Project:
Sustainable Management of Water Resources in Rural Areas in Uzbekistan

Component 1:
National policy framework for water governance and integrated water resources management and supply part

Overview of Existing River Basins in Uzbekistan and the Selection of Pilot Basins

Project report

International Water Management Institute

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Contents

List of Figures

List of Tables

Acronyms and Abbreviations

ADUOS	Amudarya Delta Irrigation System Authority
BAC	Big Andijan Canal
BFC	Big Fergana Canal
BISA	Basin Irrigation System Authority
BNC	Big Namangan Canal
BWO	Basin Water Organization
CDS	Collector Drainage System
CDW	Collector Drainage Water
CREA	Council for Agricultural Research and Economics Analysis
DOA	Description of the Action
DWR	Department of Water Resources
DRP	Domestic Regional Product
EU	European Union
GDP	Gross Domestic Product
GWL	Groundwater Level
GWM	Groundwater Mineralization
HPP	Hydro Power Plant
IDN	Irrigation and Drainage Network
ICWC	Interstate Commission for Water Cooperation
ISA	Irrigation System Authority
IWMI	International Water Management Institute
IWRM	Integrated Water Resources Management
JDC	Joint Dispatching Centre
KMC	Karshi Main Canal
MAWR	Ministry of Agriculture and Water Resources
MCMO	Main Canal Management Organization
MCOM	Main Canal Operation Management
ME	Melioration Expedition
MLRWR	Ministry of Land Reclamation and Water Resources
MCS FV	Main Canal System of Fergana Valley
O&M	Operation and Maintenance
OM	Operation Management
PSE and CA	Pump Station, Energy and Communications Administration
Rayselvodhoz	District Department of Agriculture and Water Resources
SHSC	Southern Hungry Steppe Canal
SUE	State Unitary Enterprise
SFC	South Fergana Canal
ToR	Terms of Reference
UBA	Umweltbundesant (Austrian Environment Agency) GmbH
UPRADIK	Amudarya Interstate Irrigation Canal Authority
VDW	Vertical Drainage Wells
WCA	Water Consumers' Association
WER	Wells Efficiency Ratio
ZVWMA	Zarafshan Valley Water Management Authority

Executive Summary

Over the last years a rapid population growth of the Republic of Uzbekistan has shown a high local demand for food and water supply. Moreover, the population of Uzbekistan is projected to reach 34.2 million by 2025 (EU-GIZ, 2015), which will put extra pressure on agriculture, i.e., the need to produce more food with limited land and water resources. The agriculture sector of Uzbekistan relies heavily on the resources of the Amudarya and Syrdarya rivers as well as on small tributaries rivers which have transboundary and national characters.

The EU program was designed to develop enabling policy and institutional frameworks for water resources management and capacities of individuals to put solutions into practice. This project is implemented under the EU-sponsored program on “Sustainable Management of Water Resources in rural areas in Uzbekistan” aiming to provide further assistance in the water sector of Uzbekistan. The overall objective of the EU Program is to contribute to sustainable and inclusive growth in the rural areas in Uzbekistan in the context of changing climate, while the specific objective is to improve the water supply and the efficiency of water resources management at national, basin and farm levels. Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) and its partners, IWMI, Italy’s Council for Agricultural Research and Economics Analysis (CREA) and Umweltbundesant (Austrian Environment Agency) GmbH (UBA) are responsible for implementation of the component №1: Creation of “National Policy Framework for Water Governance and Integrated Water Resources Management principles at national, basin and farm levels”. This component of the program addresses promotion of further development of the national concept in water resources management by strengthening of legal, institutional, organizational and financial mechanisms, and instruments of regulation and their adaptation to international standards. According to the signed Grant Agreement between GIZ and IWMI, the latter will use its expertise to support the project in technical and institutional aspects in accordance with the agreed activities. The current report was prepared under the activity A7 of the component №1 – development and/or strengthening of water basin management plans by the IWMI Team.

One of the main purposes of this study was to overview the existing river basins in the pilot regions to select pilot river basins for further development of the Integrated Water Resource Management (IWRM) principles adopted into the river basin management plans. The development and integration of basin planning gives an opportunity to the water management (basin) organizations to carry out the complex analysis and assessment of the existing water management situation, to perform planning of water use for the basin on short term (2-3 years), medium term (5-7 years) and long term (10-15 years) prospects. In case of basin planning, possible tendencies of economic development, population forecasts, the increasing signs of impact of climate change and other influencing factors to the pools development are considered.

River basin planning typically considers a range of social, economic and environmental issues. However, the range of issues needs to be narrowed down to key priorities to allow for a high-level strategy to be developed. Based on these priorities and the strategy determined, detailed implementation planning is undertaken. This basin planning process can be represented in four key stages:

- Conducting a situation assessment: gaining an understanding of the current and future conditions in the basin, as well as identifying and prioritizing the key issues.
- Formulating a vision and objectives: that is, spelling out the desired state of the basin over the long term, together with goals (preliminary objectives) and principles to achieve this over time.
- Developing basin strategies: specifying a coherent suite of strategic objectives and outcomes related to protection, use, disaster management and institutional development, designed to achieve the vision.
- Detailing the implementation: defining actions that give effect to the basin strategies should ultimately lead to the achievement of the vision and objectives.

The following short analytical report demonstrates an overview of existing river basins in the selected provinces of Uzbekistan: Andijan, Fergana, Namangan, Syrdarya, Kashkadarya and Surkhandarya. The current study is a situational assessment of selected pilot regions in order to gain an understanding of the current and future conditions in the regions, as well as identifying pilot river basins to implement river basin planning. The scope of work was addressed to analysis of the key socioeconomic areas of each selected regions including, demography (dynamics of city and rural population), population density and gender, geographical-administrative boundaries, climatic and meteorological conditions, relief maps, crop pattern, institutional water structures, main irrigation sources and water use (irrigation and drinking), reclamation state of irrigated lands and last but not least provision list of current issues and problems in transboundary small rivers and ‘sai’s (small rivers generated inside the country) in each province.

Overview of the existing river basins in the pilot regions of the program helped select pilot river basins to develop further river basin management plans. Out of six pilot regions, three regions are located on the upper reaches of Syrdarya River and its tributaries. These are Andijan, Namangan and Fergana Provinces. The Syrdarya Province is located on the middle reaches of Syrdarya River. Two provinces are located on the upper reaches of the Amudarya River and its tributaries. These are Kashkadarya and Surkhandarya provinces.

Based on project criteria (Annex 1), project document, request of the project stakeholders and by decision of Project NWG, two river basins have been suggested to be selected as the pilot basins to introduce river basin management plans. Those basins are Shakhimardansai in the Andijan Province and the Aksu River in the Kashkadarya Province of Uzbekistan.

All the information used in the document could be divided into primary and secondary data: a) primary data were collected during the field trip visits and assessments of six pilot regions on the ground truth basis, b) secondary data were prepared based on the documents of water management organizations in the pilot regions from the collections of the State Committee on Statistics of the Republic of Uzbekistan, the National Report of the State Committee of the Republic of Uzbekistan on Land Resources, Geodesy, Cartography and State Cadastre and existing regulations.

1. Water Management in Uzbekistan

1.1 Institutional Structure of Water Management

One of the main water resources of Uzbekistan is the surface runoff formed by the transboundary rivers Amudarya, Syrdarya and their tributaries. The main flow of the Amudarya River is formed on the territory of Tajikistan, and the Syrdarya River – on the territory of Kyrgyz Republic.

The average annual flow of the Amudarya River is 79,2 km^3, of which only 4,736 km^3 or 6.1% is formed in the territory of Uzbekistan. The average annual flow of the Syrdarya River is 37,200 km^3, of which 6,167 km^3 or 16.6% is formed in the Republic of Uzbekistan (source: cawater-info.net). At the same time, Uzbekistan annually consumes about 52 km^3 or 44.6% of the total water resources of the Aral Sea Basin. Of the total water consumption volume 92% is used by agriculture. Groundwater reserves are 18,45 km^3, of which approved operational resources are 7,8 km^3. After independence, the Central Asian countries had to establish a mechanism for regional cooperation in water resources management. On February 18, 1992, five interested republics (Kazakhstan, Kyrgyz Republic, Uzbekistan, Tajikistan and Turkmenistan) signed an agreement on the establishment of the Interstate Commission for Water Coordination (ICWC).

Established during the Soviet period, two regional institutions, Basin Water Organizations (BWO), one for the Amudarya River Basin, and one for the Syrdarya River Basin – became the executive bodies of ICWC.

BWOs are responsible for the delivery of water from the Syrdarya and Amudarya rivers to the distribution networks in each country. Throughout the year, BWOs control head water intakes and dams through monitoring water resources in accordance with the plans, adjusts the scheduled water distribution, operation and water intake plans and water levels in reservoirs and prepares water limits (quota) for ICWC. It should be noted that BWOs do not control reservoir operations directly.

BWOs exercise control and water intakes to the specified canals from the riverbeds in accordance with the limits set to the intake canals of the countries by the Ministries of Water Resources through administrative identity. The water resources of interstate and interregional canals consist of the water taken from the source and additional water inflow into canals from collectors and groundwater along the canal trunk.

Until 1996, the water management was carried out by the Ministry of Land Reclamation and Water Resources (MLRWR) of Uzbekistan. The Ministry of Agriculture and Water Resources (MAWR) was formed after the unification of MWRLR and the Ministry of Agriculture, and the Department of Water Resources (DWR) was established under it. In 2003, DWR was renamed as the General Directorate of Water Resources of the Republic of Uzbekistan.

State administration and governance over water use are implemented by the Cabinet of Ministers, local public authorities, as well as specifically authorized state administrative bodies, which regulate the water use either directly or through basin (territorial) administration and other state authorities.

The specially authorized state administrative authorities to regulate the water use are: the MAWR (surface water), the State Committee of the Republic of Uzbekistan on Geology and Mineral Resources (groundwater) and the State Inspection on oversight of safe conduct of work in industry, mining and domestic sectors of the Republic of Uzbekistan under the Cabinet of Ministers of the Republic of Uzbekistan (thermal and mineral water).

State control over the use and protection of water in accordance with the legislation is carried out by local governmental authorities, the State Committee of Uzbekistan for Nature Protection, the State Inspection on oversight of safe conduct of work in industry, mining and domestic sectors of the Republic of Uzbekistan under the Cabinet of Ministers of the Republic of Uzbekistan, the Ministry of Health of the Republic of Uzbekistan, and the MAWR. Institutional control of groundwater use is conducted by the bodies of the State Committee of the Republic of Uzbekistan on Geology and Mineral Resources.

The task of the state control over use and protection of water is to ensure compliance by all ministries, state committees, departments, enterprises, institutions, organizations, farming enterprises and citizens, the performance of duties on protection of water resources, prevention and elimination of harmful effects of water, the regulations of water accounting, as well as other regulations established by the water legislation.

In the Soviet period, the water management organizational structure was formed, in general, based on the territorial principle, but there were some structures formed within the hydrographic boundaries, such as the Amudarya Delta Irrigation System Authority (ADUOS), Amudarya Interstate Irrigation Canal Authority (UPRADIK), Zarafshan Valley Water Management Authority (ZVWMA), etc.

After the transition from administrative-territorial to basin principle of irrigation systems management in 2003, according to the Decree of the Cabinet of Ministers № 320 dated 21 July, the Basin Irrigation System Authorities (BISA) were established and consisted of the Main Canal Management Organization

(MCMO) and Irrigation System Authorities (ISA). Also, the functions of Pump Station, Energy and Communications Administration (PSE and CA) and Amelioration Expeditions (ME) were revised. The above-mentioned decree defined the basic tasks of the newly formed water management organizations. The Institutional Structure of Water Resources Management of Uzbekistan is provided in Figure 1.

The main objectives of BISA are:

- Organization of target and rational water use through the introduction of market principles and mechanisms of water use;
- Implementation of a unified technical policy in the water sector through the introduction of advanced water-saving technologies;
- Organization of uninterrupted and timely water supply to consumers;
- Provision of technical reliability of irrigation systems and water management facilities;
- Organization of irrigation system preparation for the safe operation and its maintenance;
- Sustainable water management in the basin and improvement of its efficiency;
- Provision of reliable water use accounting and reporting.

