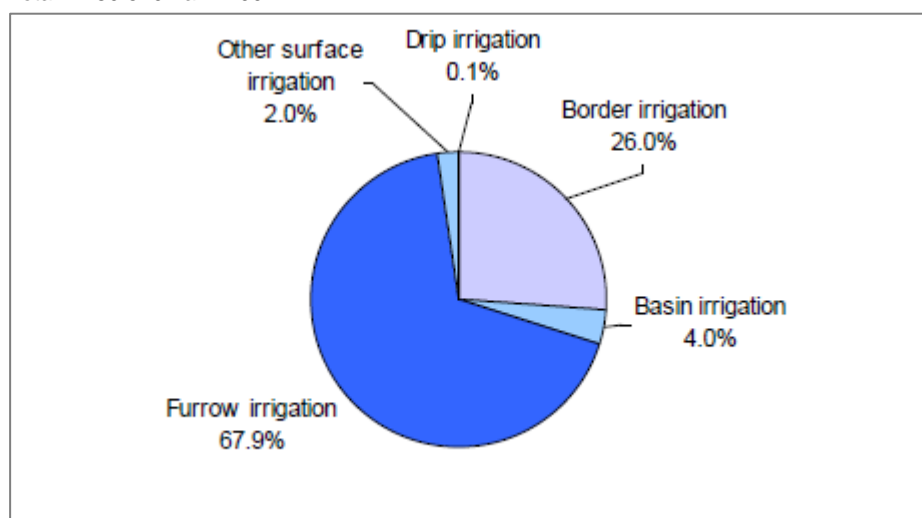
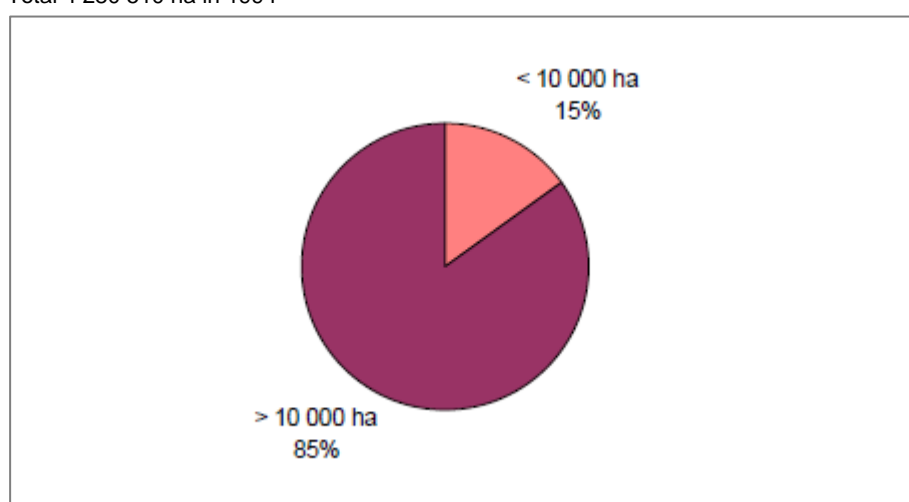


FIGURE 6
Type of full control irrigation schemes
 Total 4 280 510 ha in 1994



The total length of the inter-farm irrigation network is 27 620 km, of which 62 percent is composed of earth canals, and of the intra-farm network 167 379 km, with 80 percent composed of earth canals. There are 25 000 hydraulic works on the main and inter-farm canals and more than 44 000 on the intra-farm network. As a whole, the number of hydraulic structures is sufficient for the main and inter-farm irrigation systems, but most are in need of major repair or reconstruction.

The Amu Zang Irrigation Rehabilitation Project, presented in 2003, financed by the Asian Development Bank (ADB), helped the government improve water resources management in the south of Surkhandarya province and to rehabilitate the Amu Zang Irrigation System covering 96 800 ha near the confluence of the Amu Darya and Surkhandarya rivers, thus improving the livelihoods of about 400 000 rural people. The immediate objectives of the project were to increase the reliability, efficiency and sustainability of irrigation supplies of the Amu Zang irrigation system and to facilitate and accelerate the ongoing agricultural sector reforms in the project area. The project has four components: (i) rehabilitation of the Amu Zang irrigation system; (ii) support to improved water resources management; (iii) support to private farm development; (iv) project management, monitoring and evaluation. In addition, the project rehabilitated 102 km of drainage canals, 90 km of field canals and 258 km of field drains.

