

Scientific-Information Center
Interstate Commission for Water Coordination in Central Asia

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**IRRIGATION AND DRAINAGE IN
THE STATES OF CENTRAL ASIA,
CAUCASUS AND EASTERN
EUROPE**

Tashkent 2017

This publication was presented at the 2nd World Irrigation Forum (November 6-12, 2016, Chiang Mai, Thailand) organized by the International Commission on Irrigation and Drainage.

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Land resources in the EECCA countries

The Eastern Europe and Central Asia region accounts for 21 percent of the world's land area and 16 percent of its agricultural land. More than half of the region's land lies in the Russian Federation. Central Asia has a much higher share of agricultural to total land than Europe.

The country in the region with the highest share of agricultural land is Kazakhstan, with 77.5 percent of its 270 million hectares used for farming and stock-raising. The next is the Republic of Moldova, with 74.8 percent, and Ukraine with 71.3 percent.

Between 2009 and 2011 the proportion of agricultural land to total land increased marginally in Central Asia and South Eastern Europe.

The last two years have also seen an increase in organic agriculture's share of farming in the region. Organic agriculture as share of agricultural land in Central Asia and South Eastern Europe shows modest increases.

Table 1. Land and agricultural area (as of 2011)

Source: FAO, Statistics Division (FAOSTAT)

Country	Total area, million ha	Agricultural land, %	Forest, %	Other, %
Central Asia	393	72.3	3.1	24.6
Kazakhstan	270	77.5	1.2	21.3
Kyrgyzstan	19	55.3	5.1	39.6
Tajikistan	14	34.7	2.9	62.4
Turkmenistan	47	69.5	8.8	21.7
Uzbekistan	43	62.7	7.7	29.6
Caucasus	18	51.2	19.9	28.9
Armenia	3	60.1	9.1	30.9
Azerbaijan	8	57.7	11.3	31
Georgia	7	35.5	39.4	25
East Europe	1719	50.7	30.2	19.1
Belarus	20	43.7	42.7	13.5

Country	Total area, million ha	Agricultural land, %	Forest, %	Other, %
Moldova	3	74.8	11.9	13.3
Russian Federation	1638	13.1	49.4	37.4
Ukraine	58	71.3	16.8	11.9
EECCA	2130	58	17,7	24,3

Water resources in the EECCA countries

The EECCA countries are characterized by a wide range of climatic conditions that explain uneven water distribution in the region. The Russian Federation has 31,500 m³ of renewable water per capita a year, then Georgia has 14,300 m³/capita/year, and Uzbekistan possesses only 1,800 m³/capita/year (FAO, 2013). At the same time, the total water withdrawal in the EECCA region is only 6% of the total global water withdrawal (UN-WATER/WWDR, 2012, FAO, 2013).

The Central Asian countries, such as Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan, and Uzbekistan are covered by high mountains, vast deserts and bare, grass steppes. Climate is mainly dry, semi-arid and arid, and cold in mountains. Average annual precipitation reaches 700 mm in Kyrgyzstan and Tajikistan because of their high mountain topography. The other three countries receive from 160 mm to 250 mm of precipitation. There are two major rivers – Amudarya and Syrdarya – and their tributaries that cross the territory of the five countries and flow into the remainder of the formerly well-known landlocked Aral Sea. Other large rivers include Irtysh, Ural, and Embu in Kazakhstan and Naryn, Talas, and Chu in Kyrgyzstan.

Because of semi-arid and desert climate, agriculture in Central Asia is supported by heavy irrigation.

The Caucasus includes Armenia, Georgia and Azerbaijan that are comprised of mountain ranges, ridges and plateaus, as well as plains and lowlands. The countries lay entirely in the subtropical region but in the zones of semi-desert and dry steppe climatic systems, moderate climate, cold climate, and mountain tundra in places. Average annual precipitation varies from more than 1,000 mm in Georgia to 450 mm in Azerbaijan. The rivers are largely short and rapid because of mountainous terrain. The rivers are Akhuryan, Vorotan, and Arax in Armenia, Kuru and Chorokh in Georgia, Kuru, Arax, Araz and Ganykh in Azerbaijan.

The Eastern Europe countries include Ukraine, Belarus, and Moldova. The climate is moderately continental and the topography varies from fertile plains (steppes) to mountainous terrain and mountains. Good precipitation varies from 450 to 650 mm annually. Consequently, there is a dense river network in this region. Ukraine

has seven large rivers, such as Desna, Dnieper, Dniester, Danube, Prypyat', Severskiy Donets, and Pivdenny Buh. Major rivers of Belarus include Western Dvina, Niemen, Dnieper, Berezina, Sozh, and Prypyat'. The larger area of Moldova is located between two major rivers – Dniester and Prut. Sufficient precipitation and the fact that this region possesses the most fertile soil in the world - the Ukrainian chernozem (FAO, 2001) - indicates that agriculture needs limited irrigation here.

South Ukraine (Herson, Odessa, Nikolaev, and Zaporozhye provinces) is characterized by moderately continental climate and humid climate (Odessa province). Average annual precipitation varies from 320 mm to 470 mm and falls mainly in summer. Most typical soil types include southern and common chernozem, medium- and thin-humous soil; thin-humous and podzolic chernozem prevails in the north; and, southern alkaline chernozem dominates in the coastal area. More than 328 rivers flow through South Ukraine, the major ones being Dnieper, Dniester, Danube, Pivdenny Buh, Ingul, Ingulets, Berezan', Kodyma, Savranka, Koshevaya, Kazak, Rvach, Litvinka, Ol'khovaya, and Domakha. As many as 109 rivers flow through Zaporozhye province, the largest river being the Dnieper, which serves as major transport corridor in Ukraine, the source for province's industry, with multiple reservoirs built along this river.

The Russian Federation is the largest country and its territory includes a wide variety of climate types, topologies, and biomes. At the same time, its vast areas are under continental and subarctic climatic regimes, with plenty precipitation recharging the world's largest rivers, such as Volga, Ob', Yenisei, Lena, Kolyma and Amur. The world's largest reservoir of freshwater - Lake Baikal – is also located in its territory (UNESCO, 2013). Thus, the Russian Federation possesses largest total renewable water resources per capita among the EECAA countries (FAO, 2013).

South of the Russian Federation (Stavropol, Kuban, Kalmykia, North Caucasus) shows diversity of climatic conditions: moderately continental and continental climate in most of area; moderate and moderately warm climate (Adygei, Karachai-Cherkess); humid continental and subarctic climate in plain and foothills of Kabardino-Balkaria; moderately continental and arid (Dagestan). Average annual precipitation varies from 280 mm in plain area to 3,200 mm in mountains. The soil of Stavropol krai is mainly chernozem (south and common) and chestnut soil (light and dark). Motley grass-grasses and grass steppes prevail, with sagebrush-grass vegetation and saline and alkaline soil in east and north-east. The soil cover in Krasnodar krai is comprised mainly of Pre-Caucasian calciferous and leached chernozem in steppe zone, mountain brown forest soil and humus-carbonate soil in mountains, and mountain-meadow soil in highland. Most of plain area in North Caucasus is situated in steppe zone, which gives place to the Caspian Sea region's semi-deserts in the east. The Caucasus Mountains are covered with forest at an altitude of up to 2000 m; the Black Sea coast refers to subtropical zone. The soil of North Caucasus is high fertile: chernozem covers almost 47% of its whole area; 18% is chestnut soil; and, 6% is alluvial soil. These soil types occupy most of steppe and piedmont areas and are favorable for cultivation of various crops.

A number of rivers flows in the south of Russia, including Volga, Kuban,

Kuma, Terek, Yegorlyk, Laba, Sulak, Sunzha, Malka, Bolshoi Zelenchuk, Kura, and Manych. Almost 220 rivers, the total length of which plus tributaries is more than 10,000 km, are in Stavropol region. Kuban is the main river in Krasnodar krai, which has many left tributaries (Urup, Laba, Belaya, etc.) and which is regulated by Krasnodar reservoir. The largest rivers of Northern Caucasus include Don, Kuma, Kuban, Terek, and Sulak. Although there is abundant water, it is distributed quite unevenly throughout the territory. The piedmont of Caucasus and the Azov-Black Sea valley have a dense river network, while the steppe area of the Don's right bank and north-eastern regions are water poor.

Agriculture is the largest water consumer in most countries of the region. This sector used 136,214 million liters or 58.7 % of the total water withdrawal from 2003 to 2007. The second largest water consumer is the production sector (68,061 million liters) accounting for almost 29.3% of the total water withdrawal, and domestic sector, with its share at 11.9% of the total water withdrawal and the water use volume of 27,627 million liters takes the third place. However, these indicators differ substantially among the countries in the EECCA region.

Agricultural share in water use is the largest in Turkmenistan followed by Kyrgyzstan, Tajikistan, and Uzbekistan. These countries are agrarian ones, with the GDP share of agriculture estimated at 31% in Kyrgyzstan and more than 30% of population employed in this sector in some cases (FAO, 2013). Until now, cotton and wheat have been the major crops in these countries. Since these Central Asian countries are mainly arid and semi-arid, agriculture strongly depends on irrigation and needs a lot of water. Big quantities of water abstraction and irrigation have led to exhaustion of water resources, salinization and further desertification. The Aral Sea disaster is a well-known example of environmental problems caused by excessive irrigation water use.

Once the fourth largest lake in the world, the Aral Sea has shrunk by 90% due to steady increase of cotton production in this arid region that destructed the formerly flourishing fish industry and left fish ships aground in the vast desert.

Table 2. Annual water withdrawal by sector and sectoral shares in the total water withdrawal in EECCA countries, 2003-2007

Source: Economics and Outlook for Eastern Europe, the Caucasus, and Central Asia (UNEP 2013.)

Country	Agriculture	% of total water withdrawal	Production sector	% of total water withdrawal	Municipal	% of total water withdrawal	Total withdrawal
	Mm ³	%	Mm ³	%	Mm ³	%	Mm ³
Armenia	1890	66.1	125	4.4	843	29.5	2858
Azerbaijan	9330	76.4	2360	19.3	521	4.3	12211
Belarus	840	19.4	2332	53.8	1166	26.9	4338

Georgia	1055	58.2	400	22.1	358	19.7	1813
Kazakhstan	14030	67.7	5839	28.2	853	4.1	20722
Kyrgyzstan	7447	93.0	336	4.2	224	2.8	8007
Moldova	36	3.4	883	82.9	146	13.7	1065
Russian Federation	13200	19.9	39600	59.8	13400	20.2	66200
Tajikistan	10440	90.8	408	3.5	647	5.6	11495
Turkmenistan	26360	94.3	839	3.0	755	2.7	27954
Ukraine	1186	6.2	13440	69.9	4614	24.0	19240
Uzbekistan	50400	90.0	1500	2.7	4100	7.3	56000
EECCA	136214	58.7	68061	29.3	27627	11.9	231902

Irrigation potential

The methods used to estimate the irrigation potential vary from country to country and produce different final results. Some countries in their estimations of irrigation water quantities consider renewable water resources, while others, especially in arid regions, include fossil water sources or non-conventional sources, as well as the availability of secondary freshwater. In addition, some countries consider irrigable land, without considering water availability. Therefore, one should consider different countries, while bearing in mind the above factors. In case of the use of water from transboundary rivers, estimations by some countries of their irrigation potential in the same river basin may lead to double counting of a part of the shared water resources. Therefore, for the regional assessment of irrigation potential, it would be incorrect to sum up country figures.