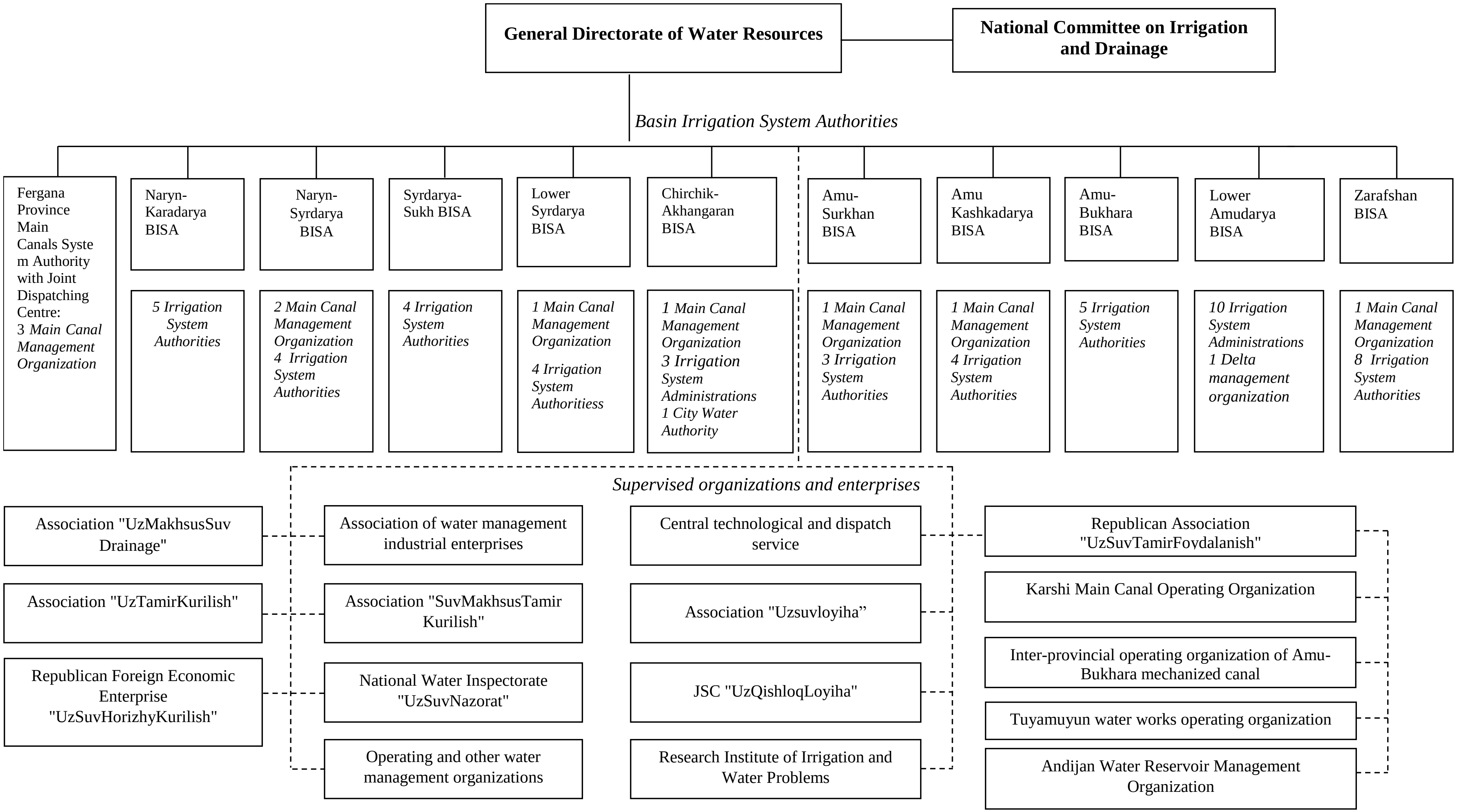
The main objectives of MCMO are:

- Sustainable water management on the main canals (systems) and facilities, its efficiency improvement;
- Ensuring overall compliance with the established order of water use on the main canal (system);
- Ensuring the technical reliability of the main canals (systems) and water management facilities;
- Preparation of the main canals (systems) for safe operation and its maintenance;
- Provision of reliable water use accounting and reporting on water intake and water supply;
- Introduction of water-saving technologies, efficiency improvement, and target use of the allocated funds, material and technical resources, equipment and machinery.

The main objectives of ISA are:

- Organization of water supply planning to water users including Water Consumers' Associations (WCAs), on the basis of contracts with them; providing them with current recommendations taking into account climatic parameters;
- Providing targeted and efficient water use, observation of the overall established water use order in the irrigation system;
- Organization of irrigation system management, improving its efficiency and performance;
- Providing technical reliability of irrigation systems and water management facilities;
- Preparation of the irrigation system for the safe operation and its maintenance;
- Maintenance of reliable water intake and water supply accounting and reporting;
- Introduction of water-saving technologies, efficiency improvement, and target use of the allocated funds, material and technical resources, equipment and machinery.

FIGURE 1. Institutional structure of Water Resources Management in Uzbekistan.



Source: MAWR of Uzbekistan.

The main objectives of Pump Station Energy and Communications Administration (PSE and CA) are:

- Ensuring good working order and safe conditions, as well as modernization of pumping stations, units, vertical drainage and irrigation wells, substations, transformers, power lines, communications, automation and remote control equipment, motor vehicles that are on its balance, as well as reliable operation and development of energy and communication systems;
- Maintenance and modernization of transmission and communications lines, automation and remote control equipment on the BISA and ISA balance;
- Strict adherence to the water supply schedules established by BISAs, preventing oversupply of water;
- Introduction of energy-saving and other resources saving technologies, maintaining accurate accounting and reporting of electricity produced and water supplied.

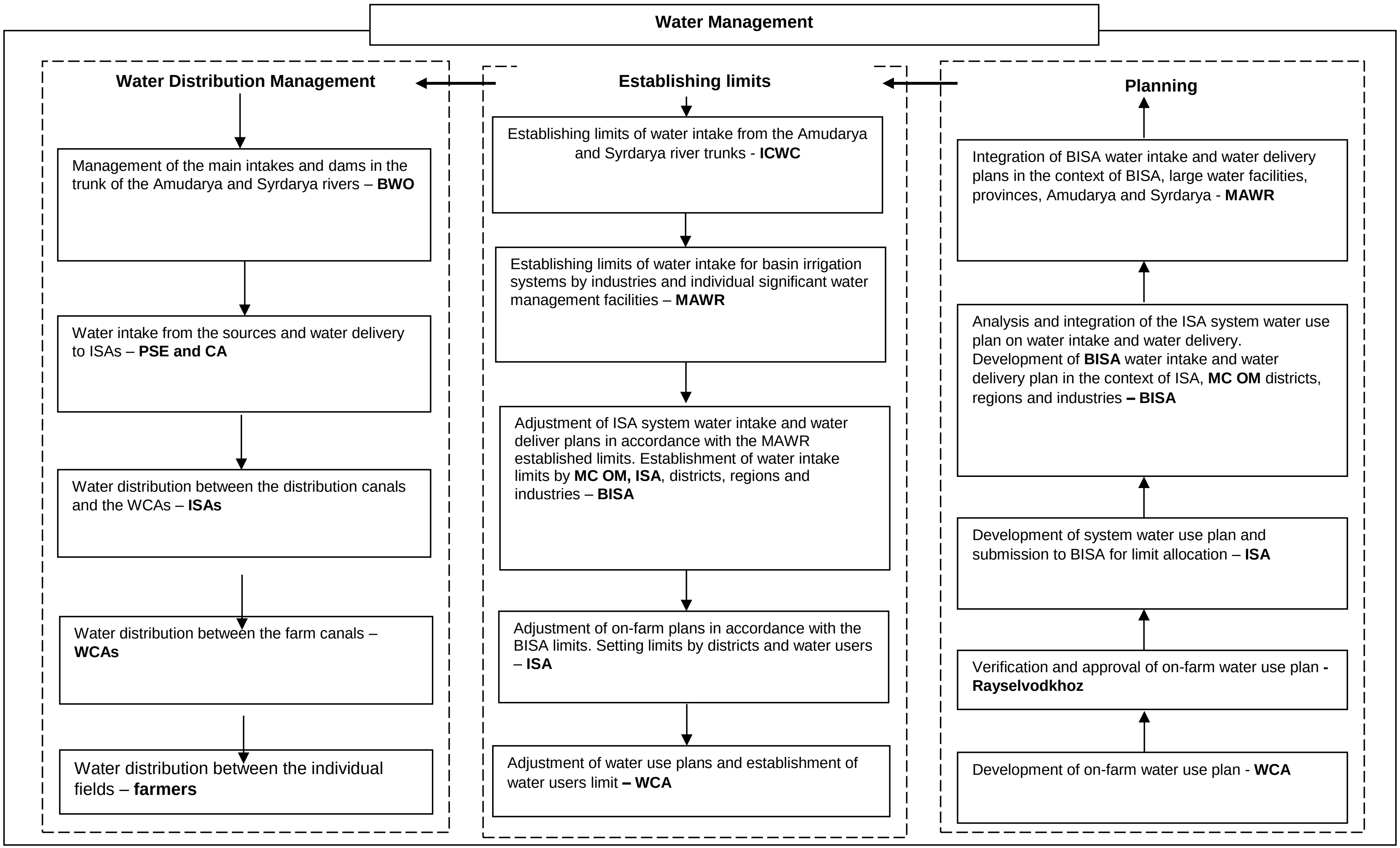
The main objectives of the Amelioration Expedition (ME) are:

- Ensuring good working order and modernization of main and interfarm collector networks and closed drainage systems, as well as equipment on the balance sheet;
- Establishment of a work regime of reclamation of pumping stations, vertical drainage wells, and monitoring of its implementation;
- Monitoring of the irrigated lands, reclamation of state lands, quality of collector, irrigation and groundwater, as well as maintenance of related reports. Informing water and land users on the ameliorative state and the required measures to achieve the reclamation well-being;
- Maintenance of inventory of the reclamation state;
- Development of measures for land reclamation, technical improvement and modernization of melioration network;
- Making recommendations for water users and follow-up on the use of saline Collector Drainage Water (CDW).

As can be seen from the above, the task of the state water management organizations are the Operation and Maintenance (O&M) of public water facilities and water delivery up to the WCA boundaries. Irrigation and drainage system O&M on the lower level of the irrigation system i.e. on-farm level, and organization of rational use of water delivered by public water management organizations, are the responsibilities of the WCA. In other words, the capacity effectiveness (fixed assets, human resources and finance) and reforms to improve management at the top of the water management hierarchy and rational use of natural resources capacity (land, water), mainly depend on the rational organization of water management and technical operation of irrigation and drainage systems at the bottom level of the irrigation system, i.e. on sustainable functioning of WCAs.

Organization, which directly has a contractual obligation with WCAs is ISA. For the diversion of water from the irrigation systems and other water bodies, WCA annually (before October 1) signs with ISA the agreement on water intake and water use. A water management flowchart is given in the Figure 2.

FIGURE 2. Water management flowchart



In accordance with the Standard Regulations on Basin Irrigation System Authorities approved by the Cabinet of Ministers dated July 21, 2003 № 320, Water Councils are established at BISAs, which are composed of the heads of BISAs (Chairman of the Board), heads (or deputy heads) of Provincial Departments of Agriculture and Water in the BISA-covered area, department heads of the main canal (system) management organizations, Irrigation System Authorities and other appropriate water management organizations, as well as the experienced and highly skilled employees. Members of the Board and its Regulation shall be approved by the MAWR.

One of the main objectives of the Water Council is to provide recommendations on water intake limits to irrigation managements system administrations, as well as other water users and consumers of the provincial (Republic of Karakalpakstan) or interdistrict water bodies by source, territory and economy sector.

From the point of public participation in water governance, it is appropriate to include in the Council not only agricultural water users but representatives of other water users: industry, utilities, ecology, etc. It would also be proper if the Council Chairman is elected from members of the Council.

1.2 Organization of Irrigation System Maintenance

To ensure good working condition and safe operation of irrigation systems the operating water management organizations carry out maintenance and repair works on water facilities by using their own sources. Maintenance of large and complex objects is implemented by contracting specialized organizations. Objects requiring rehabilitation and reconstruction are included in the territorial targeted programs implemented by the Land Reclamation Fund under the Ministry of Finance.