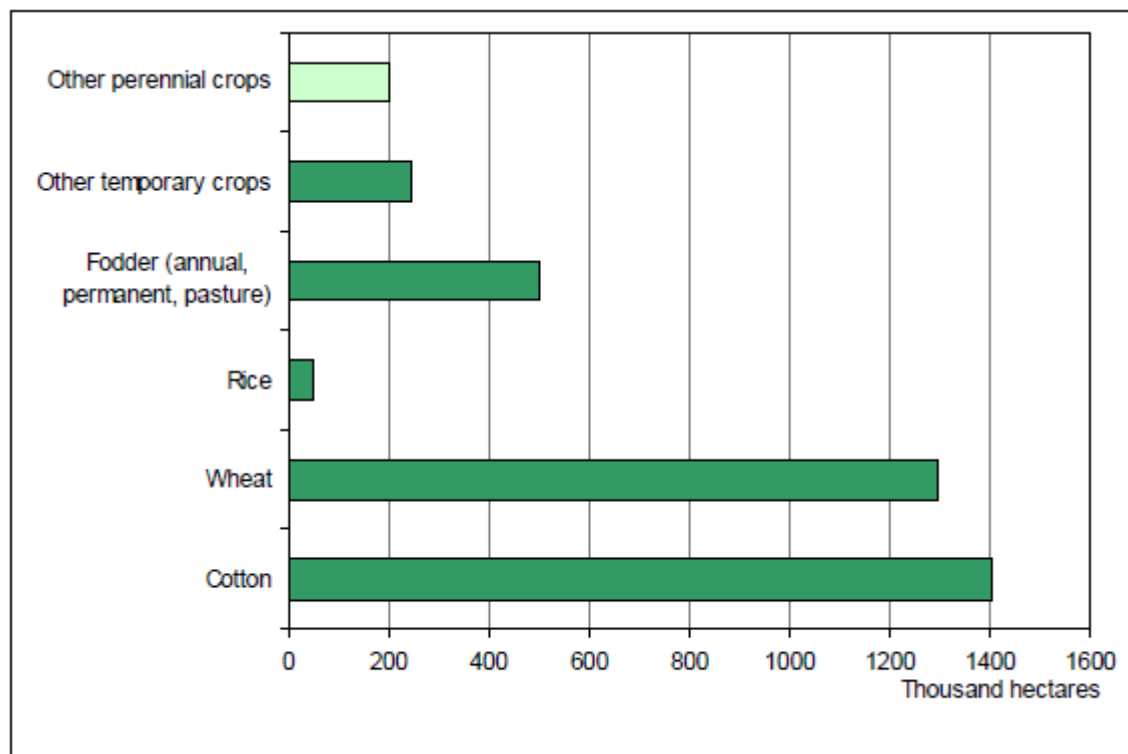
Role of irrigation in agricultural production, the economy and society

In 2005, the harvested irrigated area was 3 700 000 ha, of which 1 406 000 ha cotton (38 percent) and 1 295 000 ha wheat (35 percent) (Abdullaev et al., 2009) (Figure 7 and Table 5).

FIGURE 7

Irrigated crops on area equipped for full control irrigation

Total harvested area 3 700 000 ha in 2005 (cropping intensity on actually irrigated area: 100 %)



Since independence in 1991, cotton production in Uzbekistan has declined by approximately one-third. The major reason was a change in government policy. After independence, the government allowed the transfer of some cotton areas to private cultivation of non-cotton crops, and encouraged a shift to wheat production to cope with economic and political disruption and to meet new targets for national food security. The result was a smaller cotton area maintained by a coercive quota system both for planting and procurement. Environmental problems also contributed to the difficulty of increasing, or even maintaining, cotton productivity (Abdullaev et al., 2009).

The large increase in the area under winter wheat has negatively impacted the irrigation and drainage (I&D) network. Earlier, under cotton monoculture, during the non-vegetation period of October-March, there were no crops in the field, and the I&D network was cleaned and prepared for the next season during the fallow fall-winter months. Currently, winter wheat is grown from the fall (October) to the next vegetation season (June). While the evapotranspiration of wheat during this period is low, it still requires five to six irrigations. Therefore, the I&D network is operating almost 12 months a year, leaving little time for cleaning or minor repairs. Irrigated wheat yield is an estimated 4.4 tonne/ha while rainfed wheat yield is 1.5 tonne/ha (Abdullaev et al., 2009).