The irrigation potential in the five Central Asian countries is estimated at 14.848 million ha. Currently, the total irrigated area is about 9.151 million ha or approx. 62% of irrigation potential in the region (FAO, AQUASTAT Survey 2012).

The irrigation potential in Caucasus and Eastern Europe is estimated at 4.585 million ha and 36.0 million ha, respectively. The total irrigation potential in the EECCA region is 55.4 million ha.

Irrigated area

Irrigation is important for national economies in Central Asia. Because of arid climate, crop must be irrigated in most of the territory. Although certain areas have been irrigated for centuries, many irrigation and drainage systems were constructed in 1950-1980 under central planning in the Soviet time. Vast irrigation systems were built to irrigate desert or steppe areas, and hundreds of thousands were resettled to new irrigated land to work in agriculture. Since 1970 to 1989 (end of the Soviet era), the irrigated area increased several times: by 150% and 130% in Amudarya and Syrdarya basins, respectively.

Table 3. Distribution of areas equipped with irrigation systems and actual irrigated areas in Central Asia, the Caucasus, and Eastern Europe

Source: FAO, AQUASTAT Survey 2012 and AQUASTAT – FAO Data base

Country	Year	Irrigated areas							
		Irrigation potential	Full control irrigation	Spate irrigation	Area equipped for irrigation	Area equipped for irrigation as % of cultivated area or potential area	Area equipped for irrigation as % of total area	Area equipped for irrigation actually irrigated	Actually irrigate area as % of area equipped for irrigation
		ha	ha	ha	ha	%	%	ha	%
Kazakhstan	2010	3 768 000	1 199 600	866 300	2 065 900	9	21	1 264 970	61
		1 307 000****						700 000*****	
Kyrgyzstan	2005	2 247 000	1 021 400		1 021 400	75	10	1 021 400	100
		652 000****						364 000*****	
Tajikistan	2009	1 580 000	742 051		742 051	85	7	674 416	91
		1 808 000****						750 000*****	
Turkmenistan	2006	2 353 000	1 990 800		1 990 800	102	20	1 990 800	100
		13 770 000****						1 230 000*****	
Uzbekistan	2005	4 900 000	4 198 000		4 198 000	89	42	3 700 000	88
		14 563 000****						4 250 000*****	
Central Asia		14 848 000	9 151 851	866 300	10 018 151	67	100	8 651 586	86
Armenia	2006	660 000	273 530		273 530	41	13	176 000	64
Azerbaijan*	2003	3 200 000	1 426 000		1 426 000	45	68	-	-

Country	Year	Irrigated areas							
		Irrigation potential ha	Full control irrigation ha	Spate irrigation ha	Area equipped for irrigation ha	Area equipped for irrigation as % of cultivated area or potential area %	Area equipped for irrigation as % of total area %	Area equipped for irrigation actually irrigated ha	Actually irrigate area as % of area equipped for irrigation %
Georgia**	2007	725000	401290		401290	55	19	-	-
Caucasus		4 585 000	2100820		2100820	45.8	100	176000	8.4
Russia	2006	29000000	2375000		2375000	8	49	938900	40
Ukraine	2013	5500000	2169000		2169000	39	45	731400	34
Belarus***	2011	-	30600		30600	-	0,6	30600	100
Moldova	2014	1500000	228300		228300	15	4,7	32000	14
East Europe		36 000 000	4802900		4802900	13.3	100	1732900	36.1
EECCA		55 433 000	16 055 571	866 300	16 921 871	30.5	100	10 560 486	62.4

Note:

- 1) The data on actually irrigated area equipped for irrigation in Azerbaijan* and Georgia** and on irrigation potential in Belarus *** is not available.
- 2) **** source: Master plans for comprehensive water resources use and protection in the Aral Sea Basin.
- 3) ***** source: Central Asia Regional Water Information Base «CAREWIB», net actually irrigated area (2013).

The total area equipped for irrigation in the five Central Asian countries is 10 million ha or 3.3% of the world's irrigated area. This area in Central Asia is 73% of the area equipped for irrigation in all 54 countries in Africa (13.7 million ha). Two thirds of the area equipped for irrigation is in Uzbekistan and Turkmenistan, while Kyrgyzstan and Tajikistan together account for 19%.

Total area equipped for irrigation is larger than the cultivated area, since the irrigation area includes irrigated permanent pasture while permanent pasture is not included in cultivated area.

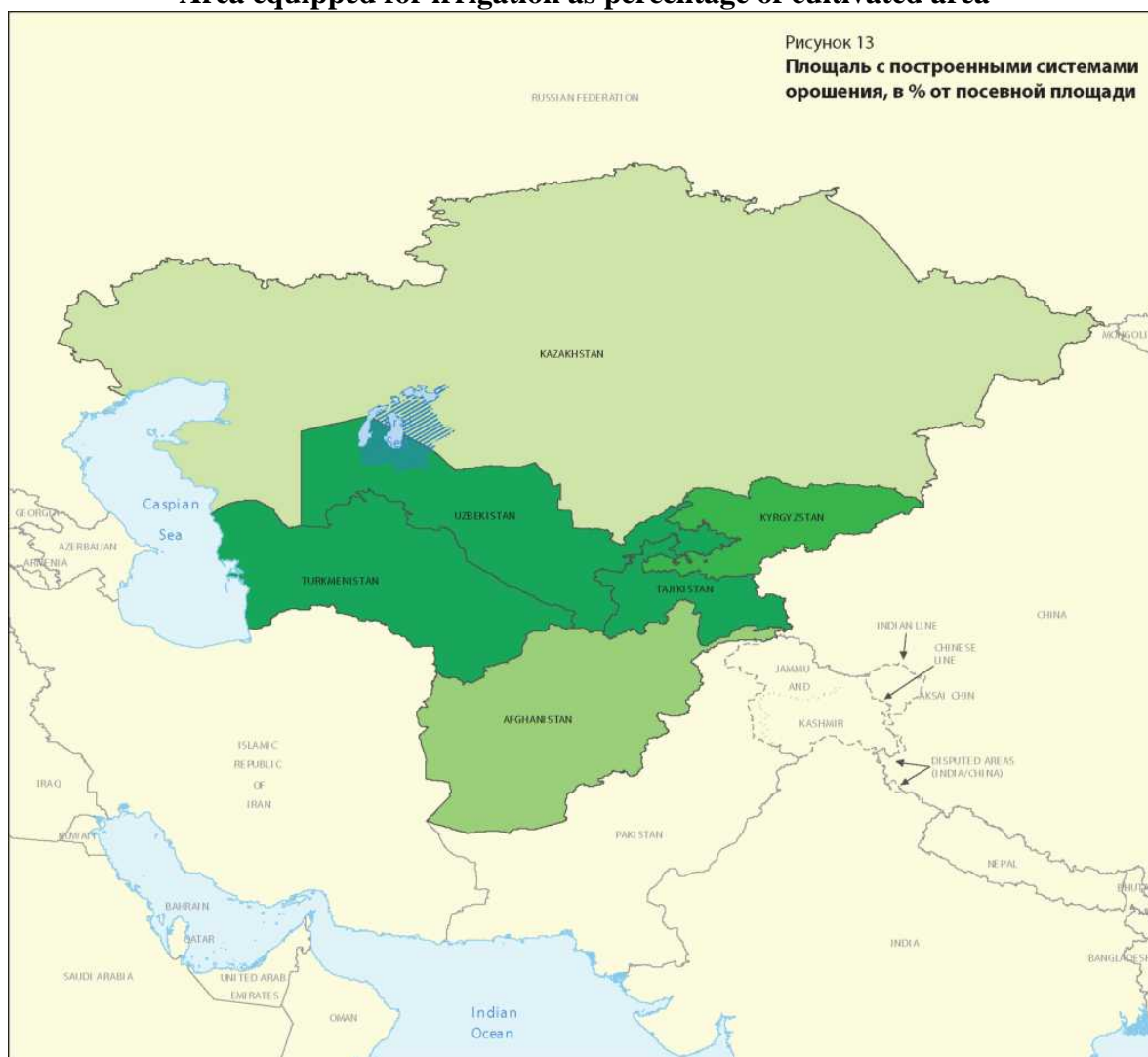
Most of the area equipped for irrigation – almost 9.8 million ha or 75 % of the total – is located in the Aral Sea basin. Not considering Afghanistan, this figure rises to 85%.

Full control irrigation covers 9.15 million ha and is by far the most widespread form of irrigation in Central Asia, accounting for 91% of the area equipped for irrigation. Only Kazakhstan reports spate irrigation, amounting to 866.3 thousand ha. It should be noted that during the previous survey the figure reported for spate irrigation in Kazakhstan was 1.105 thousand ha. It is not clear whether the previous figure was wrong or whether, maybe, much of the area that was previously reported under spate irrigation has, in the meantime, become full control irrigation.

Irrigation is practiced on 33 % of the total cultivated area in the region compared to 20 percent globally. Turkmenistan has the highest level, with 102 % of cultivated land under irrigation, the irrigated area is larger than the cultivated area, since the irrigation area includes irrigated permanent pasture, while permanent pasture is not included in the cultivated area, followed by Uzbekistan with 89 % and Tajikistan with 85 %. Kazakhstan has only 9 % of the cultivated area under irrigation.

Irrigation in Central Asia relies upon a system of dams, pumps and canals that is among the most complex in the world.

Area equipped for irrigation as percentage of cultivated area



Source: *Irrigation in Central Asia in figures – AQUASTAT Survey - 2012*

Total area equipped for irrigation covers 2.1 million ha in the Caucasus, 4.8 million ha in Eastern Europe, while accounting for 16.9 million ha in the EECCA region as a whole or 5.6% of irrigated area in the world.

More than half of the area equipped for irrigation in Eastern Europe and the Caucasus is concentrated in the Russian Federation, Ukraine, and Azerbaijan, while Belarus, Georgia, and Moldova together account for 3.3% of this area in the EECCA region.