While the planning and management of water resources is carried out in accordance with the Regulation "On the procedure of water use and consumption in the Republic of Uzbekistan" approved by the Cabinet of Ministers № 82 dated March 19, 2013. There is no single normative instrument regulating the procedure for planning and carrying out maintenance, repair and rehabilitation works on irrigation and drainage system facilities.

Only MAWR Decree of the Republic of Uzbekistan № 202 dated September 7, 2006, obliges the operating water management organizations to continuously monitor the implementation of the current and capital repairs of gauging stations, waterworks, administrative and industrial buildings, pumping stations, and machinery maintenance organizations create a commission of 5 persons headed by the Deputy Chief Operating Officer. The commission's main tasks include:

- Development of the repair schedule for gauging stations, waterworks, administrative and industrial buildings, pumping stations, power equipment, communication lines and machinery at the beginning of the plan year and its approval by the Ministry of Agriculture and Water Resources (MAWR) of the Republic of Uzbekistan;
- Performance control over all types of repairs to be in a timely manner and within established cost estimates;
- Study of defects to be repaired at gauging stations, waterworks, administrative and industrial buildings, pumping stations, power equipment, communication lines, equipment and machinery and preparation of certificates on defects of the above;
- Ensure preparation of advance defect certificates on electric motors, pumps, transformers and other equipment sent by the organization to the factories and other repair enterprises and ensure work implementation based on the commission opinion;
- Collection of old parts replaced under the established regulations each quarter, drafting certificates under the strict supervision and delivery of unusable parts to scrap, based on the commission opinion;
- Carrying out monthly monitoring of facilities under repair to establish basic capital assets, spare parts and materials;
- Perform maintenance and repair work on water facilities; 49 state unitary enterprises specialized in the implementation of reclamation and other water works were established in the Republic.

The supply of land reclamation equipment, machines and other means of mechanization to construction and operating water management organizations working on land reclamation, water consumers' associations and farmers conducted by a leasing company, "Uzmeliomashlizing", in the form of state unitary enterprise.

1.3 Financing of Water Management

Financing of water management in Uzbekistan is carried out from the state budget in the form of operating costs of water management organizations and capital expenditures in the framework of the State Program, implemented by the Land Reclamation Fund under the Ministry of Finance, as well as foreign investments in the form of a loan under the guarantee of the Government of Republic of Uzbekistan. The main sources of the Land Reclamation Fund are income from the single land tax and earmarked budget funds.

Resolution of the President of the Republic of Uzbekistan dated April 19, 2013 № PP-1958 approved the State Program "On measures for further improvement of ameliorative condition of irrigated lands and rational use of water resources for the period 2013-2017", according to which preparation of the annual draft State budget and investment program of the Republic of Uzbekistan provides in the prescribed manner for the allocation of funds for implementation of measures included in the State Program on improvement of ameliorative condition of irrigated lands.

The annual development of the State Program and Territorial Targeted Programs is implemented in accordance with the "Regulations on the procedure for the formation, development, examination, approval and implementation of projects to further improve ameliorative condition of irrigated lands" (approved by the Cabinet of Ministers on November 28, 2008 № 261). It should be noted that the reconstruction and rehabilitation of water facilities within the State Program is carried out both on public and WCA facilities.

Regional groups providing technical support for reclamation works to the Management Department of the Land Reclamation Fund under the Ministry of Finance of the Republic of Uzbekistan, provide on-site technical supervision over the quality of reclamation works, their compliance with established specifications and design parameters as well as inspection of performed works.

Joint directorate of construction enterprises of MAWR serve as a customer of construction and reconstruction of irrigation facilities, carried out at the expense of the state capital investments, repair and restoration of interdistrict and off-farm collectors and other reclamation projects.

Each year, water management organizations develop cost estimates and staffing tables in accordance with the "Regulations on the procedure of development, approval and registration of cost estimates and staffing tables of budget organizations and budget recipients" (approved by the Decree of the Minister of Finance of Uzbekistan № 74 dated November 14, 2014). The planned costs for the repair and overhaul of water management facilities are included in the estimated total operation costs of water management organizations.

O&M costs of Irrigation and Drainage Network (IDN) within the WCA boundaries are funded by water consumers' fees for services rendered.

Conclusion

Water management is implemented by the territorial departments of state organizations:

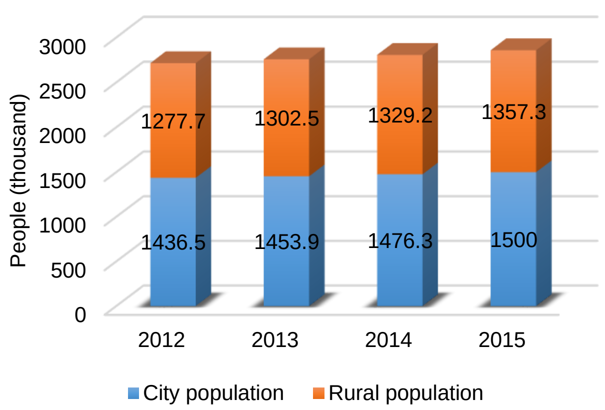
- Surface water – by MAWR;
- Groundwater – by State Committee of the Republic of Uzbekistan on Geology and Mineral Resources;
- Thermal and mineral waters – by the State Inspection on oversight of safe conduct of work in industry, mining and domestic sectors of the Republic of Uzbekistan;
- Water management on the lower level of the irrigation system is implemented by WCA;
- A legal framework ensuring the rational water use for the needs of the population and sectors of the economy, and the protection of waters from pollution and depletion is in place;
- Normative-legal documents, directly governing the water use and consumption order, water consumption and water use planning are in place;
- There are no normative documents regulating the procedure of planning and carrying out the maintenance and repair-rehabilitation of irrigation and drainage system facilities by operating water management organizations;
- As the water governing body of the BISA, Water Councils are established, which mostly include managers and specialists of agriculture and water resources. However, it should be noted that in all BISA Water Councils, a Chairman is at the same time the head of BISA – which contradicts the IWRM principles;
- Financing of water management is mainly carried out by the state budget and partially by water users. Funding from water users is collected in the form of membership fee and used to cover WCA expenses with regard to delivery and allocation of water resources.

2. Analysis and Evaluation of the Current Situation in the Pilot Regions

2.1. Andijan Province

General information. The Andijan Province falls in the latitudes 40.3673 to 41.0915 and longitudes 71.4789 to 73.1684, and the total area equals 4,200 km^2. The province is located in the eastern part of the Fergana Valley in far eastern part of the country. Province neighbors with Kyrgyz Republic and the Fergana and Namangan provinces of Uzbekistan. The province has an arid, continental climate.

FIGURE 3. Dynamics of city and rural population



Source: The State Committee of the Republic of Uzbekistan on statistics, 2015.

There are 14 districts in the province: Andijan, Asaka, Balykchi, Bulokboshi, Buz, Izboskan, Jalakuduk, Khuzhaobod, Kurgontepa, Marhamat, Oltynkul, Pakhtaobod, Shakhrikhon and Ulugnor. The city of Andijan is the administrative center of the province. The population of the Andijan Province is 2857.3 thousand people and its density equals 621.5 people per square kilometer, which renders this the province the most densely populated in Uzbekistan (The State Committee of the Republic of Uzbekistan on statistics, 2015). Although the Province occupies only 1% of Uzbekistan's territory, about 10% of the nation's population lives here. The number of population increased slightly from 2672.3 to 2857.3 thousand people between 2011 and 2015.

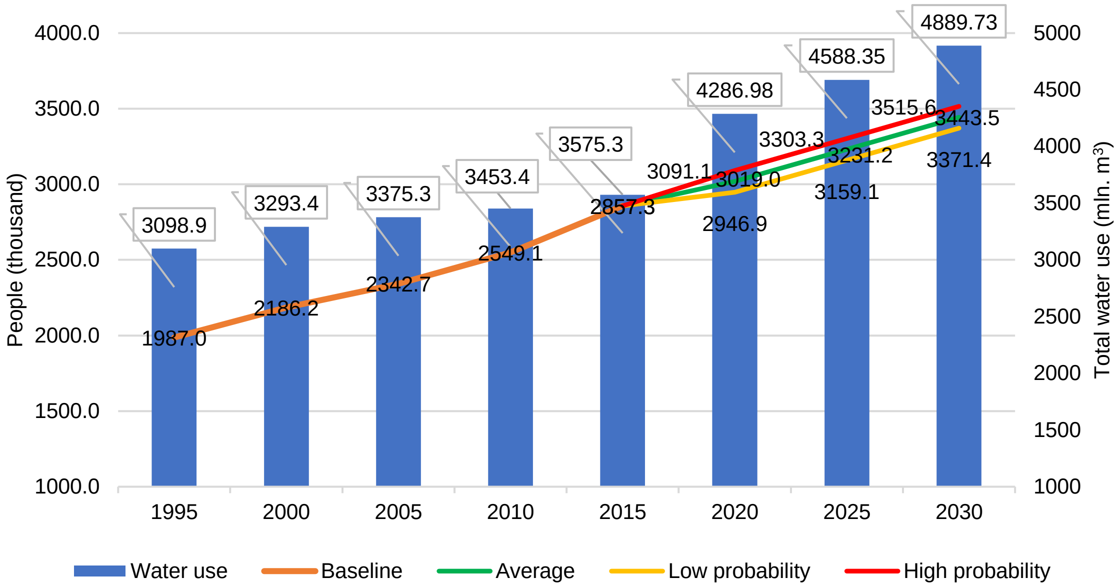
Districts with the highest population density areas are Andijan, Asaka and Oltynkul, with more than 1,000 inhabitants per square kilometer. The latest tendency of population dynamics is given in Figure 3 for the period 2012-2015. Irrigated agriculture is among the main economic activities in the Andijan Province. The average age of population in the province is 28.2 years. Proportion of male and female citizens is almost similar with a small excess of males (Figure 4). In 2015, about 47.5% of the inhabitants lived in rural areas, decreasing to 46.8% in 2011, which shows a marginal increase of rural population of the province during this period. The irrigated areas equal 2,737 thousand hectares, which is 65% of the total area. The size of the irrigated areas in the province has not significantly changed between 2012 and 2015. The main source of water for irrigation are the rivers Naryn, Karadarya and Akbura as well as small rivers (locally called "sai") such as Aravansai, Tentaksai, Maylisai, which are transboundary by nature and also internal/national small rivers: Shakhrikhonsai, Savai and Andijansai originated within the territory of Uzbekistan. The province is located in the territory of the Naryn-Karadarya BISA and consists of five ISAs: Andijansai ISA, Karadarya-Maylisai ISA, Savai-Akburasai ISA, Ulugnor-Mazgilsai ISA and Shahrihonsai ISA.

FIGURE 4. Population density and gender by districts in Andijan Province.

	District name	Population density, person per sqkm
1	Andijan	1514
2	Asaka	1093
3	Balykchi	550
4	Bulokboshi	724
5	Buz	318
6	Izboskan	777
7	Jalakuduk	460
8	Khuzhaobod	447
9	Kurgontepa	417
10	Marhamat	489
11	Oltynkul	1114
12	Pakhtaobod	652
13	Shakhrikhon	956
14	Ulugnor	129

Due to the aridity of the climate, the agricultural areas have been irrigated by the canals. Almost half portion of the province area (52%) is located under the Andijansai and Ulugnor-Mazgilsai ISAs. It is worth mentioning that according to the State Decree, the economy of the Asaka District has been shifted to specialization of cultivation orchards, wheat and vegetables starting from 2013. More detailed biophysical/technical as well as organizational aspects of water management are given in the next sub-sections below.

FIGURE 5. Forecast of population growth and total water use in Andijan province for 1995-2030.



This forecast (Figure 5) on the population growth and total water use was developed to determine how much water would be needed in future. The forecast shows that Andijan Province will face a steady growth of population and accordingly a higher demand for water. While the population of the province is projected to reach 586 thousand between 2015 and 2030, the demand for water is anticipated to be more than 1,324 million m^3. The population growth was estimated using the existing information of the State Committee on Statistics for the period of 1995 to 2015. Total water use projections for 2015-2030 are calculated according to water use per capita in 2015 (1.2 m^3 per capita). In fact, in 2015 water consumption of the region was 3,575.3 mllion.m^3. As illustrated in Figure 5, population growth directly influences an increase of total water use, which shows the need for an increased need for rational and effective water use.