In 1997, the average cost of irrigation development was about US\$11 200/ha for surface irrigation schemes using standard modern technologies, including agricultural infrastructure. Rehabilitation and modernization costs of the old irrigated areas were an estimated US\$4 500/ha. The two main elements of such work would be laser land levelling and the introduction of modern irrigation techniques (drip, surge). The cost of drip irrigation development on existing irrigated areas varied between US\$2 300 and 3 500/ha. Average annual operation and maintenance costs for full recovery was about US\$450/ha for standard systems, more than US\$640/ha for drip irrigation systems and US\$680/ha for pump systems.

Status and evolution of drainage systems

The two major land quality problems are the interrelated issues of salinity and waterlogging caused by high groundwater levels. In 1994, only 50 percent of irrigated land was classed as non-saline by Central Asian standards (toxic ions represent less than 0.5 percent of total soil weight). In the upper reaches of the Amu Darya and Syr Darya river basins, less than 10 percent of the land is saline or highly saline, while downstream (especially in Karakalpakstan) about 95 percent of the land is saline, highly saline or very highly saline. Salinity is closely related to drainage conditions. Moreover, since 1990, a reduction in the quantity of water allocated to each farm, lower water quality, and the decline of companies responsible for maintaining the drainage network have resulted in increased salinization. Though loss of crop production, resulting from soil salinization is important, generally salinized land is still cultivated.

About 3.3 million ha of irrigated land require drainage. In 1994, only 2.8 million ha were equipped with drainage infrastructure (Table 5). Most of the drainage systems are open drains. Horizontal (surface) drainage is carried out on 1.7 million ha (61 percent), subsurface drainage on 0.7 million ha (25 percent) and vertical pumping drainage on 0.4 million ha (14 percent), mainly on clay soils. The total length of main and inter-farm collectors was about 30 000 km, while the on-farm collector-drainage network extended about 110 000 km. In total the Ministry of Agriculture and Water Resources (MAWR) mentions 7 447 wells, including 3 344 for pumped-well drainage and 4 103 vertical wells for irrigation.

During the transition period, development of drainage slowed and most infrastructure deteriorated. Since 2007, however, after the creation of a special fund to improve irrigated land, more than US\$110 million is spent annually to improve infrastructure, with the result that main and inter-farm collectors are in satisfactory condition. The intra-farm open collector-drainage network is to some extent satisfactorily maintained in Bukhara, Kashkadarya, Ferghana and Namangan regions. The "Drainage, Irrigation and Wetland Improvement Project" in South Karakalpakstan, recently improved drainage in that region. In other areas it is in disrepair.

The following drainage problems remain: ongoing operational activities that do not conform to drainage design parameters; lack of funds for maintenance, repair and development of drainage. Under current conditions the unit cost for the operation and maintenance of irrigation and drainage facilities is US\$86.2/ha, including a share of US\$7.18 for drainage (8.3 percent).

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

Institutions

The General Authority of Water Resources (GAWR) of the MAWR carries out water management. MAWR, established in 1996 after the merger of the Ministry of Agriculture with the Ministry of Water Resources, performs the following main functions (GoU, 2011b):

- conducts monitoring of compliance with water legislation, cooperatives (shirkat) and private farms, considers infringement and takes appropriate decisions;
- participates in the development and implementation of branch and regional agriculture and water management development programmes in conjunction with other concerned ministries, agencies, state committees, local and government state bodies;
- together with other ministries, agencies and state committees coordinates the development and implementation of measures directed at the development of multi-sectoral agriculture and rights protection of rural producers;
- together with the Ministry of Economics and the State Demonopolization and Competition Development Committee, within the coordinated programmes, the Ministry of Finance carries out a review of agricultural market conditions in the regions for the purpose of identifying

practices of artificial increase of prices, abuse of a monopoly situation in the market and unfair competition;

- prevents or addresses infringement of legislation concerning agriculture, water resources and water use;
- monitors use of budget funds of subordinate enterprises and organizations;
- conducts financial and economic analysis and provides methodical assistance to auditing commissions of cooperatives;
- together with other agencies develops a development strategy on rural industrial and social infrastructure;
- participates in the coordination of economic and social development of construction by industrial, project enterprises, organizations, agencies and their associations subordinate to the MAWR.