In the EECCA region as a whole, full control irrigation covers 16.1 million ha, including 57% in Central Asian countries (not considering Afghanistan), 30% in Eastern Europe, and 13% in the Caucasus.

Table 4. Irrigation technique in full control irrigation area
Full control irrigation areas

Source: FAO AQUASTAT survey-2012 and AQUASTAT – FAO Database

Country	Year	Total	Surface irrigation		Sprinkler irrigation		Localized irrigation	
		ha	ha	% of total	ha	% of total	ha	% of total
Kazakhstan	2010	1 199 600	1 158 800	96.6	30 000	2.5	10 800	0.9
Kyrgyzstan	2005	1 021 400	1 021 000	99.96	400	0.04		-
Tajikistan	2009	742 051	742 051	100	-	-		-
Turkmenistan	2006	1 990 800	1 990 800	100	-	-		-
Uzbekistan	2005	4 198 000	4 193 577	99.89	-	-	4 423	0.11
Central Asia		9 151 851	9 106 228	99.5	30 400	0.33	15 223	0.17
Armenia	2006	273 530	247 530	90.5	25 000	9.1	1 000	0.4
Azerbaijan	2005	146 000	130 200	91.3	149 000	10.4	2 618	0.2
Georgia	2007	401 290	372 980	92.9	0	0	28 310	7.1
Caucasus		2 100 820	1 922 510	91.5	174 000	8.3	31 928	1.5
Russian Federation	2006	2 375 000	0	0	0	0	0	0
Ukraine	2013	2 169 000	525 000	24.2	2 080 000	95.9	0	0
Belarus	2011	30 600		0	0	0	0	0
Moldova	2014	228 300	68 300	29.9	145 000	63.5	15 000	6.6
East Europe		4 802 900	593 300	12.4	2 225 000	46.3	15 000	0.3

Table 5. Irrigation water sources in full control irrigation (primary and secondary water)

Source: FAO, AQUASTAT survey-2012 and AQUASTAT – FAO Database

Country	Year	Full control irrigation area	Surface water		Groundwater		Mixed surface and groundwater	
			area	% of total	area	% of total	area	% of total
			ha	%	ha	%	ha	%
Kazakhstan	2010	1 199 600	1 197 600	99.8	2 000	0.2		
Kyrgyzstan	2005	1 021 400	1 011 186	99	10 214	1		
Tajikistan	2009	742 051	696 476	93.9	32 500	4.4	13 075	1.8
Turkmenistan	2006	1 990 800	1 981 190	99.5	9 610	0.5		
Uzbekistan	2005	4198000	3 929 282	93.6	268 718	6.4		
Central Asia		9 151 851	8 815 734	96.3	323042	3.6	13 075	0.1
Armenia	2006	273530	222653	81.4	50876	18.6	0	0
Azerbaijan	2005	1426000	1326180	93	99820	7	0	0
Georgia	2007	401290	401290	100	0	0	0	0
Caucasus		2100820	1950123	92.8	150696	7.2	0	0
Russian Federation	2006	2375000	1900000	80	475000	20	0	0
Ukraine	2013	2169000	2169000	100	0	0	0	0
Belarus	2006	30600	26010	85	4590	15	0	0
Moldova	2014	228300	228300	100	0	0	0	0
Eastern Europe		4802900	4323310	90.0	479590	10.0	0	0
EECCA		16 055 571	15 089 167	94	953328	5.9	13 075	0.1

Note: Part of the area is irrigated directly by agricultural drainage water or treated wastewater, the data is not available.

Surface water is the main source for irrigation of crops in the EECCA countries. The area irrigated by surface water accounts for 94% of the full control irrigation area in the EECCA region, as a whole, and particularly 96.3% in Central Asia, 92.8% in the Caucasus, and 90% in Eastern Europe.

Surface water is the major source of irrigation water in Central Asia, 92.6 % on average, varying from 82% to 99.8%.

Groundwater resources were not widely used for irrigated agriculture in the Central Asian Republics during the Soviet period because farmers had sufficient surface water, reliable water supply and irrigation infrastructure. Groundwater resources were used primarily for the livestock sector and for drinking water in both urban and rural areas. During the recent drought years (1998–2001) the Aral Sea basin nations started to use groundwater for vital agricultural production, because of its relatively good quality and quantity and as an alternative to the saline surface water.

In a very different situation, Afghanistan has traditionally relied on surface water and groundwater springs and *karez*s (constructed underground channels) for irrigated agriculture. The share of groundwater irrigation for the cultivated area is around 18 %, being the highest in the region. In Uzbekistan and Tajikistan groundwater represents 6 and 4 % respectively, while in Kyrgyzstan, Turkmenistan and Kazakhstan, it is less than 1 % of the total irrigated area. On average, in Central Asia, groundwater represents 7.3 % of total full control area equipped for irrigation.

Tajikistan is the only country that gives a figure for mixed surface water and groundwater, accounting for 13 075 ha or 1.8 percent of the country's total irrigated area. No information is available from the other countries for other sources of water.

Information on power-irrigated area is available for all countries except Afghanistan. The power-irrigated area represents 2 % of the total area equipped for irrigation in Kazakhstan, 5 % in Kyrgyzstan, 40 % in Tajikistan, 16 % in Turkmenistan and 27 % in Uzbekistan.

Full control irrigation scheme sizes

The definition of large schemes varies from one country to another. While Tajikistan considers a large scheme to be 3 000 ha, other countries, such as Uzbekistan and Kazakhstan classify a large scheme to be a minimum of 10 000 and 20 000 ha respectively.

Irrigated crops in full control irrigation schemes

Cropping patterns have changed extensively since the Central Asian countries became independent. Cotton is still one of the most important crops, although between 1990

and 1998 its share of irrigated agriculture decreased from 45 to 25%. In the same period, the area under cereals (wheat, rice, maize and others) increased from 12 to more than 50%. Wheat became the dominant crop in the region. Fodder crops occupied less than 20% of the total irrigated area in 1998, compared to 28% in 1990 (CAWater-Info, 2011).

Table 7A shows the national distribution of harvested irrigated crop areas in five Central Asian countries. Cereals represent 41% of all harvested irrigated crop areas in the region. Wheat alone represents about 34%, ranging from 18% in Kazakhstan to 45% in Turkmenistan. Cotton is the second most widespread harvested irrigated crop, accounting for 29% on average. Mainly cultivated in Uzbekistan, Tajikistan and Turkmenistan, cotton represents 38, 33 and 32% of total harvested irrigated cropped area respectively. Fodder accounts for 14% of the irrigated crops in the region, of which temporary fodder occupies 5%, permanent grass and fodder 2% and permanent meadows and pastures 6%. Vegetables represent 3%, with special importance in Kazakhstan (15 %). Potatoes account for 2% of the total irrigated cropped area, with higher production in Kyrgyzstan (7 %), Kazakhstan (5 %) and Tajikistan (4 %).

Table 7B shows the national distribution of harvested irrigated cropped area for the countries of Eastern Europe. The area under cereals accounts for about 17% of total harvested irrigated area in the region. The share of wheat area averages 3.5% in the region, while this figure is 6.5% in the Russian Federation.

Vegetables account for about 8% of the total irrigated cropped area, particularly 6.1% in the Russian Federation, 10% in Ukraine, 9.8% in Belarus, and 10.9% in Moldova. Potato area is 8.5% of the total irrigated cropped area, with the largest production in Moldova (10.9%), Belarus (9.5%), and Russian Federation (8.7%).

The information on the harvested irrigated cropped area in the Caucasus is given in Table 7C. Cereals account for 50.7% of the total harvested irrigated area in the region. Wheat area averages about 38.1% varying from 19.9% in Armenia to 43.9% in Azerbaijan. The share of cotton area is 4.6% of the total harvested irrigated area in the region. Cotton is grown only in Azerbaijan, with the cotton area accounting for 5.6% of the total harvested irrigated area in the country. Vegetables cover 5.9%, with the largest production in Armenia (13.2%). Potato accounts for 5.3% of the total irrigated cropped area, showing largest production in Armenia (13.6%) and Azerbaijan (4.7%).

Table 6A Central Asia
Irrigated crops in full control irrigation schemes, actually irrigated (ha)

Source: FAO, AQUASTAT Survey -2012

	Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan	Uzbekistan	Central Asia
Year	2010	2005	2009	2006	2005	
Wheat	208 000	360 700	179 742	917000	1 295 000	2 960 442
Barley	92 000	86 600	18 017	-	-	196 617
Maize	95 600	61 500	14 743	-	-	171 843
Rice	94 000	5 000	14 126	11 000	52 000	176 126
Other cereals	-	1 600	7 225	-	-	8 825
Vegetables, incl. roots and tubers	182 600	40 600	37 162	29 400	-	289 762
Potato and sweet potato	60 000	76 000	29 901	8 800	-	174 701
Leguminous crops	-	20 800	4 667	-	-	25 467
Oil-bearing crops*	40 000	59 200	3 493	-	-	102 693
Cotton	134 200	45 500	237 130	652 000	1 406 000	2 474 830
Sugarcane and sugar beet**	8 720	14 500	-	12 000	-	35 220
Temporary fodder	-	35 800	8 323	93 000	300 000	437123
Perennial grass and fodder	26 000	73 400	34 043	-	100 000	233 443
Other annual crops***	6 430	33 300	886	100100	247 000	387 716
Other perennial crops	54 000		98 957	65 000	200 000	417 957
Permanent meadows and pastures	180550	106900	40 868	125 500	100 000	553 818
Total:	1 182100	1 021 400	729 283	2 013 800	3 700 000	8 646 583
Actually irrigated area	1 182100	1 021 400	674 416	1 990 800	3 700 000	8 568 716
Cropping intensity in %	100	100	108	101	100	103

* of which in Kyrgyzstan and Tajikistan all areas under sunflower, ** of which only sugar beet in all countries, *** of which 1,600 ha tobacco in Kazakhstan and 5,600 ha tobacco in Kyrgyzstan

Table 6B Eastern Europe
Irrigated crops in full control irrigation schemes, actually irrigated (ha)

Source: FAO, AQUASTAT Survey -2012

	Russia	Ukraine	Belarus	Moldova	East Europe
Year	2006	2003	2011	2007	
Wheat	61300	0	0	0	61300
Rice	38000	21000	0	0	59000
Barley	26000	0	0	0	26000
Maize	15000	100 000	0	0	115000
Other cereals	23000	0	0	7000	30000
Vegetables	57000	74000	3000	3500	137500
Potato	82000	59490	2900	3500	147890
Leguminous crops	32000	52490	2300	0	86790
Sugar beet	32 000	21800	0	2200	56000
Temporary fodder	328 000	100000	0	0	428000
Sunflower	0	46210	0	0	46210
Fruit trees	66 000	76410	2300	4800	149510
Grass and fodder	0	180000	0	0	180000
Permanent meadows and pastures	178000	0	20100	11000	209100
Total:					1732300,00
Actually irrigated area	938300	731400	30600	32000	
Irrigated cropping intensity %	99,9	100	100	100	