2.1.1 Climatic and Meteorological Conditions

The Andijan Province is surrounded by Chatkal and Fergana on the northwest, north and northeast, and by Alay and Turkestan ranges on the south, which creates specific natural conditions. The natural conditions here are based on the physical and geographical location of the area on the inner edge of the raised huge mountain basin, almost entirely surrounded by high mountains. The warm climate eliminates the sharp decrease of temperatures in early spring and autumn and hence favors a cultivation of cotton as well as other agricultural crops. Main climate indicators are shown in Table 1.

TABLE 1. Main climate indicators of Andijan Province (long-term annual average data).

Weather station	Period: months IV-IX					Period: months III-X		Frost-free period, days
	Air temperature, °C	Relative humidity, %	Precipitation, mm	Evaporation, mm	Moisture deficit, mm	Precipitation, mm	Evaporation, mm	
Baytok	22,4	50	69	983	914	189	199	230
Andijan	22,3	51	91	962	871	135	221	217
Asaka	21,7	56	65	855	790	166	208	209
Kzylkiya	21,5	44	122	1081	959	170	244	204

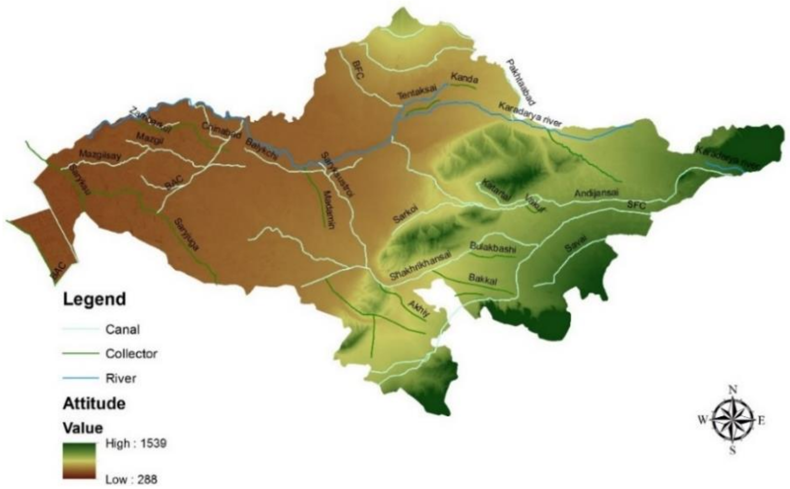
Source: Uzbek Academy of Agricultural Sciences, 1992.

During a growing season, the average daily temperature is 21.5-22.4°C. The relative air humidity at this time varies between 44 and 56%. Precipitation is low and unevenly distributed during a season: 135-189 mm a year, but evaporation from the water surface is very high and ranges from 850 to 1,081 mm. As a result, there is a moisture of substantial deficit with 790-959 mm during the growing season. The frost-free period ranges from 204 to 230 days.

2.1.2 Relief Map of Andijan Province

Many foothills have a flat terrain and unlike hill zones, are suitable for irrigated agriculture. The western side of the province is part of the valley plain, composed of almost horizontally lying, powerful loess, sometimes dismembered with bumps and waterways (Sadykov, 1975).

FIGURE 6. Digital elevation model and irrigation network for Andijan Province.



It should be noted that mountain-hill zones generally occupy the territories of the Andijan, Shakhrikhon and Savai-Akbura ISAs, and flat zones are under the Karadarya-Maylisai and Ulugnor Mazgilsai ISAs (Figure 6).

2.1.3 Irrigation Systems

The main sources of irrigation in the province are the rivers Karadarya (snow-fed), Naryn (glacier and snow-fed) and Akbura and Aravansai (glacier fed), and Maylisai and Tentaksai (snow-fed), as well as the so-called sais Shakhrikhonsai, Savai and Andijansai, which are generated in the territory of Uzbekistan (Figure 7). Spring water and water from 69 irrigation wells, 469 vertical drainage wells and collectors are also used for irrigation. Mineralization of irrigation water is 0.3-0.5 g/l, irrigation wells 0.2-0.3 g/l, vertical drainage 0.7-0.8 g/l and Collector Drainage System (CDS) 1.5-1.7 g/l. Map of the Naryn-Karadarya BISA command area is shown in Figure 7.

FIGURE 7. Map of the Naryn-Karadarya BISA command area.

The Naryn, Karadarya, Akbura, Aravansai, Maylisay and Tentaksai rivers receive the highest annual runoff during the period from July to September (40-60% of annual runoff). More detailed information about the irrigation-drainage networks of the Naryn-Qaradarya BISA is given in Figure 8. During this time, the rivers are fed mainly from snow runoff and glaciers melting. From March to June, these rivers receive a minimum flow ranging between 20-30% from annual runoff, but not more than 40%. A detailed information about the rivers of the Andijan Province is given in Table 2.

Groundwater resources of the province are formed in the geological sediments of all ages and are province-wide. Projected operating reserves of fresh groundwater are 36.8 m^3/s, approved reserves 22.4 m^3/s. Groundwater is mainly used for domestic and industrial purposes. It is worth mentioning that big industries of the provinces use mainly water from the Vertical Drainage Well (VDW) system.

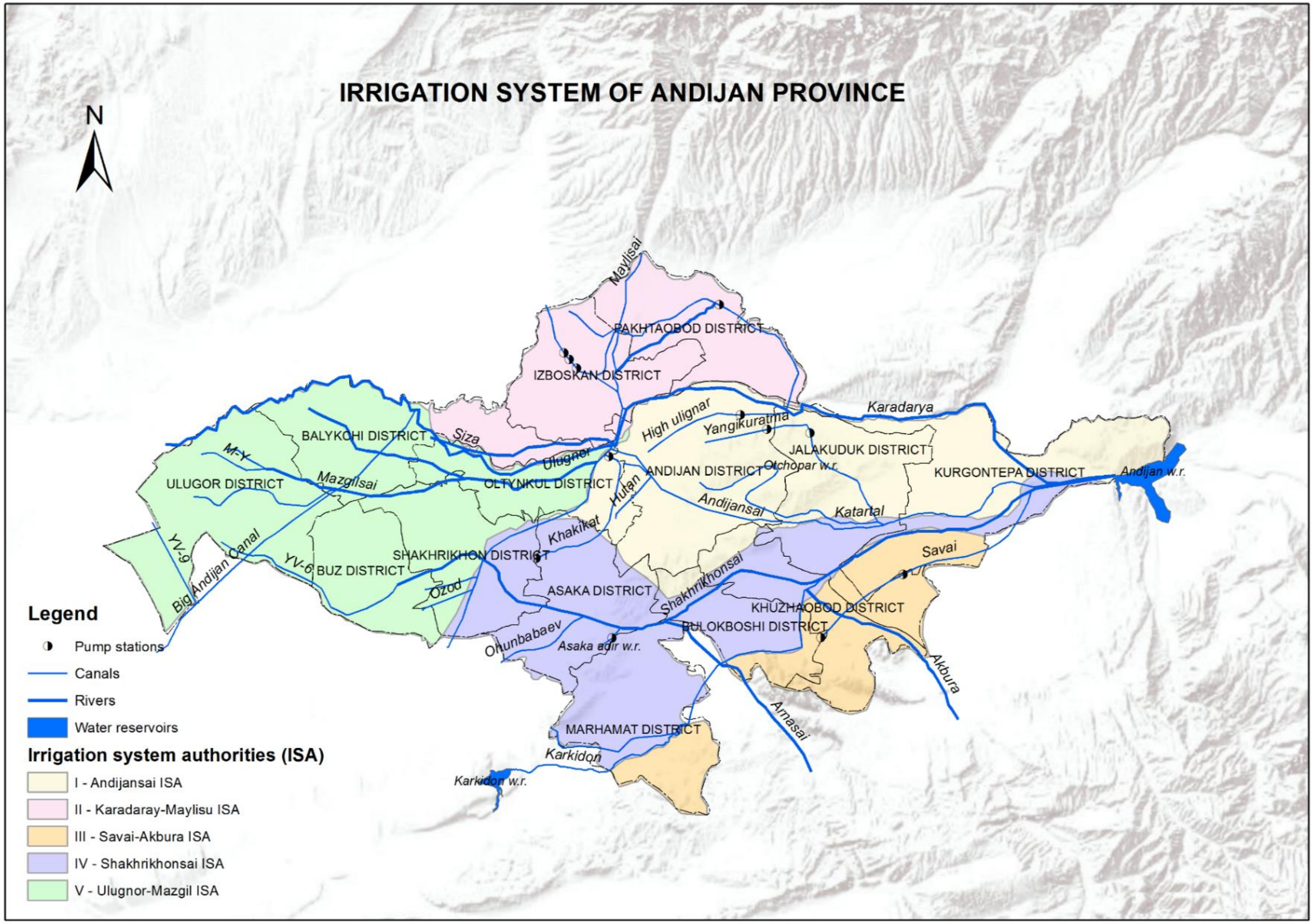
TABLE 2. Key indicators of the Andijan Province rivers.

Region	River	River source	River characteristics	Irrigation System Administration (ISA)	Districts crosses	Irrigated zone, (ha)	Transboundary river (yes/no)	Water use million/m^3			
								Irrigation	Economy	Domestic	Other
Andijan Province	Andijan sai	Fed by waters of the Karadarya River (Andijan Reservoir)	The canal was built in 1903, water-transmitting capacity is 50 m^3/s, the length is 76.7 km, of which 9.35 km have concrete lining	Andijansai ISA	Kurgantepa, Jalakuduk and Andijan provinces	42,580	No	427.53	0.6	102.3	41.26
	Karadarya	Formed by snow and glaciers of the Alay mountain range	The total length is 180.0 km of which 37.0 km is in Kyrgyz Republic and 143.0 km – in the Republic of Uzbekistan. Basin area is 28,600 km²	Andijansai ISA	Kurgontepa, Jalakuduk, Pakhtaobod, Andijan, Izboskan, Oltynkul, Balykchi districts of Andijan and Namangan provinces	61,232	Yes	199.27	0.91	2.4	31.61
	Aravan sai	Fed by snow and glacier	The total length is 102.0 km of which 87.9 km are in Kyrgyz Republic and 14.1 km in the Republic of Uzbekistan. Catchment area is 464 km²	Savai-Akbura ISA	Aravan Town, Marhamat and Bulokboshi districts	1,420	Yes	7.54	-	-	-
	Akubra	Fed by snow and glacier	The total length is 130.0 km of which 114.7 km are in Kyrgyz Republic and 21.3 km in the Republic of Uzbekistan. Catchment area is 2,676 km²	Savai-Akbura ISA	Jalakuduk and Khuzhaobod districts	4,540	Yes	33.12	-	-	4.7
	Maylisai	Fed by snow and glacier	The total length is 18,9 km, water-transmitting capacity is 200 m^3/s	Karadrya -Maylisai ISA	Pakhtaobod	8,600	Yes	16,3	-	9,1	-
	Tentak sai	Formed by snow and glaciers of the Fergana mountain range	The total length is 126 km of which 21,7 km are in the Republic of Uzbekistan Catchment area is 4,130 km². Multiyear water discharge is 35,8 m^3/s, transmitting capacity is 250 m^3/s	Karadrya-Maylisai ISA	Pakhtaobod, Izboskan,	1,500	Yes	3,031	-	-	-
	Savai	Fed by waters of the Andijan reservoir	The total length is 47,3 km transmitting capacity is 44,1 m^{3}/s	Savai-Akbura ISA	Kurgontepa, Jalakuduk, Balykchi, Khuzhobod, Bulokboshi districts (25 km Kyrgyz Republic)	15,000	Yes	157	-	8,9	-

	Shakhrihansai	Fed by waters of the Kampirravot water reservoir	The total length is 120 km of which 118,3 km are in the Republic of Uzbekistan, transmitting capacity is 240 m^3/s	Shakhrikhonsai ISA	Kurgontepa, Jalakuduk, Khuzhobod, Bulokboshi Shakhrikhon, Buz	59,000	No	358	-	42	-

Source: Akromov 2008 and Authors' survey.