Institutional organizations dealing with water management at state, provincial and district level fall under the MAWR. They are responsible for water distribution and delivery to the farm inlet, to assist water users to implement advanced technologies, for water use and water quality control. The special land reclamation service, under the MAWR, monitors the main reclamation indicators of irrigated land (groundwater level, drainage discharge, soil salinity, state of the collector-drainage network) at national, provincial and local level. It also plans the required measures for irrigation and drainage network maintenance and for the reclamation of degraded lands, including leaching, repairing and cleaning of drainage-collectors and network rehabilitation. MAWR is also in charge of agricultural research and extension, on-farm agricultural and land reclamation development, and on-farm operation and maintenance of the irrigation network.

After Uzbekistan gained independence there was a change in the water resources administration from that of a regional and district-based administrative water management system, established with the creation of the USSR, into an irrigation basin water management system based on hydrological principles. The latter involved the creation in 2003 of the Basin Authorities of Irrigation Systems (BAIS), composed of the Authorities of the Main Canals (AMC) and Irrigation Systems Authorities, following the resolution of the Cabinet of Ministers of the Republic of Uzbekistan No. 320 d/d on 21 July 2003, for ‘improvement of water management’.

The Central Asia Scientific Research Institute of Irrigation (SANIIRI) undertakes research on the water resources development sector. This autonomous institute, linked to MAWR, was responsible for all Central Asia. It also manufactures irrigation equipment.

The Goskompriroda (State Committee for Nature Protection) is in charge of water quality monitoring and control of industrial and municipal pollutants.

Uzbekistan is a member of the IFAS, the ICWC, and the Amu Darya and Syr Darya River Basin Water Organizations (BWOs).

The Association of Uzbekistan for Sustainable Water Resources Development (AUSWRD) was established in 1998 and promotes cooperation in water resources development for Aral Sea basin workers. It also aims to share information on water issues, influence government decisions with regards to water and provide education on water use and sanitation. The AUSWRD vision is to have Uzbekistan become an example for sustainable water use.

In 2011, the government adopted the decision to create the National Committee on Large Dams, to represent the country’s interests at the International Commission of Large Dams (ICOLD). According to this document, its main tasks are to promote the interest of Uzbekistan in ensuring the security of large dams, and Uzbekistan’s position regarding the rational use of transboundary water resources. The committee will also improve the system to ensure the security of dams by studying the experience of

other countries and exchanging scientific, technical and other information with similar foreign committees. The committee will also participate in the work of ICOLD.

Water management

After the demise of the USSR, the newly emerging states began to change their agricultural policies. In Uzbekistan changes included: (1) preventing social unrest by redistributing land to families; (2) increasing wheat production for food security; (3) implementing a quota system for cotton and wheat; (4) changing agricultural subsidies; (5) distributing large collective farms (Abdullaev et al., 2009).

During the Soviet period, cotton was produced on large-scale collective farms, typically 2 000–3 000 ha. The farms managed all aspects of the production system, including agricultural machinery and irrigation. Because the farms were believed to be inefficient, after independence their land was split into smaller, although still collective, farm units known as shirkats. However, no restructuring was undertaken of other system assets such as irrigation. The result was land management units no longer matched the input units, resulting in poor performance of irrigation and drainage networks, with cotton yields being lower than they were during the 1980s.

A second trend in farm management after independence was the emergence of individual farms, which began in 1992. The government had originally considered individual farms experimental, they were allocated low fertility land with poor water supply. At the beginning of 2003, the government began to transform the collectives into individual farms. Under the new policy, priority was given to the development of individual farms as the major producers of agricultural commodities. Between 2004 and 2006, 55 percent of collective farms were transformed into individual farms. By 2004, individual farms occupied 17 percent of agricultural land and hired 765 300 workers.

The final transformation was the rise of the so-called dehkan farms. These are the legalized family plots from which most of the population earns their income. The state now encourages family plots to be registered as legal entities so they can acquire credit and benefit from other financial instruments. Dehkan farms are allowed to grow any crop except cotton and sell output on the open market. They cannot join the cotton and wheat quota system. Much of the production, primarily fruits and vegetables, grown on dehkan farms is exported to the neighbouring Russian Federation and to Kazakhstan. However, what is most striking about dehkan farms is their large contribution to agricultural GDP, an estimated 25 percent in 2004, despite their relatively small area (Abdullaev et al., 2009).