Table 6C Caucasus
Irrigated crops in full control irrigation schemes, actually irrigated (ha)

Source: FAO, AQUASTAT Survey -2012

	Armenia	Azerbaijan	Georgia	Caucasus
Year	2006	2004	2005	
Wheat	35000	610919		645919
Rice	-	2573		2573
Barley	5900	158909		164809
Maize	3100	33190		36290
Other cereals	0	9302		9302
Vegetables	23200	77248		100448
Cotton	0	78161		78161
Potato	24000	65796		89796
Pulses	2000	0		2000
Sugar beet	200	3202		3402
Temporary fodder	26 000			26000
Sunflower	200	11381		11581
Tobacco	200	2649		2849
Other annual crops	5300	236780	126060	368140
Tea	-	3658		3658
Other perennial crops	50900	97749		148649
Total:				1693577
Actually irrigated area	176000	1391517	126060	
Irrigated cropping intensity %	100	97.6	31.4	

Table 7B Eastern Europe
Harvested irrigated crops on areas equipped for full control irrigation actually irrigated (%)

Source: AQUASTAT – FAO Data base

	Russia	Ukraine	Belarus	Moldova	East Europe
Year	2006	2003	2011	2007	
Wheat	6.5	-	-	-	3.5
Rice	4.0	2.9	-	-	3.4
Barley	2.8	-	-	-	1.5
Maize	1.6	13.7	-	-	6.6
Other cereals	2.5	-	-	21.9	1.7
Leguminous crops	-	-	7.5	-	0.1
Vegetables	6.1	10.1	9.8	10.9	7.9
Potato	8.7	8.1	9.5	10.9	8.5
Pulses	3.4	7.2	-	-	4.9
Sugar beet	3.4	3.0	-	6.9	3.2
Temporary fodder	35.0	13.7	-	-	24.7
Sunflower	-	6.3	-	-	2.7
Fruit trees	7.0	10.4	7.5	15.0	8.6
Grass and fodder	-	24.6	-	-	10.4
Permanent meadows and pastures	19.0	-	65.7	34.4	12.1
Total:	100.0	100.0	100.0	100.0	100.0

Table 7C Caucasus
Harvested irrigated crops on areas equipped for full control irrigation actually irrigated (%)

Source: AQUASTAT – FAO Database

	Armenia	Azerbaijan	Georgia	Caucasus
Year	2006	2004	2005	
Wheat	19.9	43.9	-	38.1
Rice	-	0.2	-	0.2
Barley	3.4	11.4	-	9.7
Maize	1.8	2.4	-	2.1
Other cereals	-	0.7	-	0.5
Vegetables	13.2	5.6	-	5.9
Cotton	-	5.6	-	4.6
Potato	13.6	4.7		5.3
Pulses	1.1	-		0.1
Sugar beet	0.1	0.2		0.2
Temporary fodder	14.8	-		1.5
Sunflower	0.1	0.8		0.7
Tobacco	0.1	0.2		0.2
Other annual crops	3.0	17.0	100.0	21.7
Tea	-	0.3		0.2
Other perennial crops	28.9	7.0		8.8
Total:	100.0	100.0	100.0	100.0

Irrigation and drainage in the Caucasus

The total irrigation potential in Caucasus is 4 585 000 ha, including 660,000 ha in Armenia, 3.2 million ha in Azerbaijan, and 725 000 ha in Georgia. At present, the area equipped for full or partial control irrigation in Caucasus is estimated at 2 100 820 ha (Table 8).

The main water structures in Armenia, together with the main and secondary canals, are under state ownership whereas the tertiary level irrigation system (the intra-community irrigation network) was transferred to community ownership. Around 80 percent of the total irrigated land is irrigated through the main network operated by the “Vorogum-Jrar” Closed Joint Stock Company (CJSC), while the remaining 20 percent is irrigated through the community-owned networks (WB-IBRD, 2004). Most irrigation schemes in Azerbaijan were state-owned. Farmer-owned irrigation started to appear in 1992 and in 1996 represented 1 percent of the area. There is no private irrigation in Georgia. All irrigation schemes are managed by the State through its Department of Melioration and Water Resources. Though irrigation remains the responsibility of the State in Georgia, the land irrigated can be owned either by private farmers or by the State but leased to farmers, cooperatives or agro-firms.

Surface irrigation is practiced on over 90 percent of the area equipped for irrigation through reservoirs, river diversion or pumping in rivers. The remaining part is irrigated from groundwater, except for Georgia, where groundwater is not used for irrigation.

In Armenia, in 2006, drainage was practiced on 34 457 ha, of which 7 729 ha of horizontal closed drainage, 26 408 ha of horizontal open drainage and 320 ha of vertical drainage. The part of the irrigated land that is waterlogged is 18 722 ha.

In Azerbaijan, the total drainage network covers 608 336 ha, all in the areas equipped for irrigation. In more than half the drained area the installations need to be renovated. In 2003 the area salinized by irrigation was estimated at 635 800 ha.

In 1996, the total drained area in Georgia was estimated at 164 740 ha, consisting mainly of surface drainage. However, the infrastructure deteriorated drastically during the 1990s, reducing the drainage area to 65 000 ha. Drainage has been developed mainly in the high rainfall region of western Georgia (Kolkhety lowland), on 132 940 ha out of a total of 164 740 ha for the whole country. About 31 800 ha of full or partial control irrigation equipped areas are also equipped with a network of surface and subsurface drains. About 31 800 ha of the equipped wetland and inland valley bottoms are also power drained. They are located in the coastal regions of west Georgia, in polder systems where electric pumps drain seawater and excess floodwater.

Table 8. Irrigation and drainage in Caucasus*Source: AQUASTAT – FAO Data base*

Irrigation potential	-	4585000	ha
Irrigation			
1. Full or partial control irrigation: equipped area	2003-2007	2100820	ha
- surface irrigation	1995-2007	1922510	ha
- sprinkler irrigation	1995-2007	174000	ha
- localized irrigation	1995-2007	31928	ha
. % of area irrigated from surface water	1995-2007	91.5	%
. % of area irrigated from ground water	1995-2007	8.5	%
. % of area irrigated from mixed surface water and groundwater	1995-2007	0	%
. % of area irrigated from non-conventional sources of water	1995-2007	0	%
. area equipped for full or partial control irrigation actually irrigated		-	ha
- as % of full/partial control area equipped		-	%
2. Equipped lowlands (wetland, ivb. flood plains, mangroves)	1996	31500	ha
3. Spate irrigation		-	ha
Total area equipped for irrigation (1+2+3)	2003-2007	2132320	ha
. as % of cultivated area	2003-2007	52.9	%
. % of total area equipped for irrigation actually irrigated		-	%
. average increase per year over the last 11 years	1995-2006	-0.45	%
. power irrigated area as % of total area equipped	2002-2007	32.7	%
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)	2003-2007	2132320	ha
. as % of cultivated area		52.9	%
Full or partial control irrigation schemes: Criteria:			
Small-scale schemes < 200 ha*, < 10000 ha**, < 500 ha***	1995-2007	236887	ha
Medium-scale schemes	1995-2007	282950	ha
Large-scale schemes > 200 ha*, > 20000 ha**, > 1000 ha***	1995-2007	1608003	ha
Total number of households in irrigation		-	
Irrigated crops in full or partial control irrigation schemes			

Total irrigated grain production (wheat and barley)		-	metric tons
- as % of total grain production		-	%
Harvested crops:			
Total harvested irrigated cropped area	2004-2007	1693581	ha
Annual crops:total	2004-2007	1415214	ha
- Wheat	2004-2006	645919	ha
- Rice	2004	2573	ha
- Barley	2004-2006	164809	ha
- Maize	2004-2006	36294	ha
- Other cereals	2004	9302	ha
- Potatoes	2004-2006	89796	ha
- Sugar beet	2004-2006	3402	ha
- Vegetables	2004-2006	100448	ha
- Cotton	2004	78161	ha
- Tobacco	2004-2006	2849	ha
- Fodder	2006	26000	ha
- Pulses	2006	2000	ha
- Sunflower	2004-2006	11581	ha
- Other annual crops	2004-2006	242080	ha
Permanent crops: total	2004-2006	152307	ha
- Tea	2004	3658	ha
- Other perennial crops (bananas, olives, grapes, strawberries)	2004-2006	148649	ha
Irrigated cropping intensity (on full/partial control irrigation equipped area)	2004-2006	76.3	%
Drainage - Environment			
Total drained area	1996-2006	807493	ha
- part of the area equipped for irrigation drained	1996-2006	674593	ha
- other drained area (non-irrigated)	1996	132900	ha
- drained area as % of cultivated area	2006	2.1	%
Flood-protected areas		-	ha
Area salinized by irrigation	2002-2006	769775	ha
Population affected by water-related diseases	2001	1644	inhabitants

Note: *Armenia, **Azerbaijan, ***Georgia.

Armenia

At present, the area equipped for full or partial control irrigation is estimated at almost 274 000 ha (Table 10). The reason for the decrease in recent years has been, on the one hand, the earthquake of 1988 that destroyed part of the area, and on the other, the difficult economic situation due to the transition period, that has made it difficult to keep or maintain the irrigation infrastructure. The major irrigation schemes are located on the left bank of the Araks River.