FIGURE 8. Scheme of the irrigation system in Andijan Province.

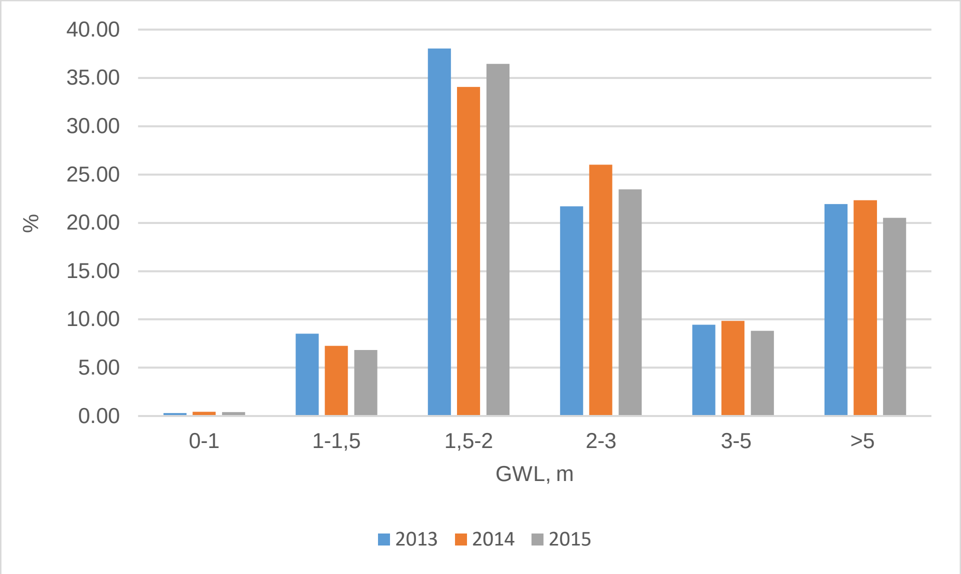


2.1.4 Reclamation State of Irrigated Lands

Natural conditions of the province determine a favorable reclamation state of irrigated lands. Groundwater regime is mainly controlled by both horizontal and vertical drainage. There are 469 Wells Efficiency Ratios (WER) in the province. However, WER does not exceed 0.5.

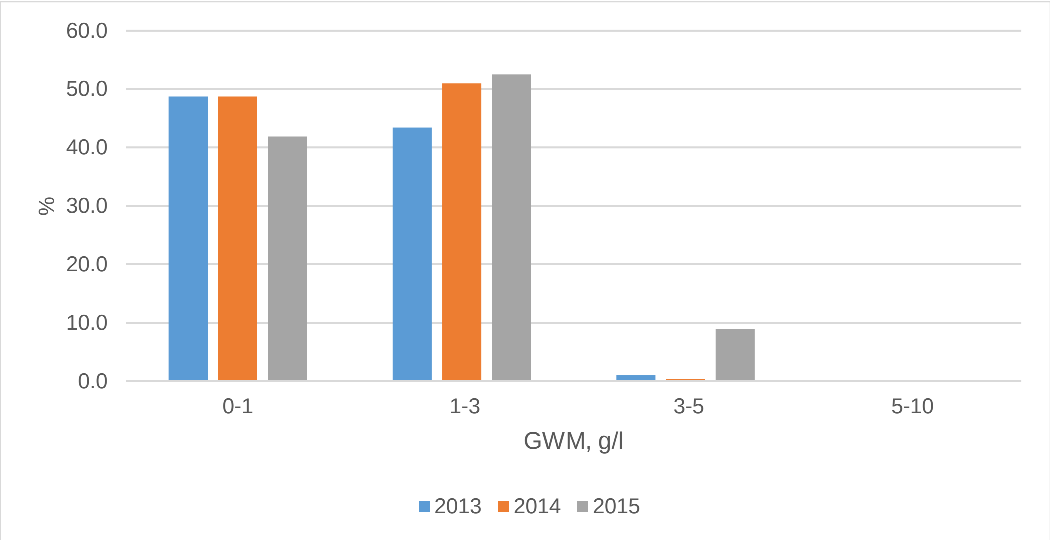
In the last years, there has been an insignificant decrease in the area of average groundwater level (GWL) during the crop growth season in the province with the levels of 1-1.5 m (Figure 9).

FIGURE 9. Distribution of average depths of GWL during crop growth season in Andijan province.



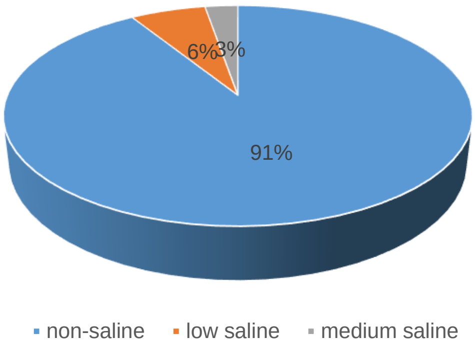
An increasing groundwater salinity during the growing season is observed in the province. Areas with groundwater mineralization (GWM) of 0-1 g/l decreased from 48.7 to 41.9% for the period from 2013 to 2015. During this period, the areas with GWM of 1-3 g/l increased from 43.4 to 52.5%, and the areas with GW mineralization of 3-5 g/l - from 1 to 8.9%. There were areas with GWM of more than 5 g/l (Figure 10).

FIGURE 10. Distribution of the areas with GWM during crop growth season in Andijan Province.



In recent years, there was almost no change observed in the dynamics of soil salinity in the province; the areas under non-saline soils remain relatively constant at 91% (Figure 11).

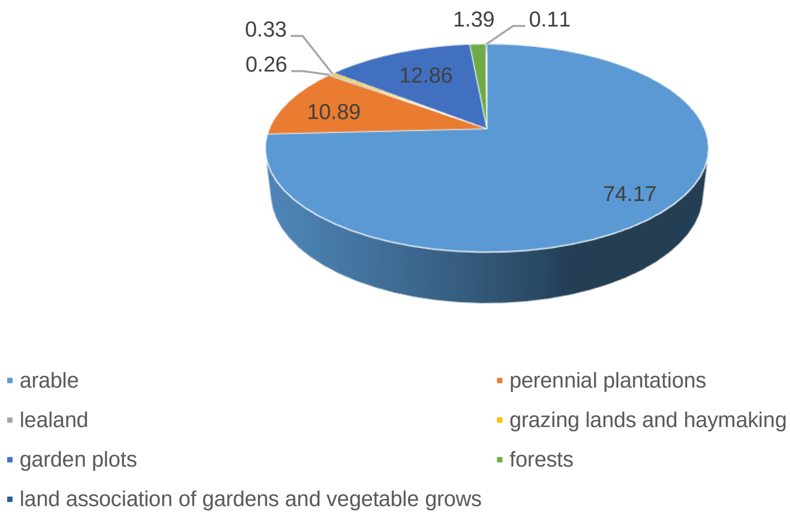
FIGURE 11. Distribution of irrigated areas by soil salinity in Andijan Province.



2.1.5 The Use of Water and Land Resources

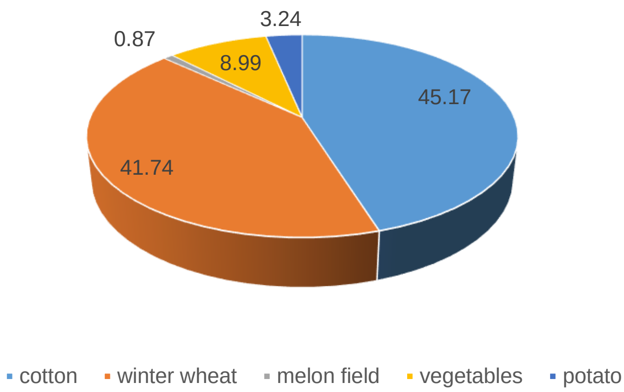
Use of the land resources. The land area of the province is 430,3 thousand ha, out of which 273,7 thousand h are irrigated (Source: The Statea Committee of the Republic of Uzbekistan on Land Resources, Geodesy, Cartography and State Cadastre). The structure of the irrigated land use is shown in Figure 12**.**

FIGURE 12. The structure of the irrigated areas, %.



Due to the diversification of agricultural production over the past 5 years, the cotton-producing area decreased by 6.2 thousand ha, area under grain crops increased by 1.0 thousand ha, vegetables – by 4 thousand ha, potatoes – by 1.1 thousand ha. The percentage of the cropping pattern including household backyards for the year 2014 is shown in Figure 13.

FIGURE 13. Crop pattern including backyards, in %.

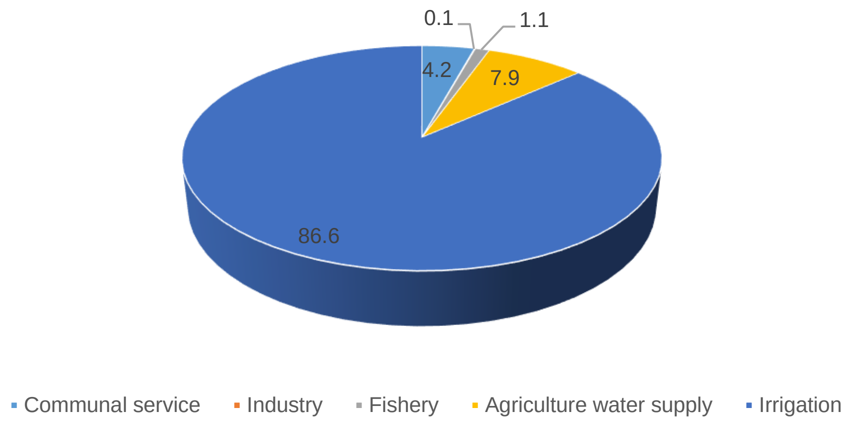


Organization of water use. Andijan Reservoir Management Organization is under the Republican Association "Uzsuvtamirfoydalanish". The main canals: Big Fergana Canal (BFC), South Fergana Canal (SFC) and Big Andijan Canal (BAC) are operated by the Joint Dispatching Centre (JDC) of the Main Canals System Authority based in Fergana.

State unitary enterprise (SUE) "Andijansuvokova" provides the population with water for drinking and household needs. Water intake for this purpose is carried out from both underground and surface sources.

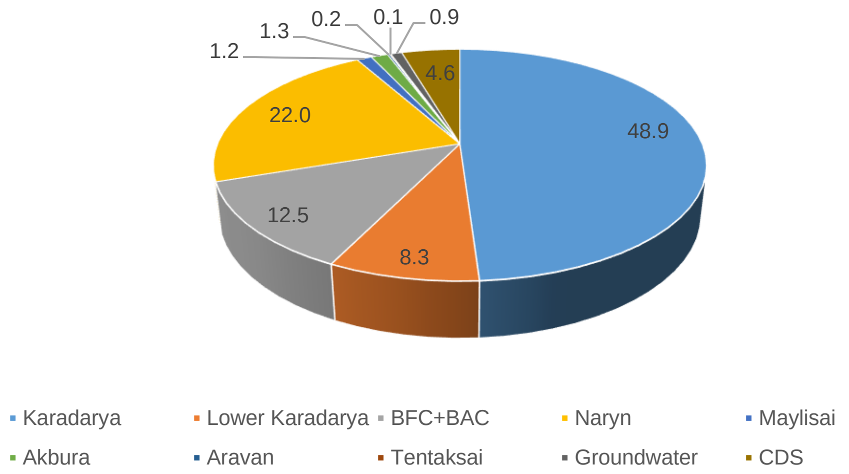
Water use. The principal water consumers are irrigation (86.6%), agriculture (7.9%) and domestic utilities (4.2%). The small volume of water is used by industry and fisheries (Figure 14).

FIGURE 14. Water use by industry (%).