During the first land reform, the state and collective farms were transformed into different economic organizations, but continued to function in the same way as former collective farms. Only a small portion of the land held by the state and collective farms was privatized, but they depended on the collective farms for water allocation and distribution. In the second land reform, collective farms were abandoned, collective farm land was leased to farmers, and water user associations (WUAs) were introduced. The second reform started in 1996, with the government contracting SANIIRI to establish a framework for WUAs in Uzbekistan. Three years later, at the end of 1999, SANIIRI completed its research on establishing WUAs. The second wave of land distribution took place at the beginning of 2000. Unprofitable collective farms were privatized, and their land distributed to former employees. Land privatization was accompanied by irrigation management, transfers and the introduction of Farm Organizations (FO) and WUAs (Wegerich, 2002).

Until 2003, the management of major irrigation canals and water reservoirs was solely under state control. All irrigation infrastructure at the main system level was managed territorially, through provincial and district-level water management organizations. Each of the territorial units (district, province) had state production quotas for cotton and wheat. As water was such a crucial factor, each governor tried to appropriate more water for his or her district. The resulting territorial fragmentation of water resources management led to inequitable water distribution and head-tail water disputes.

On 21 July 2003, the Cabinet of Ministers of the Republic of Uzbekistan issued the earlier mentioned decree No. 320 (related to the creation of the Basin Authorities on Irrigation Systems) to reform the water management system by transferring water management from an administrative-territorial system to a basin approach. The main goal of this reform was to consolidate water management through the establishment of WUAs and Canal Management Organizations (CMOs), operating within single hydraulic units, in order to ensure equal access to water for different users and improve water use efficiency (Abdullaev et al., 2009). By the end of 2010 there were 1 486 successfully functioning WUAs, providing water services to more than 80 000 water users, including farmers. On 29 December 2009, the “Water and water use” law was revised and the previously used WUA concept related to irrigation was renamed into the Water Consumers Association (WCA). The distinction between them was clarified as follows: “water user” refers to not affecting the actual amount of available water (such as fisheries and hydropower) and “water consumer” refers to reducing the actual amount of available water (such as irrigation).

Karakalpakstan and Khorezm are located in the driest part of Uzbekistan. Over the last three decades, the drying up of the Aral Sea has further aggravated the water shortage problem. Since mid-2000, Karakalpakstan and Khorezm have been suffering from the worst drought in 100 years. About 90 percent of the rice crop and 75 percent of the cotton crop were lost in 2000 and 2001. The Western Uzbekistan Rural Water Supply Project was launched in 2002 with a loan from the ADB. It provided urgently needed assistance by responding to the worsening consequences of drought during the previous years in the Aral Sea area of northwest Uzbekistan. The Project covered Karakalpakstan and Khorezm by: improving potable water supply and providing support to sanitation and personal hygiene practices to about 700 000 rural population in the Project area, of whom over 60 percent were poor, by introducing water conservation measures, educating the public about the value of water and promoting health awareness campaigns.

In 2001 and 2002, USAID and MAWR implemented a large-scale pilot project on the Pakhtaabad canal which serves more than 20 000 ha of irrigated land and about 100 000 farmers in Andijan (Uzbekistan) and Jalalabad (Kyrgyzstan). Although Andijan and Jalalabad are high-yield farming areas, ineffective water management in the last decades had diminished irrigated land and reduced yields. The pilot project demonstrated how cost-effective technologies and automated systems could improve water control and management along major existing watercourses (USAID, 2003b).

To improve the situation in the water resources management sector, the government of Uzbekistan, international organizations, and International Financial Institutions (IFIs) are developing and implementing a number of projects, dealing with urban water supply, improvement of irrigation and drainage systems, improvement of sewerage systems and wastewater treatment facilities.

The Water Supply, Sanitation and Health Project (1999–2007), was prepared by the government with the International Bank for Reconstruction and Development (IBRD) and United Nations Development Programme (UNDP) assistance in support of the Aral Sea area. The objectives of the project were to improve water supply, sanitation and health in the project area (Karakalpakstan and Khorezm) through the provision of safe drinking water and sanitation facilities and the strengthening of the financial, operational and managerial capacities of water supply and sanitation utilities (UNDP, 2000).