Table 10. Irrigation and drainage in Armenia

Source: AQUASTAT – FAO Data base

Irrigation potential	-	660000	ha
Irrigation			
1. Full or partial control irrigation: equipped area	2006	273530	ha
- surface irrigation	2006	247530	ha
- sprinkler irrigation	2006	25000	ha
- localized irrigation	2006	1000	ha
. % of area irrigated from surface water	2006	81.4	%
. % of area irrigated from ground water	2006	18.6	%
. % of area irrigated from mixed surface water and groundwater	2006	0	%
. % of area irrigated from non-conventional sources of water	2006	0	%
. area equipped for full or partial control irrigation actually irrigated	2006	176000	ha
- as % of full/partial control area equipped	2006	64.3	%
2. Equipped lowlands (wetland, ivb. flood plains, mangroves)		-	ha
3. Spate irrigation		-	ha
Total area equipped for irrigation (1+2+3)	2006	273530	ha
. as % of cultivated area	2006	49.3	%
. % of total area equipped for irrigation actually irrigated	2006	64.3	%
. average increase per year over the last 11 years	1995-2006	-0.40	%
. power irrigated area as % of total area equipped	2002	42.6	%
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)	2006	273530	ha
. as % of cultivated area	2006	49.3	%
Full or partial control irrigation schemes: Criteria:			
Small-scale schemes < 200 ha	2006	55697	ha
Medium-scale schemes			ha
Large-scale schemes > 200 ha	2006	217833	ha
Total number of households in irrigation		-	
Irrigated crops in full or partial control irrigation schemes			
Total irrigated grain production (wheat and barley)		-	metric tons
- as % of total grain production		-	%

Harvested crops:			
Total harvested irrigated cropped area	2006	176000	ha
Annual crops: total	2006	125100	ha
- Wheat	2006	35000	ha
- Barley	2006	5900	ha
- Maize	2006	3100	ha
- Potatoes	2006	24000	ha
- Sugar beet	2006	200	ha
- Pulses	2006	2000	ha
- Vegetables	2006	23200	ha
- Tobacco	2006	200	ha
- Fodder	2006	26000	ha
- Sunflower	2006	200	ha
- Other annual crops	2006	5300	ha
. Permanent crops: total	2006	50900	ha
- Other perennial crops	2006	50900	ha
Irrigated cropping intensity (on full/partial control area actually irrigated)	2006	100	%
Drainage - Environment			
Total drained area	2006	34457	ha
- part of the area equipped for irrigation drained	2006	34457	ha
- other drained area (non-irrigated)		-	ha
. drained area as % of cultivated area	2006	6.2	%
Flood-protected areas		-	ha
Area salinized by irrigation	2006	20415	ha
Population affected by water-related diseases	2001	1644	inhabitants

The irrigation systems of Armenia were mainly established during the Soviet period. The irrigation infrastructure includes 80 reservoirs (77 of which are used only for irrigation and 3 used for both irrigation and drinking water), together with more than 3 000 km of main and secondary canals, about 15 000 km of tertiary canals, over 400 small and large pumps, 1 276 tube wells, and 945 artesian wells. Eight major conveyance systems distribute irrigation water to some 150 000 ha, and minor systems cover the rest of the areas. The conveyance systems are served by main, branch and secondary canals/pipes. Three-quarters of the canals are lined with concrete or are pipes. The main water structures, together with the main and secondary canals, are under state ownership whereas the tertiary level irrigation system (the intra-community irrigation network) was transferred to community ownership with the establishment of the Local Self-Governments in 1997. Around 80 percent of the total irrigated land is irrigated through the main network operated by the “Vorogum-Jrar” Closed Joint Stock Company (CJSC), while the remaining 20 percent is irrigated through the community-owned networks (WB-IBRD, 2004). Surface irrigation is practiced on over 90 percent of the area equipped for irrigation and can be divided into four categories of irrigation: furrow, borderstrip, flooding or basin, and that using hydrants and flexible hose systems. Flooding is used where soil depth does not permit the grading of either furrows or borderstrips. The water is let out over the land by cutting an irrigation head canal at intervals. Sprinkler irrigation and localized irrigation are practiced on the remaining area equipped for full or partial control irrigation. Groundwater is used for

irrigation on 19 percent of the equipped area. The remaining part is irrigated from surface water through reservoirs, river diversion or pumping in rivers.

Status and evolution of drainage systems

In 2006 drainage was practiced on 34 457 ha, of which 7 729 ha of horizontal closed drainage, 26 408 ha of horizontal open drainage and 320 ha of vertical drainage. The part of the irrigated land that is waterlogged is 18 722 ha.

Azerbaijan

The irrigation potential is estimated at 3.2 million ha. In the last century, irrigation was concentrated alongside the rivers and it was only at the beginning of this century that the construction of large irrigation canals started. In 1913, 582 000 ha were irrigated. The most intensive development took place after the Second World War and in 1975 the area equipped for irrigation was 1.17 million ha. By 1995 this had become 1.45 million ha, which is 45 percent of the irrigation potential.

In 1995, the total length of all irrigation canals was 65 900 km, of which only 2 400 km, or 3.6 percent, were concrete canals. National irrigation efficiency was estimated at 55 percent. The largest canals are the Upper Garabakh, the Upper Shirvan and the Samur-Apsheron, all earthen. The Upper Gabarakh canal runs southeast from the Mingacevir reservoir to the Araks River. It is about 174 km long and has a capacity of 113.5 m³/s. About 85 000 ha were irrigated by this canal in 1995. The Upper Shirvan canal also starts from the Mingacevir reservoir and runs east to the Akhsu River. It is about 126 km in length and has a capacity of 78 m³/s and in 1995 irrigated about 91 100 ha.

In 1995, almost 90 percent of the irrigation was surface irrigation, mainly furrow and border strip irrigation. Sprinkler irrigation and localized irrigation were used mainly on perennial plantations and vineyards (Table 11). Surface water was used on 93 percent of the area, mainly from reservoirs and through direct pumping in rivers and canals. About 96 700 ha were irrigated by groundwater through more than 5 000 wells. Private farmers exploit this source intensively as the major irrigation installations are seriously degraded.

Table 11. Irrigation and drainage in Azerbaijan

Source: AQUASTAT – FAO Data base

Irrigation potential	-	3 200 000	ha
Water management			
1. Full or partial control irrigation: equipped area	2003	1 426 000	ha
- surface irrigation	1995	1 302 000	ha
- sprinkler irrigation	1995	149 000	ha

- localized irrigation	1995	2618	ha
. % of area irrigated from surface water	1995	93	%
. % of area irrigated from groundwater	1995	7	%
. % of area irrigated from mixed surface water and groundwater	1995	0	%
. % of area irrigated from non-conventional sources of water	1995	0	%
. area equipped for full or partial control irrigation actually irrigated		-	ha
- as % of full/partial control area equipped		-	%
2. Equipped lowlands (wetland, ivb, flood plains, mangroves)		-	ha
3. Spate irrigation		-	ha
Total area equipped for irrigation (1+2+3)	2003	1 426 000	ha
. as % of cultivated area	2003	69	%
. as % of cultivated area		-	%
. average increase per year over the last 8 years	1995-2003	-0.23	%
. power irrigated area as % of total area equipped	2003	33.6	%
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)	2003	1 426 000	ha
. as % of cultivated area	2003	69	%
Full or partial control irrigation schemes: Criteria:			
Small-scale schemes < 10 000 ha	1995	77 420	ha
Medium-scale schemes	1995	192 600	ha
large-scale schemes > 20 000 ha	1995	1 183 000	ha
Total number of households in irrigation		-	
Irrigated crops in full or partial control irrigation schemes			
Total irrigated grain production (wheat and barley)		-	metric tons
- as % of total grain production		-	%
Harvested crops:			
Total harvested irrigated cropped area	2004	1 391 521	ha
-Annual crops:total	2004	1 290 114	ha
-wheat	2004	610 919	ha
-rice	2004	2 573	ha
-barley	2004	158 909	ha
- maize	2004	33 194	ha
-other cereals	2004	9 302	ha
- potato	2004	65 796	ha
-sugar beet	2004	3 202	ha
-vegetables	2004	77 248	ha
- cotton	2004	78 161	ha
-tobacco	2004	2 649	ha
- sunflower	2004	11 381	ha
-other annual crops	2004	236 780	ha
permanent crops: total	2004	101 407	ha
-tea	2004	3 658	ha
- other perennial crops (bananas, olives, grapes, strawberries)	2004	97 749	ha

Irrigated cropping intensity (on full/partial control irrigation equipped area)	2004	97.6	%
Drainage - Environment			
Total drained area	2003	608 336	ha
- part of the area equipped for irrigation drained	2003	608 336	ha
- other drained area (non-irrigated)		-	ha
. drained area as % of cultivated area		-	%
Flood-protected areas		-	ha
Area salinized by irrigation	2003	635 800	ha
Population affected by water-related diseases		-	inhabitants

In 1995, small schemes (<10 000 ha) covered 5.3 percent of the total area equipped for irrigation, medium size schemes (10 000–20 000 ha) 13.3 percent and large schemes (>20 000 ha) 81.5 percent. Most schemes were state-owned. Farmer-owned irrigation started to appear in 1992 and in 1996 represented 1 percent of the area.

In 2003, the total area equipped for irrigation was about 1 426 000 ha and the power-irrigated area was estimated at 479 249 ha.

In 2004, the harvested irrigated area was 1 391 521 ha. Annual crops represent 93 percent of this area and permanent crops 7 percent. The main irrigated crops are wheat (44 percent), barley (11 percent), cotton (5.6 percent) and vegetables (5.6 percent), while the most important permanent crops are tea, bananas, olives, grapes and strawberries.

Status and evolution of drainage systems

The total drainage network covers 608 336 ha, all in the areas equipped for irrigation. In more than half the drained area the installations need to be renovated. In 2003 the area salinized by irrigation was estimated at 635 800 ha (Table 11).

Georgia

The irrigation potential in Georgia is estimated at 725 000 ha. The country has a tradition of land improvement through irrigation and drainage. At the beginning of the twentieth century, the total irrigated area in Georgia was about 112 000 ha. Major investments were made in the irrigation sector during the Soviet period, resulting in a total area of about 500 000 ha equipped for irrigation at the beginning of the 1980s, mainly located in the more arid eastern part of the country.

During the 1990s, civil strife, war, vandalism and theft, as well as problems associated with land reform, the transition to a market economy, and the loss of markets with traditional trading partners, contributed to a significant reduction of the irrigated area. It has been reported that during the severe drought of 2000 only about

160 000 ha were irrigated. Almost all pumping schemes (about 143 000 ha) were out of order. As a consequence, Georgia's State Department of Melioration and Water Resources started a rehabilitation programme to renew the infrastructure of existing irrigation and drainage schemes and to establish Amelioration Service Cooperatives. About 255 000 ha are covered by these programmes.

In 2007, irrigation covered 432 790 ha, of which 31 500 ha equipped wetland and inland valley bottoms and 401 290 ha full or partial control irrigation. River diversion is the main source of water for irrigation and groundwater is not used for irrigation in Georgia. The main irrigation technology is surface irrigation (372 980 ha). Localized irrigation is practiced on 28 300 ha (Table 12).