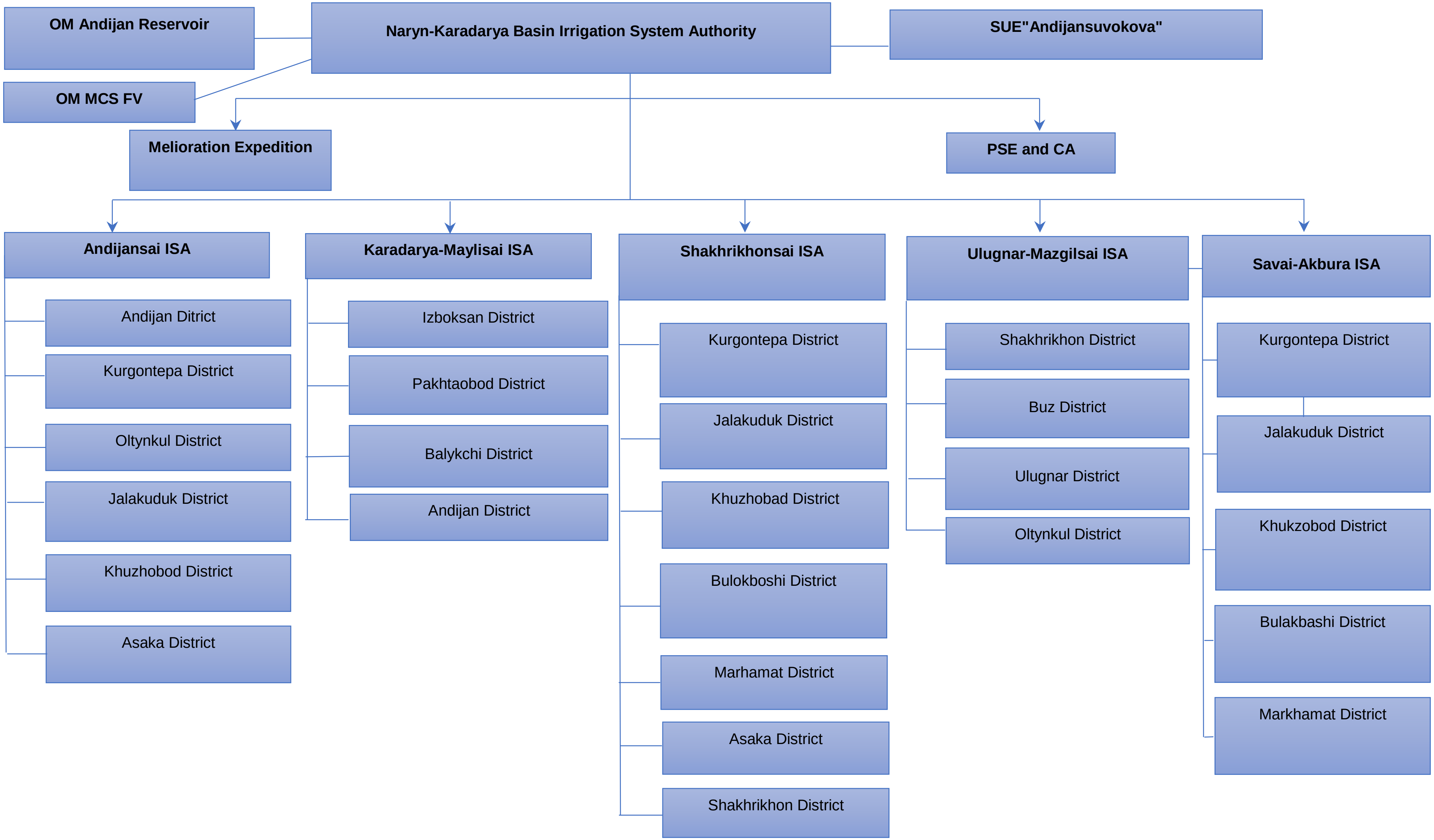
Specific water supply on the WCA border during the growing season is 8,7 - 9,3 m^3/ha; during the nongrowing season it is 2,4-2,9 m^3/ha. Of the total water intake, 48.9% is taken from Karadarya River and 22.0% from Naryn River (Figure 15).

FIGURE 15. Water intake structure (%).



The institutional structure of the water management in the province is given in Figure 16.

FIGURE 16. Institutional water management structure of Andijan Province.



2.1.6 Findings of the Andijan Province River Basins Assessment

Of the population of the province about 47.5% lived in rural areas in 2015. Compared to 46,8% in 2011, which shows a marginal increase of rural population in the province during this period. It should be noted that water intake for irrigation is a very important aspect for the rural population of the region. The specific weight of area in Gross Domestic Product (GDP) of the country is 6,4%[1] in 2014. Moreover, agricultural industry constitutes 10,2% of all products of the country in 2014. About 30% of the population of the province are employed in the rural economy.

Growth rates of agricultural production average 108% for 2014 in comparison with 2013. The segment of the crop production (farmings) in a product structure of agricultural industry in 2014 constitutes 72,8%, while livestock production was 27.2%.

It should be noted that the water intake for irrigation is a very important aspect for livelihoods of the rural population in the province. The irrigated area is 273,7 thousand ha of which 73,6 thousand ha areunder pumped irrigation, where the water is lifted by 141 pumping stations. Main irrigated areas are under cotton and wheat cultivation, but there is a tendency to diversify crop production, whereby the land under cotton and wheat is gradually decreasing.

The main sources of irrigation are the rivers Karadarya, Naryn, Akbura and Aravansai, Maylisai, Shakhrixonsai and Tentaksai. The flows of Naryn and Karadarya rivers are regulated by reservoirs and therefore there are no problems with water availability in the river basins of the province. The largest annual runoff of the Akbura, Aravansai, Maylisai and Tentaksai river basins is during the period from July to September (40-60% of annual runoff). During this time, the rivers are fed mainly from melting of snow and glaciers. From March to June, these rivers receive a minimum of 20-30% of the annual flow. In March-April, the water demand of winter wheat is increasing and exactly in this period there is a problem with water availability in small river basins.

The problems regarding irrigation water management include: 19-20% of the water taken from the source is lost in the course of the main canals; 14-16% of water delivered to the province border is lost in the distribution canals. In general, delivery losses from river to the WCA boundaries during the growing season constitute 30% and in the nongrowing season - up to 45% of the total withdrawn from the source. There is no data on water losses in irrigation systems within the WCAs.

A feature of irrigation systems is that they are fed by different sources. For example, the Karadarya and Mailisai basins are additionally fed by the Naryn River. In addition, numerous interdistrict pumped and in some cases, discharge canals, allow maneuvering with water sources, and more or less align water availability in the systems of the province throughout the year. The unstable and insufficient water supply of individual irrigation systems is also regulated by the Andijan, Asaka and Otchopar reservoirs.

Table 3 provides a registry of current issues and problems in small rivers and small canyons of the Andijan Province. It is worth mentioning that Table 3 shows the current issues and problems in small rivers and sais of Andijan Province. The small rivers Mailisai, Aravansai, Akbura and Tentaksai are considered as transboundary small rivers, while Shakhrikhon, Andijansai and Savai are considered as internal/national rivers generated within the territory of Uzbekistan. Most of the transboundary small rivers have issues regarding water shortage (especially during the crop- growth period), natural disasters and water pollutions due to transboundary character of the basins and its related consequences. However, in the conditions of the internal/national rivers no problems with water availability have been experienced due to guaranteed water supply by the reservoirs in the country. The major problems in those basins are the overuse of water resources, water losses within the system, hindrances of data exchange as well as occasional natural disasters.

According to the local stakeholders, the solutions to the transboundary character of the problems such as introduction of the water-energy saving technologies, integration of the early warning mechanisms to prevent natural disasters as well as reduction of the pollutions into the basin, are suggested to improve transboundary water cooperation. As solution to the national small rivers, the suggestions are to introduce water-energy saving technologies, rehabilitation of the parts of the river, introduction of water information system in order to improve the data transmission as well as integration of the early warning mechanisms. BISA representatives informed that it will be good to bring governance representatives of the different sectors within the basin into the small river basins governance process. As a proposal, the Naryn-Karadarya BISA suggested to select the Shakhrikhon small river as the pilot river basin to introduce River Basin Water Management plan. The Shakhrikhon River Basin fully coincides with the criteria of the selection of the pilot basin given in Annex 1.

[1] *Source*: Statistical Yearbook of the regions of Uzbekistan, the State Statistics Committee of Uzbekistan. Tashkent 2015

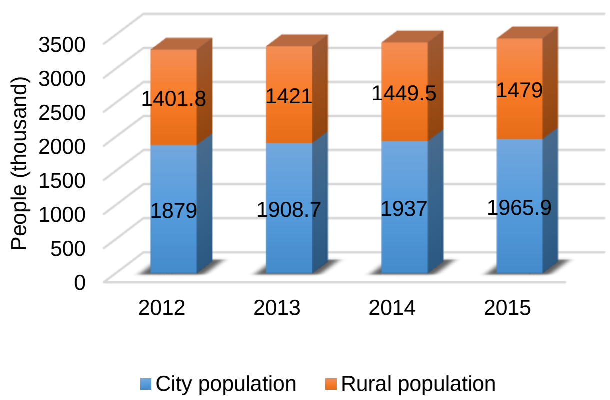
TABLE 3. List of current issues and problems in small rivers and sais of Andijan Province.

Name	Identified problems	Negative consequences and risks	Causes	Activities
Isfara	• Lack of irrigation water • Mismanagement of the head water intake (transboundary character) • Nonequitable water distribution on the head water intake • Natural disasters	• It brings to the degradation of the land resources, low yields of agricultural crops, ecologic and social damages as well as threats to the community	• Transboundary problem, nonadherence to the agreements, head vs tail problem • Head water intake is mainly managed by the upstream users. Downstream users cannot get access to repair the head water intake • Mismanagement and also transboundary character does not allow to properly manage the infrastructure • Absence of the early-warning mechanisms to inform about natural disaster	Agriculture (irrigation cropping) Emergency situations
Shakhimardansai	• Lack of irrigation water • Deterioration of the irrigation system • Water pollution	• Occurrence of the conflicts between farmers, WCA and ISA • Non-rational use of water resources and very high losses of water resources. • Loss of yields, conflicts between water consumers, WCA and ISAs • Decrease of the biodiversity and vegetation and health problem of the communities	• Transboundary problem, non-adherence to the agreed agreements, head vs tail problem • Lack of financial means for rehabilitation • Kadamjay plant for the production of metal surma in Kyrgyz Republic	Agriculture (irrigation cropping) Chemical Industry
Isfayramsai	• Lack of irrigation water • Deterioration of the irrigation system • Natural disasters	• Occurrence of the conflicts between farmers, WCA and ISA • Nonrational use of water resources and very high losses of water resources. Decrease of the biodiversity and vegetation	• Transboundary problem, nonadherence to the agreed agreements, head vs tail problem • Lack of financial means for rehabilitation • Absence of the early-warning mechanisms to inform about natural disaster	Agriculture (irrigation cropping) Emergency situations
Sukh	• Water losses in the irrigation system • Lack of irrigation water • Natural disasters	• Loss of yields, deterioration of the social well-being of the communities. • Occurrence of the conflicts between farmers, WCA and ISA • Nonrational use of water resources and very high losses of water resources. Decrease of the biodiversity and vegetation	• Deteriorated infrastructure, left from the Soviet Union • Transboundary problem, nonadherence to the agreements, head vs tail problem • Absence of the early warning mechanisms to inform about natural disaster	Maintenance of water infrastructure Agriculture (irrigation cropping) Emergency situations

2.2. Fergana Province

General Information. The Fergana Province is located within the latitudes 40.1084 to 40.8214 and longitudes 70.2581 to 72.2188, and occupies the area of 6,800 km^2. The province is located in the southern part of the Fergana Valley in the far east of the country. The neighbors of the province are Namangan and Andijan provinces of Uzbekistan, and the province also borders with the Kyrgyz Republic and Tajikistan. There are 15 districts in the province – Oltinarik, Kushtepa, Bagdad, Besharik, Buvayda, Dangara, Kuva, Rishtan, Sukh, Toshlok, Uzbekistan, Uchkuprik, Fergana, Furkat and Yozovon. City of Fergana is the administrative center of the province.