In 2004, the government and the World Bank signed a US\$74.55 million Drainage, Irrigation and Wetlands Improvement Project, to increase productivity of irrigated agriculture, employment and incomes in Karakalpakstan, to improve water quality of the Amu Darya river by safe disposal of drainage effluent, and enhance the quality of wetlands in the Amu Darya delta. It also developed institutions to improve water management, operation and maintenance of irrigation and drainage systems, and promoted sustainable irrigated agriculture through participatory irrigation management. The Ministry of Agriculture and Water Resources was responsible for the timely implementation of the project.

MAWR has initiated reforms of irrigated agriculture to increase crop productivity and system operators' administrative efficiency. An important reform is the restructuring of the Zeravshan river irrigation systems into one basin administration under the control of a single operating agency. USAID works with the ministry and the basin's operating agency and is also collaborating closely with the government to implement substantial improvements to the main delivery canals of the Surkhandarya river irrigation system and the Zeravshan river basin. Over 3.5 million people are directly engaged in farming in these areas (USAID, 2003a).

In 2010, the World Bank launched the Fergana Valley Water Resource Management Phase-I Project, which deals with increasing water use efficiency and rehabilitating the irrigation and drainage infrastructure in Fergana Valley to promote economic development.

Finances

During the Soviet period, Uzbek cotton was among the most highly subsidized crops. Inputs were provided to collective farms at large discounts, and credits were allocated to state-owned enterprises by the government banking systems at concessional interest rates. The state still controls, monopolizes and subsidizes input markets. Starting in 1993, the government established a range of state-owned agencies for agricultural inputs, which provide inputs such as machinery and fertilizers. Credit subsidies, both through low rates and write-offs, especially for collectives, also existed. In 2004, the government provided approximately US\$400 million in subsidies, equivalent to approximately 43 percent of the value of the cotton crop. It also provided subsidies to the agricultural sector of which \$261 million or 65 percent went to irrigation service provision (Abdullaev et al., 2009).

In 1995 a land tax was introduced. The amount payable depends on irrigation and land quality, which is calculated by province on the basis of a soil fertility parameter. For example, in 1997, in Karakalpakstan, the tax varied from US\$0.64/ha for the lowest fertility class to US\$6.5/ha for the best fertility class. In the south of the country, the tax varied between US\$1.1 and 11.2/ha. A WCA is in charge of operating and maintaining the on-farm water infrastructure through irrigation service fee (ISF) collection. However, most WCAs are still not able to take full responsibility and generate sufficient investment for the infrastructure maintenance.

Policies and legislation

A water law was approved in May 1993. It introduced the notion of water rights. Within the general objective of water savings, Article 30 emphasizes the need for water pricing, although it still leaves room for subsidies to the water sector.

The legal framework is constantly being improved and in 2009 a new law was approved on 'Introducing amendments to some legislative acts of the Republic of Uzbekistan in connection with the deepening of economic reforms in agriculture and water management'. The law is said to be a successful in the water sector, because it clearly governs the relationship between water users, increases their responsibility concerning the rational and economical use of water, determines the status of water consumer associations (former water users associations) and reflects the basic principles of Integrated Water Resource Management (IWRM).

A policy framework for water supply and environmental sanitation is being developed, which besides providing water supply and sanitation to areas currently without, will contribute to a reduction in water-borne and water-related diseases and improve the nutritional status of the population in general and children in particular (UNICEF, 2003).

ENVIRONMENT AND HEALTH

From 1960 to 1992 the surface area of the Aral Sea was halved and its volume quartered, as the Amu Darya and Syr Darya rivers were channelled and dammed to provide irrigation for agriculture. The dry land has separated the remaining bodies of water into two main lakes (OrexCA, 2011). The areas most affected are Karakalpakstan and the neighbouring region of Khorezm, which together contain a population of over 2.5 million people at risk (UNICEF, 2003).

As the sea level drops by 1 m/year, more land is exposed, and chemical pesticides used in cotton production are concentrated in a crust on the newly-exposed land. Winds then disperse the crust as a cloud of lethal dust, causing health problems among the population and reducing agricultural productivity as a result of land and water salinization. The people in these regions suffer from high levels of anaemia, together with rising levels of tuberculosis, while children suffer from liver, kidney and respiratory diseases, micronutrient deficiencies, cancer, immunological problems and birth defects.