Table 12. Irrigation and drainage in Georgia

Source: AQUASTAT – FAO Data base

Irrigation potential	-	725 000	ha
Irrigation			
1. Full or partial control irrigation: equipped area	2007	401.290	ha
- surface irrigation	2007	372.980	ha
- sprinkler irrigation	2007	0	ha
- localized irrigation	2007	28.310	ha
. % of area irrigated from surface water	2007	100	%
. % of area irrigated from groundwater	2007	0	%
. % of area irrigated from mixed surface water and groundwater	2007	0	%
. % of area irrigated from non-conventional sources of water	2007	0	%
. area equipped for full or partial control irrigation actually irrigated		-	ha
- as % of full/partial control area equipped		-	%
2. Equipped lowlands (wetland, ivb. flood plains, mangroves)	1996	31.500	ha
3. Spate irrigation		-	ha
Total area equipped for irrigation (1+2+3)	2007	432.790	ha
. as % of cultivated area	2007	40.5	%
. % of total area equipped for irrigation actually irrigated		-	%
. average increase per year over the last 11 years	1996-2007	-0.72	%
. power irrigated area as % of total area equipped	2007	21.9	%
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)	2007	432.790	ha
. as % of cultivated area	2007	40.6	%
Full or partial control irrigation schemes: Criteria			
Small-scale schemes < 500 ha	2007	103.770	ha
Medium-scale schemes	2007	90.350	ha
Large-scale schemes > 1 000 ha	2007	207170	ha
Total number of households in irrigation			
Total number of households in irrigation			
Total irrigated grain production (wheat and barley)		-	metric tons

- Total irrigated grain production (wheat and barley)		-	%
Harvested crops:			
as % of total grain production	2005	126.060	ha
. Annual crops: total		-	ha
- Other annual crops		-	ha
. Permanent crops: total		-	ha
- Permanent crops: total		-	ha
- Other perennial crops (bananas, olives, grapes, strawberries)		-	ha
Irrigated cropping intensity (on full/partial control irrigation: equipped area)	2005	31.4	%
Drainage – Environment			
Total drained area	1996	164.700	ha
- part of the area equipped for irrigation drained	1996	31.800	ha
- other drained area (non-irrigated)	1996	132.900	ha
. drained area as % of cultivated area		-	%
Flood-protected areas		-	ha
Area salinized by irrigation	2002	113.560	ha
Population affected by water-related diseases		-	inhabitants

Most of the schemes are large-scale. The largest one are: the upper Alazani (41 100 ha), the lower Alazani (29 200 ha), the upper Samgori (28 100 ha), and the lower Samgori (29 200 ha). There is no private irrigation in Georgia. All irrigation schemes are managed by the State through its Department of Melioration and Water Resources. Though irrigation remains the responsibility of the State, the land irrigated can be owned either by private farmers or by the State but leased to farmers, cooperatives or agro-firms.

The unfavourable location of plots, low soil fertility, the failure of old irrigation and drainage systems, desertification, secondary bogging, salinization and erosion processes contribute to the non-lease and non-transfer of land to private owners. In addition, the slow pace of registering land ownership is due to the fact that the existing system deals with owner registration only, which is an insufficient basis for the full exercise of land ownership rights and the conclusion of subsequent transactions. Moreover, land registration and the process of proving land ownership are time consuming as old Soviet data have to be checked thoroughly (Government of Georgia, 2002).

Status and evolution of drainage systems

In 1996, the total drained area was estimated at 164 740 ha, consisting mainly of surface drainage. However, the infrastructure deteriorated drastically during the 1990s, reducing the drainage area to 65 000 ha.

Drainage has been developed mainly in the high rainfall region of western Georgia (Kolkhety lowland), on 132 940 ha out of a total of 164 740 ha for the whole country. The total area of the Kolkhety lowland where drainage infrastructure could be developed in the future is about 800 000 ha.

About 31 800 ha of full or partial control irrigation equipped areas are also equipped with a network of surface and subsurface drains. About 31 100 ha of the equipped wetland and inland valley bottoms are also power drained. They are located in the coastal regions of west Georgia, in polder systems where electric pumps drain seawater and excess floodwater.

Irrigation and drainage in Eastern Europe

The total irrigation potential in Eastern Europe is 36.0 million ha, including 29.0 million ha in Russian Federation, 5.5 million ha in Ukraine and 1.5 million ha in Moldova. At present, the area equipped for full or partial control irrigation in Eastern Europe is estimated at 4 802 900 ha (Table 9).

In the Russian Federation, in 2006, total area equipped for irrigation was estimated at 2 375 000 ha, of which 80 percent were irrigated by surface water and 20 percent by groundwater. About 938 900 ha, or 40 percent of the total area equipped for irrigation, was actually irrigated.

In Ukraine, the irrigation potential has been estimated at 5.5 million ha. The most suitable areas for irrigation development, from a technical and economic point of view, are: the coastal plain along the Black Sea coast between Odessa and the Danube Delta; the area between Odessa and the Southern Bug valley; central Crimea; and the coastal areas along the Sea of Azov. In 2013, total area equipped for irrigation was estimated at 2 169 000 ha (Ukrstat, 2014). In 1992, almost 80 percent used sprinkler irrigation technology. In 2003 actually irrigated area accounted for 731 400 ha, which was only about one third of the area equipped for irrigation in that year.

As to Belarus, all irrigation takes place on land that has been excessively drained. In fact, there is no real need for irrigation, except in areas where the groundwater has been lowered too much by excessive drainage. For this reason, no figure on irrigation potential is available. The area equipped for irrigation was 114,100 ha in 2006 (and went down in the following years). Of the 114 100 ha in 2006, 85 percent was irrigated by surface water and the remaining 15 percent by groundwater.

The irrigation potential in Moldova has been estimated at 1.5 million ha. In 1992, just after independence, the area equipped for irrigation covered 312 000 ha. The irrigation water was stored in reservoirs and tanks, built on the rivers, and pumped into the main irrigation canals. Since then the irrigation sector has declined for several reasons, but mainly due to economic factors and the unfit structure of old irrigation systems for the newly emerging pattern of private farming. In 2014, total area equipped for irrigation is estimated at 228 300 ha (NBS, 2014). In 2007 actually irrigated area accounted for only 32 000 ha.

In 1990, the drained area in the Russian Federation was 7.4 million ha, of which almost 44 percent was equipped with subsurface drainage systems and 56 percent with surface drainage systems. In 1990, only 21 percent of the irrigated land was equipped

with a drainage system. Since then the drained area dropped. In 1994, about 25.6 million ha were estimated to be excessively humid and marshy areas needing drainage. Over 15 million ha were estimated to be salinized and 24.3 million ha to have saline soils.

In Ukraine, in 1994, the drained area was estimated at 3.3 million ha, of which 63 percent was equipped with subsurface drains, mainly pipes. About 1.8 million ha of irrigated land were equipped with drainage facilities to prevent salinization. In these areas, the groundwater level is kept at 1.5-3.0 m below the soil surface. In 2013, the total drained cultivated area is also estimated at 3.3 million ha.

For Belarus, due to the climatic conditions, there is a need for drainage rather than irrigation in the country, except in areas where the groundwater level has fallen too much due to excessive drainage. The history of drainage in Belarus dates back to the second half of the 18th Century in the then Polish state. In 1993, about 3 million ha had been drained for agricultural purposes. In addition, land had also been drained for non-agricultural purposes, such as construction. On average, in 1993, there were 250 m of drains per ha of drained land. Subsurface drains existed on more than 75 percent of the drained area, the remaining 25 percent being drained by open canals. The total length of the irrigation and drainage network exceeds 800 000 km, which is almost nine times the total length of the natural rivers in the country. The total area where drainage infrastructure could be developed has been estimated at 7.9 million ha. In 2011, the area of drained lands of the republic was 3.41 million ha, of which 2.95 million ha was drained agricultural land: 43.1 percent croplands, 56.8 percent meadows and pastures, 0.1 percent permanent crops (MNREP, 2009; NSC, 2011).

In Moldova, in 1992, the drained area was estimated at 42 000 ha. About 70 percent or 29 400 ha was equipped with subsurface drains, usually pipes, located in the area equipped for irrigation. Drainage is mainly concentrated in the central and southern parts of the country.

Table. Irrigation and drainage in Eastern Europe

Source: AQUASTAT – FAO Data base

Irrigation potential	-	36000000	ha
Irrigation:			
1. Full control irrigation: equipped area	1992-2014	4802900	ha
- Surface irrigation			ha
- Sprinkler irrigation			ha
- Localized irrigation			ha
• Area equipped for full control irrigation actually irrigated	2003-2011	1732900	ha
- As % of area equipped for full control irrigation	2003-2011	47	%
2. Equipped lowlands (wetland, ivb, flood plains, mangroves)		0	ha

3. Spate irrigation		0	ha
Total area equipped for irrigation (1+2+3)	2006-2014	4802900	ha
• As % of cultivated area	2006-2014	4.9	%
• % of area irrigated from surface water	1992-2014	91	%
• % of area irrigated from groundwater	1992-2014	8.8	%
• % of area irrigated from mixed surface water and groundwater		-	%
• % of area irrigated from non-conventional sources of water		-	%
• Area equipped for irrigation actually irrigated	2003-2011	1732900	ha
- Area equipped for irrigation actually irrigated	2003-2011	47	%
• Average increase per year	1992-2014	-5.6	%
• Power irrigated area as % of total area equipped for irrigation		-	%
4. Non-equipped cultivated wetlands and inland valley bottoms		-	ha
5. Non-equipped flood recession cropping area		-	ha
Total agricultural water managed area (1+2+3+4+5)	2006-2014	4802900	ha
• As % of cultivated area	2006-2014	4.8	%
Size of full control irrigation schemes:		Criteria:	
Small schemes < - ha	-	-	ha
Medium schemes > - ha and < - ha	-	-	ha
Large schemes >- ha	-	-	ha
Total number of households in irrigation	-	-	
Total number of households in irrigation			
Total irrigated grain production			metric tons
- Total irrigation grain production		%	
Harvested crops:			
Total harvested irrigated cropped area	2003-2011	1732900	ha
• Temporary crops: total	2003-2011	1194290	ha
rice	2003-2011	59000	ha
wheat	2003-2011	61300	ha
barley	2003-2011	26000	ha
maize	2003-2011	115000	ha

other cereals	2003-2011	30000	ha
vegetables	2003-2011	137500	ha
sunflower	2003-2011	46210	ha
potato	2003-2011	147890	ha
pulses	2003-2011	86790	ha
sugar beet	2003-2011	56000	ha
temporary fodder	2003-2011	428600	ha
• Permanent crops: total	2003-2011	329510	ha
Fruits	2003-2011	149510	ha
Grass and fodder	2003-2011	180000	ha
• Permanent meadows and pastures	2003-2011	209100	
Irrigated cropping intensity (on full control area actually irrigated)	2003-2011	100	%
Drainage – environment			
Total cultivated area drained	1992-2011	11302900	ha
Non-irrigated cultivated area drained	1992-2011	4415900	ha
Area equipped for irrigation drained	1992-2011	1860000	ha
As % of total area equipped for irrigation	1992-2011	44.5	%
Area salinized by irrigation		-	ha
Area waterlogged by irrigation		-	ha

Russian Federation

Based on climate and soil conditions, it is estimated that 15-20 percent of the cultivable area needs irrigation in the moderately warm dry semi-desert zone, 5-8 percent in the moderately warm semi-dry steppe zone, 2-5 percent in the moderately warm semi-dry forested steppe zone, and 1-2 percent in the moderately warm forest zone. Figures for irrigation potential are estimated at almost 29 million ha under permanent irrigation. Other sources give a potential of more than 74 million ha of complementary irrigation.