FIGURE 17. Dynamics of city and rural population



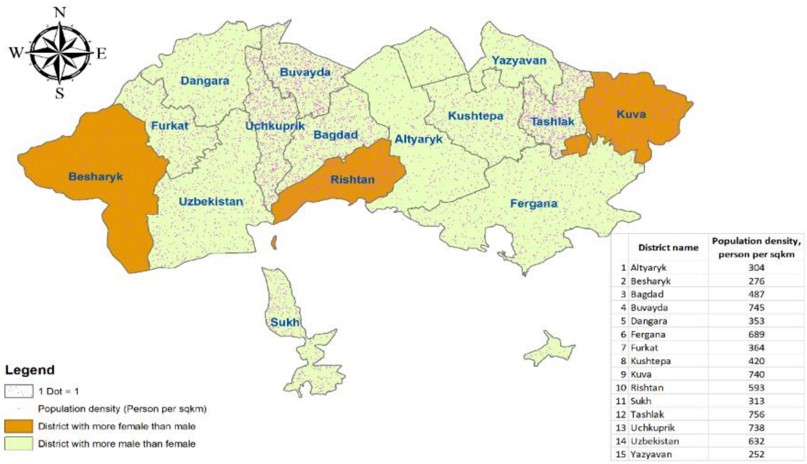
The population of Fergana Province is 3,444.9 thousand inhabitants and the population density equals to 509,6 people per square kilometer. The population increased slightly between 2011 and 2015, from 3,229.2 to 3,444.9 thousand (Figure 17). The district with the highest population density is Toshlok. The average age of population is 28,6 years. Proportion of male and female citizens is almost the same with slight excess in male population (The State Committee of the Republic of Uzbekistan on statistics, 2015).

In 2015, about 42,9% of the population of the province lived in rural areas and the number was 43% in 2011, which shows nonsignificant changes in the rural population of the province during this period (Figure 18).

Source: The State Committee of the Republic of Uzbekistan on statistics, 2015.

Irrigated agriculture is the main economic activity in the Fergana Province. The irrigated area equals to 298,2 thousand ha or 44% of the total area. The size of irrigated area in the province has not significantly changed between 2012 and 2015. The main sources of water for irrigation are Syrdarya, Shohimardansai, Isfayramsai, Isfara and Sukh rivers. The province is located in the Syrdarya-Sukh BISA and consists of four ISAs: Isfara-Syrdarya ISA, Isfayram-Shohimardon ISA, Naryn-Fergana ISA and Sukh-Oktepa ISA. The largest ISA is Isfayram-Shokhimardon, which covers 30% of total area. There are 127 functioning Water Consumers Associations with an average area of 2,823 ha. The agricultural areas are irrigated entirely from the irrigation canals.

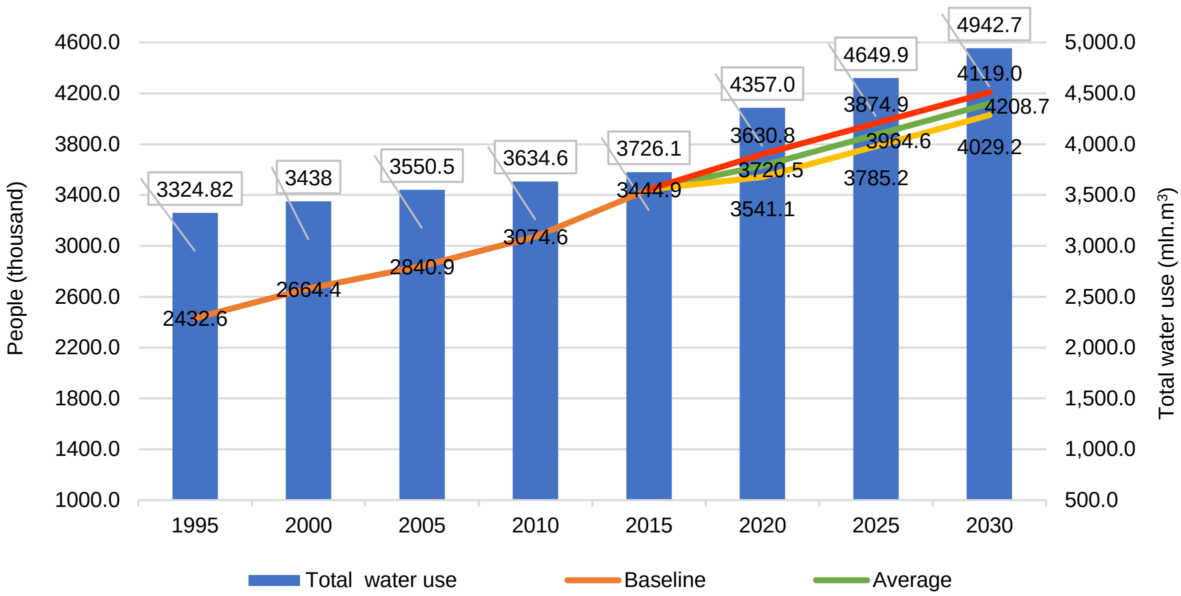
FIGURE 18. Population density and gender by districts in the Fergana Province.



	District name	Population density, person per sqkm
1	Altyaryk	304
2	Besharyk	276
3	Bagdad	487
4	Buvayda	745
5	Dangara	353
6	Fergana	689
7	Furkat	364
8	Kushtepa	420
9	Kuva	740
10	Rishtan	593
11	Sukh	313
12	Tashlak	756
13	Uchkuprik	738
14	Uzbekistan	632
15	Yazyavan	252

A forecast (Figure 19) on the population growth and total water use projections was developed to determine how much water would be needed in future. The forecast shows that the Fergana Region will experience a substantial population growth and accordingly increased water demand in order to satisfy the needs based on past and current tendencies. While the population of the Fergana Province is projected to increase by 763,8 thousand between 2015 and 2030, the amount of water needed is anticipated more than 1,216.6 million .m^3. The existing information obtained from the State Committee on Statistics (1995-2015) has been used as an input data for the population growth calculations. The total water use projections for the period of 2015-2030 are calculated according to water use per capita in 2015, which equals 1,08 m^3 per capita. In fact, in 2015 water consumption of the region was 3,726.1 million m^3. As illustrated in Figure 19, the population growth directly influences total water use, which indicates that more pressure on rational and effective water use is anticipated.

FIGURE 19. Forecast of population growth and total water use in Fergana Province for 1995-2030.



2.2.1 Climatic and Meteorological Conditions

The Fergana Province is characterized by a hot and dry climate with high humidity. The frost-free period, based on average long-term data, varies from 190 to 215 days and the sum of effective temperatures ranges from 2,060 to 2,620 (Table 4).

TABLE 4. Main climate indicators of the Fergana Province (long-term average annual data).

Weather station	Period: Months IV-IX					Period: Months III-X		Frost-free period, days
	Air temperature, °C	Relative humidity, %	Precipitation, mm	Evaporation, mm	Moisture deficit, mm	Precipitation, mm	Evaporation, mm	
Baytok	22,4	50	69	983	914	189	199	230
Andijan	22,3	51	91	962	871	135	221	217
Asaka	21,7	56	65	855	790	166	208	209
Kzylkiya	21,5	44	122	1081	959	170	244	204

Source: Uzbek Academy of Agricultural Sciences, 1992.

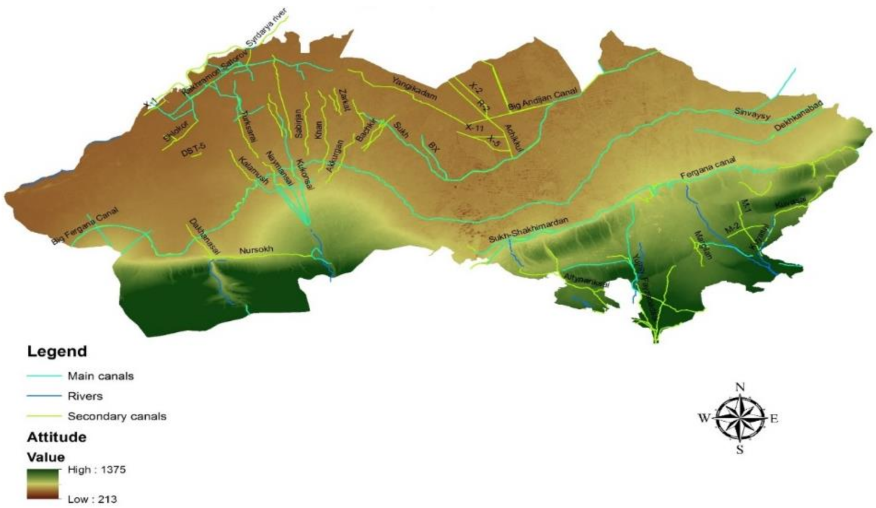
The average relative humidity during the growing period is about 50%. Annual long-term average precipitation varies between 85-86 mm in the desert zone and up to 106 mm in the area of sierozemic-meadow soils. The major amount falls each year in January-March, slightly less in October-December. From 29 to 33% of the annual amount falls in the growing period; 60 to 75% of it falls during April and May. Potential evaporation during the growing season exceeds 9-10 times the total precipitation; therefore, the whole agricultural area in the province must be irrigated.

The winter period with temperatures below -5°, when it is impossible to carry out leaching, is practically absent. Periods with temperatures below 0° C are between 53-60 days. Thus, the duration of recharge and leaching irrigations is not constrained by the air temperature.

2.2.2 Topographic Map of the Fergana Province

The Fergana Province is located in the central and western parts of Fergana Valley. Fergana Valley is a tectonic depression, bordered by a strip of hill and inter-hill depressions to the north and the south (Figure 20).

FIGURE 20. Digital elevation model and irrigation network for Fergana Province.

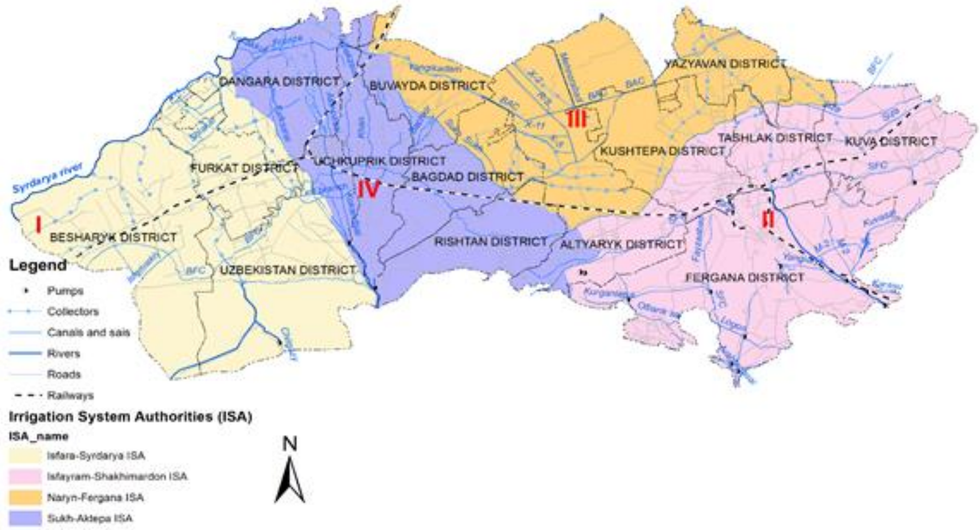


2.2.3 Irrigation Network

The main sources for irrigation are mountainous rivers Isfara, Sukh, Shakhimardonsai and Isfayramsai, but the Naryn and Karadarya rivers are also used and supply water through the SFC and BFC canals. Furthermore, spring and collector waters are used for irrigation, as well as groundwater through 923 irrigation wells and 1,198 VDW. However, not the entire flow of these rivers is used in Uzbekistan: part of it is taken for irrigation in the upper reaches, on the territory of the Kyrgyz Republic and Tajikistan.

Mineralization of water: very fresh mountain rivers contain 0.2-0.4 g/l; irrigation water contains 0.6-1.2 g/l; VDW contains 0.7-1.9 g/l; CDS contains 1.0-1.5 g/l in the seroziem belt, and 1.42-2.11 g/l in the desert zone. Syrdarya-Sukh BISA service area map is shown in Figure 21.

FIGURE 21. Map of the Syrdarya-Sukh BISA command area.