All existing wetlands are used for fishing. Environmental wetland problems are mainly associated with the unstable regime of water flow and the low level of its protection, thus limiting the possibilities of conservation of habitats and biodiversity of flora and fauna of this ecosystem.

In Karakalpakstan the fishing industry has disappeared and agricultural land is no longer productive, resulting in a rapid loss of employment opportunities for local people. Consequently, vulnerability to poverty has increased. Forty-percent of the rural population depend on small subsistence plots of land for their livelihoods, but these plots have been adversely affected by water shortages or pollution and the rural population consequently face increasing hardship, malnutrition and illness.

In 2001 and 2002, the situation in Karakalpakstan and Khorezm declined further as a result of two consecutive years of drought that brought water shortages. The drought had a negative impact on domestic and personal hygiene exposing the population to higher risk of water-borne diseases such as typhoid, diarrhea and worm infection. Although the government has made progress, in this region still only 54 percent of urban and 3 percent of rural populations have access to adequate sewage systems, the rest rely on very basic and unhygienic pit latrines. One of the major problems is salinization and although Karakalpakstan has 63 out of 80 functioning desalination units, most of these are working well below their capacity and need major repairs (UNICEF, 2003).

Intensive development of new irrigated areas in 1960–1980s was accompanied by land salinization, waterlogging, land degradation and increased discharge of highly salinized drainage water into the Amu Darya river through a system of collector drains. These led to increased salinization and pollution of the river, as well as negative impacts on the health of the population and on agricultural production. Waterlogging and/or salinization already affect 50 percent of irrigated areas in Uzbekistan.

Salinity of irrigation water in the middle reaches of rivers has become 1–1.1 g/litre with a low content of organic substances, and in the lower reaches at certain periods it becomes an average of 2 g/litre and more (compared to the original 0.2–0.3 g/litre), and organic substances 29.6 mg/litre. Sewage and municipal wastewater discharged into some rivers leads to increased pollution along the course from its source downstream. Pollution by petroleum products goes from 0.4 to 8.2 maximum allowable concentration (MAC), by phenols up to 6 MAC, by nitrates up to 3.7 MAC, by heavy metals up to 11 MAC. The contamination rate of groundwater has also increased.

PROSPECTS FOR AGRICULTURAL WATER MANAGEMENT

As population and industrialization increase, growing municipal and industrial water needs will compete with demands for irrigated agriculture. Increasing the efficiency of agricultural water use is essential for supporting rural livelihoods, producing sufficient food for the growing population, and producing

commodity crops, that are important to the national economy, and continuing social and economic development (USAID, 2003a).

Economic deterioration in Central Asian countries, which had followed the disintegration of the USSR, resulted in less than normal water use. Also, the partial thawing of the Pamirs and Tien Shan glaciers, along with global warming, provided temporary relief for an inevitable water shortage. The situation is predicted to become more serious by 2020 when the glaciers feeding the Amu Sarya and Syr Darya rivers will have lost their critical mass (FIA, 2008).

Out of the countries located in the basins of the Amu Darya and Syr Darya rivers, Uzbekistan has the largest population and requires the largest amount of water. The population is growing by half a million people per year, meaning that there is a need for more products and expansion of irrigated lands, which requires even more water. Based on the data of the 'Vodoproekt' (Water project) association of the MAWR, in 10–15 years the population may reach 32–35 million and water requirements will far exceed those available in the country. Thus, the urgency of the problem is beyond question (Akhmadov, 2008).

Even if policy changes reduce cotton exports, it is much more likely that any water 'saved' from reduced cotton production will instead be used to produce other crops, as has been the pattern to date. Soviet planners made the initial decision to trade the viability of the Aral Sea for agriculture. There is currently no reason to think that present and future governments will reverse that decision. If water scarcity is to be a factor for the Uzbek cotton production, it is most likely to occur because of the regional trade-offs between downstream agriculture (Uzbekistan and Kazakhstan) and upstream energy production (Kyrgyzstan and Tajikistan), than between agriculture and environment, at least in the foreseeable future (Abdullaev et al., 2009).

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