In 1990, irrigation covered 6.12 million ha. In 1994, however, it had fallen to 5.16 million ha. One reason for the decrease was the economic recession. The sprinkler systems (accounting for almost 96 percent of the area equipped for irrigation in 1990) were overused, and there was no maintenance and operation system. This progressively resulted in the complete destruction and subsequent abandonment of the schemes. The largest irrigation development took place in the north Caucasian and Volga regions. Irrigation was undertaken mainly on huge sovkhoz and, to a smaller extent, on kolkhoz. Most of the land under irrigation is commanded by reservoirs, and open canals convey the water to the irrigation schemes. The largest canals are: Saratovski, Donski, Magistral, Great Stavropolski, Tersko-Kumski and Kumo-Manycki. Within the schemes, underground pipes convey the water to the emitters (rain guns), surface irrigation being used on the remainder.

In 2006, total area equipped for irrigation was estimated at 2 375 000 ha, of which 80 percent were irrigated by surface water and 20 percent by groundwater (Table 13). About 938 900 ha, or 40 percent of the total area equipped for irrigation, was actually irrigated.

Table 13. Irrigation and drainage in Russian Federation*Source: AQUASTAT – FAO Data base*

Irrigation potential	-	29 000 000	ha
Source			
1. Full control irrigation: equipped area	2006	2375000	ha
- Surface irrigation	-	-	ha
- Sprinkler irrigation	-	-	ha
- Localized irrigation	-	-	ha
• Area equipped for full control irrigation actually irrigated	2006	938900	ha
- As % of area equipped for full control irrigation	2006	40	%
2. Equipped lowlands (wetland, ivb, flood plains, mangroves)	-	0	ha
3. Spate irrigation	-	0	ha
Total area equipped for irrigation (1+2+3)	2006	2375000	ha
• As % of cultivated area	2006	2	%
• % of area irrigated from surface water	2006	80	%
• % of area irrigated from groundwater	2006	20	%
• % of area irrigated from mixed surface water and groundwater	-	-	%
• % of area irrigated from non-conventional sources of water	-	-	%
• Area equipped for irrigation actually irrigated	2006	938900	ha
- As % of total area equipped for irrigation	2006	40	%
• Average increase per year	1994-2006	-6	%
• Power irrigated area as % of total area equipped for irrigation	-	-	%
4. Non-equipped cultivated wetlands and inland valley bottoms	-	-	ha
5. Non-equipped flood recession cropping area	-	-	ha
Total agricultural water managed area (1+2+3+4+5)	2006	2375000	ha
- As % of cultivated area	2006	2	%
Size of full control irrigation schemes:		Criteria	
Small schemes	< - ha	-	ha
Medium schemes	> - ha and < - ha	-	ha
large schemes	>- ha	-	ha
Total number of households in irrigation	-	-	
Irrigated crops in full control irrigation schemes:			
Total irrigated grain production	-		metric tons
• As % of total grain production	-		%
Harvested crops:			
Total harvested irrigated cropped area	2006	938900	ha
• Temporary crops: total	2006	694900	ha
- Wheat	2006	61300	ha
- Rice	2006	38000	ha
- Barley	2006	26000	ha
- Maize	2006	15000	ha
- Other cereals	2006	23000	ha
- Vegetables	2006	57000	ha
- Potatoes	2006	82000	ha

- Pulses	2006	32000	ha
- Sugar beet	2006	32000	ha
- Temporary fodder	2006	328600	ha
• Permanent crops: total	2006	66000	ha
- Fruit trees	2006	66000	ha
• Permanent meadows and pastures	2006	178000	ha
Irrigated cropping intensify (on full control area actually irrigated)	2006	100	%
Drainage - Environment			
Total cultivated area drained	1994	5027000	ha
Non-irrigated cultivated area drained	-	-	ha
Area equipped for irrigation drained	-	-	ha
- As % of total area equipped for irrigation	-	-	%
Area salinized by irrigation	-	-	ha
Area waterlogged by irrigation	-	-	ha

Yields of irrigated crops are higher than those of rainfed crops. Irrigated maize yields are about 2.7 t/ha compared with 1.7 t/ha for rainfed maize. For barley, the respective figures are 2.25 and 1.65 t/ha.

Status and evolution of drainage systems

In 1990, the drained area was 7.4 million ha, of which almost 44 percent was equipped with subsurface drainage systems and 56 percent with surface drainage systems. In 1990, only 21 percent of the irrigated land was equipped with a drainage system.

In 1994 the drained area dropped to about 5 million ha. This fall was due either to the breakdown of the infrastructure because of overexploitation without proper maintenance, or to the theft of pipes or the destruction of drains. In 1994, crops were grown on 2.45 million ha of drained land, the major crops being fodder crops followed by cereals. Yields of drained crops are somewhat lower than those of rainfed crops. This might be explained by the fact that drained land is already of marginal quality. Soils are very poor with a low pH and are not really suitable for cultivation. Another reason for the low yields might be the advanced state of degradation of large parts of the drained land.

In 1994, about 25.6 million ha were estimated to be excessively humid and marshy areas needing drainage. Over 15 million ha were estimated to be salinized and 24.3 million ha to have saline soils.

Ukraine

The irrigation potential has been estimated at 5.5 million ha. The most suitable areas for irrigation development, from a technical and economic point of view, are: the

coastal plain along the Black Sea coast between Odessa and the Danube Delta; the area between Odessa and the Southern Bug valley; central Crimea; and the coastal areas along the Sea of Azov.

In 1984, the irrigated areas in Ukraine amounted to 2.4 million ha. More than 50 percent of this total was concentrated in the four districts that border the Black Sea and the Sea of Azov. Other important regions for irrigation are the valleys of the Donets and of the Dnipro where supplementary irrigation is practiced in summer.

In 1992, the area equipped for irrigation covered about 2.6 million ha of which 0.5 million ha surface irrigation and 2.1 million ha sprinkler irrigation. Surface water was the only source of irrigation water and the reservoirs built on the main rivers, and particularly on the Dnipro river, provided water to the irrigated areas downstream through canals up to 500 km long. These canals also provided water to cities and industrial complexes in Crimea and in the far southwest of the country.

In 2013, total area equipped for irrigation was estimated at 2 169 000 ha (Ukrstat, 2014). In 1992, almost 80 percent used sprinkler irrigation technology. In 2003 actually irrigated area accounted for 731 400 ha, which was only about one third of the area equipped for irrigation in that year.

Role of irrigation in agricultural production

In 2003, the area equipped for irrigation was 731 400 ha, of which 25 percent were permanent grass and fodder, 14 percent cereals, 14 percent annual fodder, 10 percent fruit trees, 10 percent vegetables, 8 percent potatoes, 7 percent pulses, 6 percent sunflowers, 3 percent sugar beet and 3 percent rice (Table 14).

Table 14 Irrigation and drainage in Ukraine*Source: AQUASTAT – FAO Data base*

Irrigation potential	-	5500000	ha
Irrigation:			
1. Full control irrigation: equipped area	2013	2169000	ha
- Surface irrigation	1992	525000	ha
- Sprinkler irrigation	1992	2080000	ha
- Localized irrigation	1992	0	ha
• Area equipped for full control irrigation actually irrigated	2003	731400	ha
- As % of area equipped for full control irrigation	2003	34	%
2. Equipped lowlands (wetland, ivb, flood plains, mangroves)	-	0	ha
3. Spate irrigation	-	0	ha
Total area equipped for irrigation (1+2+3)	2013	216900	ha
• As % of cultivated area	2013	6	%
• % of area irrigated from surface water	1992	100	%
• % of area irrigated from groundwater	1992	0	%
• % of area irrigated from mixed surface water and groundwater	-	-	%
• % of area irrigated from non-conventional sources of water	-	-	%
• Area equipped for irrigation actually irrigated	2003	731400	ha
- As % of total area equipped for irrigation	2003	34	%
• Average increase per year	1992-2013	-0.9	%
• Power irrigated area as % of total area equipped for irrigation	-	-	%
4 Non-equipped cultivated wetlands and inland valley bottoms	-	-	ha
5. Non-equipped flood recession cropping area	-	-	ha
Total agricultural water managed area (1+2+3+4+5)	2013	2169000	ha
• As % of cultivated area	2013	6	%
Size of full control irrigation schemes:		Criteria:	
Small schemes	< - ha	-	ha
Medium schemes	> - ha and < - ha	-	ha
large schemes	>- ha	-	ha
Total number of households in irrigation	-	-	
Irrigated crops in full control irrigation schemes:			
Total irrigation grain production			metric tons
As % of total grain production		%	
Harvested crops:			
Total harvested irrigated cropped area	2003	731400	ha
• Temporary crops: total	2003	474990	ha
Rice	2003	21000	ha
Maize	2003	100000	ha
Vegetables	2003	74000	ha
Sunflower	2003	46210	ha

Potatoes	2003	59490	ha
Pulses	2003	52490	ha
Sugar beet	2003	21800	ha
Fodder	2003	100000	ha
Permanent crops: total	2003	256410	ha
Fruit trees	2003	76410	ha
Grass and fodder	2003	180000	ha
Irrigated cropping intensity (on full control area actually irrigated)	2003	100	%
Drainage – environment			
Irrigated cropping intensity (on full control area actually irrigated)	1994	3281000	ha
Irrigated cropping intensity (on full control area actually irrigated)	1994	1481000	ha
Irrigated cropping intensity (on full control area actually irrigated)	1994	1800000	ha
- As % of total area equipped for irrigation	1994	69	%
Area salinized by irrigation			
Area waterlogged by irrigation			

Status and evolution of drainage systems

The first drainage works were introduced at the end of the eighteenth century in northwest Ukraine, then part of Poland. At that time, major canals were built mainly for communication and transport purposes, and the swamps were drained for cultivation. Drainage development has continued in the nineteenth and twentieth centuries.

In 1994, the drained area was estimated at 3.3 million ha, of which 63 percent was equipped with subsurface drains, mainly pipes (Table 14). About 1.8 million ha of irrigated land were equipped with drainage facilities to prevent salinization. In these areas, the groundwater level is kept at 1.5-3.0 m below the soil surface. In 2013, the total drained cultivated area is also estimated at 3.3 million ha.

Belarus

All irrigation takes place on land that has been excessively drained. In fact, there is no real need for irrigation, except in areas where the groundwater has been lowered too much by excessive drainage. For this reason, no figure on irrigation potential is available.

Irrigated areas first appeared in the statistics in 1974. In 1993, the area equipped for irrigation was equal to 131 000 ha. It was largest in 1980 when it still was part of the Soviet Union, with 163 000 ha, but the Chernobyl nuclear accident in 1986, combined with the difficult economic situation, resulted in a deterioration of the drainage and irrigation systems, and cultivation on part of these lands was abandoned.

In 1993, the whole area was reported to be sprinkler irrigated, using moving sprinkler irrigation systems. With this type of irrigation, the area equipped for irrigation may vary from year to year and is in fact equal to actually irrigated area. The variation depends mainly on whether precipitation is sufficient or not, but has decreased considerably during the last 5 years. While it was still 114 100 ha in 2006, it went down to 52 900 ha in 2009, 56 900 ha in 2010 and 30 600 ha in 2011 (NSC, 2011). Of the 114 100 ha in 2006, 85 percent was irrigated by surface water and the remaining 15 percent by groundwater (Table 15).

Table 15 Irrigation and drainage in Belarus

Source: AQUASTAT – FAO Data base

Irrigation potential	-		ha
Irrigation			
1. Full control irrigation: equipped area	2011	30600	ha
- Surface irrigation	-	-	ha
- Sprinkler irrigation	-	-	ha
- Localized irrigation	-	-	ha
• Area equipped for full control irrigation actually irrigated	2011	30600	ha
- As % of area equipped for full control irrigation	2011	100	ha
2 Equipped lowlands (wetland, ivb, flood plains, mangroves)	-	-	ha
3. Spate irrigation	-	-	ha
Total area equipped for irrigation (1+2+3)	2011	30600	ha
• As % of cultivated area	2011	0.5	%
• % of area irrigated from surface water	2006	85	%
• % of area irrigated from groundwater	2006	15	%
• % of area irrigated from mixed surface water and groundwater	-	-	%
• % of area irrigated from non-conventional sources of water	-	-	%
• Area equipped for irrigation actually irrigated	2011	30600	ha
- As % of total area equipped for irrigation	2011	100	%
• Average increase per year	2003-2011	-14	%
• Power irrigated area as % of total area equipped for irrigation	-	-	%
4 Non-equipped cultivated wetlands and inland valley bottoms	-	-	ha
5. Non-equipped flood recession cropping area	-	-	ha
Total agricultural water managed area (1+2+3+4+5)	2011	30600	ha
• As % of cultivated area	2011	0	%
Size of full control irrigation schemes:		Criteria	
Small schemes	< - ha		ha
Medium schemes	> - ha and < - ha		ha
large schemes	>- ha		ha
Total number of households in irrigation			
Irrigated crops in full control irrigation schemes:			
Total irrigated grain production			metric tons
• As % of total grain production			%
Harvested crops:			

Total harvested irrigated cropped area	2011	30600	ha
• Temporary crops: total	2011	8200	ha
- Vegetables	2011	3000	ha
- Potatoes	2011	2900	ha
- Leguminous crops	2011	2300	ha
• Permanent crops: total	2011	2300	ha
- Fruits	2011	200	ha
• Permanent meadows and pastures irrigated: total	2011	20,100	ha
Irrigated cropping intensify (on full control area actually irrigated)	2011	100	%
Drainage - Environment:			
Total cultivated area drained	2011	2952900	ha
• Non-irrigated cultivated area drained	2011	2922300	ha
• Area equipped for irrigation drained	2011	30600	ha
- As % of total area equipped for irrigation	2011	100	%
Area salinized by irrigation	-	-	ha
Area waterlogged by irrigation	-	-	ha

Status and evolution of drainage systems

Due to the climatic conditions, there is a need for drainage rather than irrigation in the country, except in areas where the groundwater level has fallen too much due to excessive drainage.

The history of drainage in Belarus dates back to the second half of the 18th Century in the then Polish state. On huge private estates marshes were drained, mainly by open canals, to turn them into meadows. In the final quarter of the 19th Century, large-scale drainage works were carried out in the Polesye region, where about 4 700 km of canals were built with an average depth of 1.1 m. These works were also intended to facilitate wood exploitation and the floating of timber down to Ukraine. Drainage work stopped at the beginning of the 20th Century but restarted in the 1920s, independently in the western part (Poland) and the eastern part (the Soviet Union). During the Second World War, work was suspended and when it restarted after the war it was initially on a small scale. Following the Land Draining and Sovkhoz Building Act of 1966, large-scale drainage work started again. Most of the drainage work was concentrated in the Polesye region, where 85 000 ha had been drained by 1939, and this drained area amounted to 560 000 and 1 400 000 ha in 1966 and 1986 respectively. In the period 1966-1986, mainly subsurface drainage systems were built. Most of this drained land in the Polesye region was contaminated after the accident at the Chernobyl nuclear power plant which, combined with the difficult economic situation, resulted in a deterioration of the drainage systems and cultivation on part of these lands was abandoned.

In 1993, about 3 million ha had been drained for agricultural purposes. In addition, land had also been drained for non-agricultural purposes, such as construction. On average, in 1993, there were 250 m of drains per ha of drained land. Subsurface drains existed on more than 75 percent of the drained area, the remaining 25 percent being drained by open canals. The total length of the irrigation and drainage

network exceeds 800 000 km, which is almost nine times the total length of the natural rivers in the country. The total area where drainage infrastructure could be developed has been estimated at 7.9 million ha.

In 2011, the area of drained lands of the republic was 3.41 million ha, of which 2.95 million ha was drained agricultural land: 43.1 percent croplands, 56.8 percent meadows and pastures, 0.1 percent permanent crops (MNREP, 2009; NSC, 2011).

Moldova

The irrigation potential has been estimated at 1.5 million ha. About 30 percent of this, or 500 000 ha, is located in the Nistru basin, 200 000 ha in the area surrounding the Costesti-Stanca reservoir on the Prut river, and another 200 000 ha in the extreme south, if using water stored in the Ukrainian Ialpug and Cahul lakes close to the border. The remaining areas consist of extension possibilities of the existing schemes (mainly in the Nistru basin) and of areas scattered all over the country. On most of these lands rainfed agriculture is currently practiced or they are used as pastures.

In 1992, just after independence, the area equipped for irrigation covered 312 000 ha. The irrigation water was stored in reservoirs and tanks, built on the rivers, and pumped into the main irrigation canals. The three largest schemes in 1992 were: the Rabnita in the Nistru valley, with a total area of 24 000 ha; and the Suklei and Etului irrigation schemes, with an area of 10 000 ha each.

Since then the irrigation sector has declined for several reasons, but mainly due to economic factors and the unfit structure of old irrigation systems for the newly emerging pattern of private farming. In 2014, total area equipped for irrigation is estimated at 228 300 ha (NBS, 2014), of which 30 percent surface irrigation, 63 percent sprinkler irrigation and 7 percent localized irrigation (Table 16). In 2007 actually irrigated area accounted for only 32 000 ha.

Table 16 Irrigation and drainage in Moldova

Source: AQUASTAT – FAO Data base

Irrigation potential	-	1500000	ha
Irrigation:			
1. Full control irrigation: equipped area	2014	228300	ha
- Surface irrigation	2014	68300	ha
- Sprinkler irrigation	2014	145000	ha
- Localized irrigation	2014	15000	ha
• Area equipped for full control irrigation actually irrigated	2007	32000	ha
- As % of area equipped for full control irrigation	2007	14	ha
2. Equipped lowlands (wetland, ivb, flood plains, mangroves)	2014	0	ha
3. Spate irrigation	2014	0	ha
Total area equipped for irrigation (1+2+3)	2014	228300	ha

• As % of cultivated area	2014	11	%
• % of area irrigated from surface water	2014	100	%
• % of area irrigated from groundwater	2014	0	%
• % of area irrigated from mixed surface water and groundwater	2014	0	%
• % of area irrigated from non-conventional sources of water	2014	0	%
• Area equipped for irrigation actually irrigated	2007	32000	ha
- As % of total area equipped for irrigation	2007	14	%
• Average increase per year	1992-2014	-1.4	%
• Power irrigated area as % of total area equipped for irrigation	-	-	%
4. Non-equipped cultivated wetlands and inland valley bottoms	-	-	ha
5. Non-equipped flood recession cropping area	-	-	ha
Total agricultural water managed area (1+2+3+4+5)	2014	228300	ha
• As % of cultivated area	2014	11	%
Size of full control irrigation schemes:		Criteria	
Small schemes < - ha	-	-	ha
Medium schemes > - ha and < - ha	-	-	ha
large schemes >- ha	-	-	ha
Total number of households in irrigation	-	-	
Irrigated crops in full control irrigation schemes:			
Total irrigated grain production	-		metric tons
• As % of total grain production	-		%
Harvested crops:			
Total harvested irrigated cropped area	2007	32000	ha
• Temporary crops: total	2007	16200	ha
- Cereals	2007	7000	ha
- Vegetables	2007	3500	ha
- Potatoes	2007	3500	ha
- Sugar beet	2007	2200	ha
• Permanent crops: total	2007	4800	ha
- Fruit trees	2007	4800	ha
• Permanent meadows and pastures	2007	11000	ha
Irrigated cropping intensify (on full control area actually irrigated)	2007	100	%
Drainage - Environment:			
Total cultivated area drained	1992	42000	ha
• Non-irrigated cultivated area drained	1992	12600	ha
• Area equipped for irrigation drained	1992	29400	ha
- As % of total area equipped for irrigation	1992	9	%
Area salinized by irrigation	-	-	ha
Area waterlogged by irrigation	-	-	ha

Irrigation is mainly concentrated in the central and southern parts of the country, in the Nistru and Prut valleys. The Prut and Nistru rivers are the main sources of irrigation water, although tributaries of these rivers are also important sources. No groundwater is used for irrigation. As the private agribusiness started to grow, the

water supply from inland lakes and ponds became very popular and more convenient to access (World Bank, 2008).

Status and evolution of drainage systems

In 1992, the drained area was estimated at 42 000 ha. About 70 percent or 29 400 ha was equipped with subsurface drains, usually pipes, located in the area equipped for irrigation. Drainage is mainly concentrated in the central and southern parts of the country.

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