These sources are interconnected with each other and form the following systems: Isfayram - Shakhimardon - SFC - Karkidon Reservoir; BFC - Sukh and BFC-Isfara. The BAC cut tails of the first two systems. The interconnection is characterized as follows:

1. The areas irrigated from the shallow spring mountainous rivers Isfayram, Shakhimardon, Sukh and Isfara, are fed from the high-water spring rivers Naryn and Karadarya through the SFC and the BFC canals. At the crossing points of the mountain streams with the mentioned canals different hydrostructures were built, enabling to transfer water from the old systems and deliver water to them through the BFC and the SFC (Table 5).
2. The driest mountainous river systems of all four is Shakhimardon. It is fed from the east from the high-water Isfayram through the Yangiaryk and Lyagan canals. From the west, the Shahimardan system is fed from the high-water summer Sukh through the Sukh-Shakhimardan Canal.

3. Dry in late summer BFC is fed by flood waters (Figure 22):
   a. Isfayramsai through Margilansai discharge;
   b. Shahimardansay through Altyaryk discharge;
   c. Sukhsai through Sukh feeding canal;
   d. Isfara through Isfara feeding canal.
4. Dry in the second half of the summer SFC can be fed by flood waters of the Isfayram river using the discharge of Beshalyshsai and Margilansai (Sadykov, 1975).

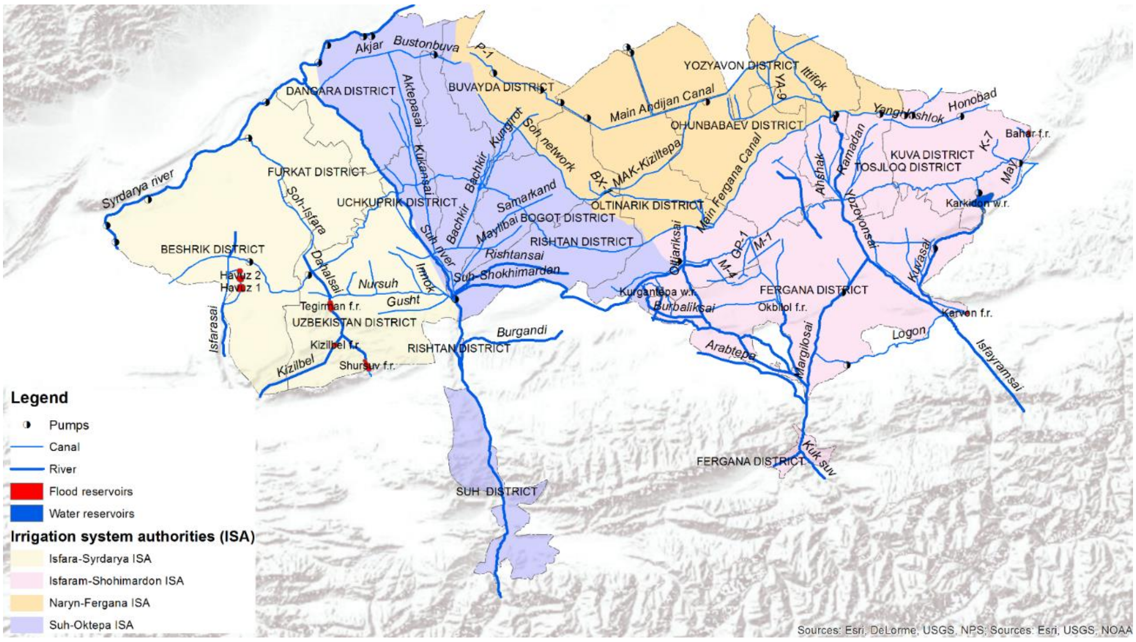
Water availability in some irrigation networks is regulated by reservoirs Korkidon, Kurgontepa reservoirs, etc. Approved operational reserves of fresh groundwater is 68.0 m^3/s. Groundwater is mainly used for domestic and industrial water supply.

TABLE 5. Key indicators of the Fergana Province rivers.

Region	River	River source	River characteristics	Irrigation System Authority (ISA)	Districts crosses	Irrigated zone, ha	Transboundary river (yes/no)	Water use million/m^3			
								Irrigation	Economy	Domestic	Other
Fergana Province	**Isfara**	The river is glacier and snow- fed from the glaciers of Turkestan Range	The river is 107 km long, the basin area is 3,240 km²	Isfara-Syrdarya ISA	Besharik District	12,519.5	Yes	13,651	-	2,250	1,465
	Shakhimardonsai	Formed by the confluence of the Koksu and Aksu rivers	The river is 112 km long, the basin area is 1,300 km²	Isfairam-Shakhimardon ISA	Fergana, Altyaryk	13,965.9	Yes	114,282	13,200	12,900	1,259
	Isfayramsai	Originates in the spurs of Alai range	The river is 122 km long, the basin area is 2,220 km²	Isfairam-Shakhimardon ISA	Kuvasoy, Kuva, Toshlok, Yazyavan	25,476.7	Yes	185,034	57,400	7,200	3,630
	Sukh	Formed by snow and glaciers of the Alai mountain ranges	The river is 124 km long, and the basin area is 3,510 km²	Sukh-Oktepa ISA	Sukh, Rishtan and Altyaryk.Uzbekistan Besharyk, Furkat, Bagdad, Buvayda, disricts	74,644.4	Yes	679,698	-	56,900	77,023

Source: Akromov 2008 and Authors' survey.

FIGURE 22. Scheme of irrigation system in the Fergana Province.



2.2.4 Reclamation State of Irrigated Lands

Natural conditions of the province determine a favorable reclamation state of irrigated lands. Groundwater regime is mainly controlled by both horizontal and vertical drainage. There are 1,198 VDWs in the province. Groundwater regime in the province is significantly influenced by underground tributaries from the alluvial fan of the Sukh River, the Sukh-Shakhimardon inter-canal depression and the Shakhimardon-Isfayram alluvial fan. Difference between inflow and outflow of groundwater is 4,000-9,000 m^3/ha per year. Due to the spread of artesian waters the VDW systems are developed, which cover 87.8 thousand ha.a Of the total CDWs in the province, 94.0% are allocated to the Syrdarya river and, 6.0% to canals or irrigation. The desalinization trend is observed in areas of sierozem belt (Kuva, Kushkupr, Tashlak and Fergana districts) and desert zone areas. A substantial decrease of the areas under GWL within 1-1.5 m during crop growth periods re-observed due to increased areas under GWL of 2-3 m (Figure 23).

FIGURE 23. Distribution of the areas by groundwater mineralization during the growing season in the Fergana Province.

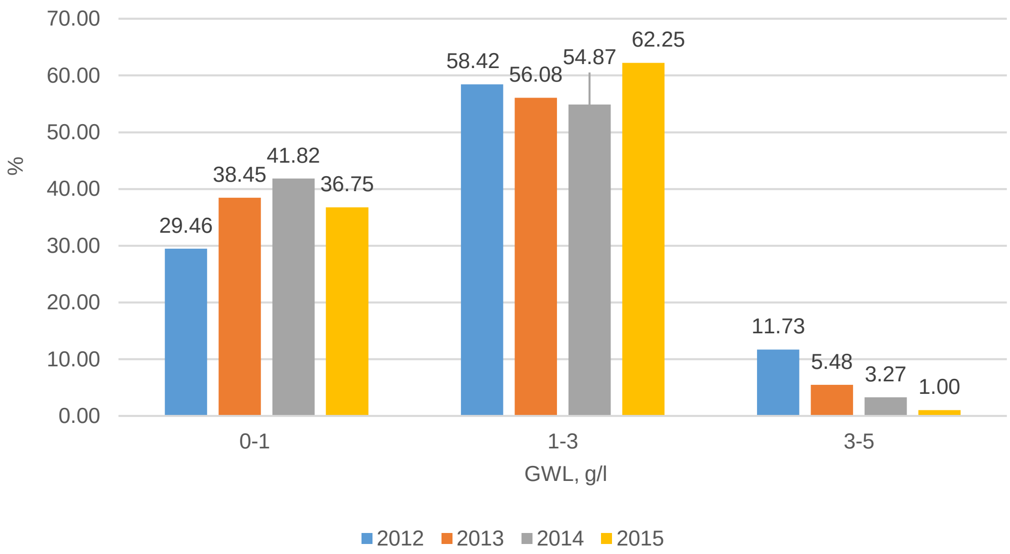
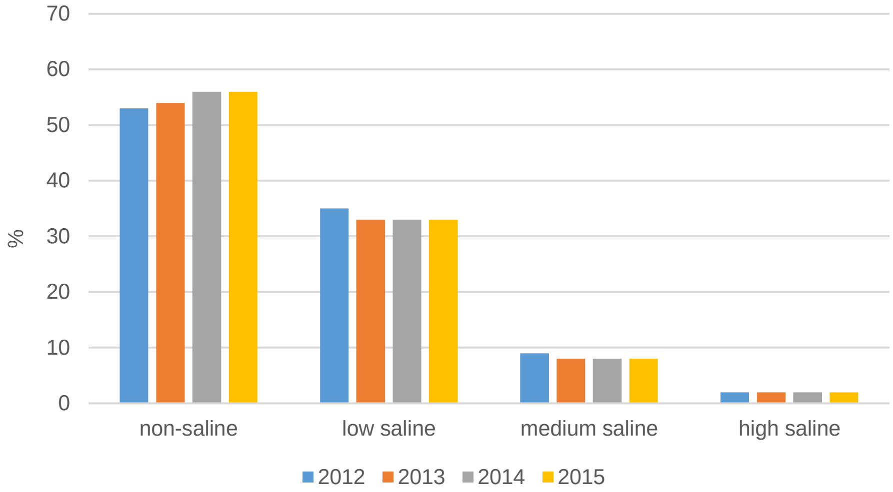


FIGURE 24. Distribution of irrigated lands by soil salinity in the Fergana Province.

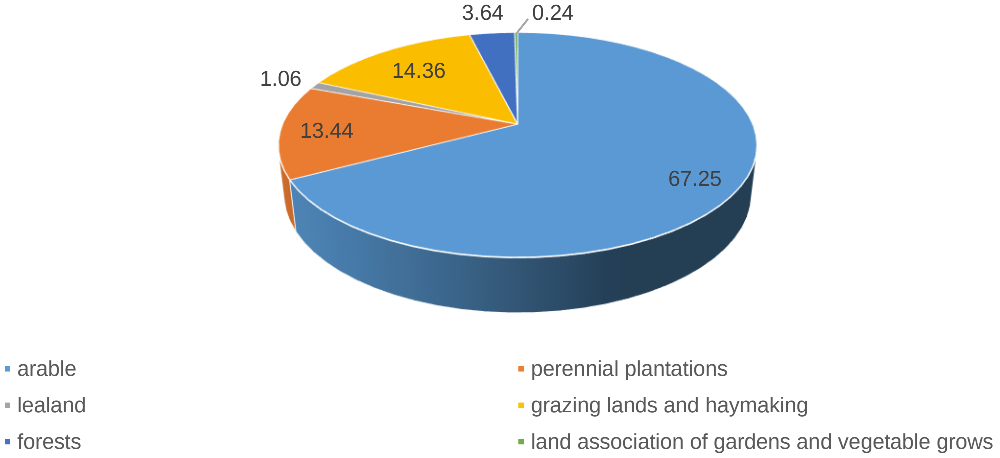


From 2012 to 2015, the nonsaline areas had increased by 13% in the areas of sierozem belt, slightly saline lands decreased by 7%, and medium saline lands by 4% (Figure 24). In the same period, the nonsaline areas of the desert zone had increased by 13%, slightly saline lands decreased by 8% and medium saline lands by 3%.

2.2.5 Water and Land Resources Use

Use of the land resources. The land resources of the province are 700,5 ha of which irrigated land constitutes 298,2 thousand ha. The structure of irrigated land is shown in Figure 25.

FIGURE 25. Irrigated land structure (%).



In Fergana Province, cotton and winter wheat were the main crops on the irrigated lands, covering 35% and 43.80%. Crop pattern including household backyards for the year 2014 is shown in Figure 26. Due to the diversification of agricultural production over the past 5 years, the areas under cotton have decreased by 3,5 thousand ha, under orchards they have increased by 2 thousand ha, area of vegetables by 1,5 thousand ha and area of potatoes by 1,2 thousand ha (Figures 27 and 28).

FIGURE 26. Crop pattern including backyards (%)

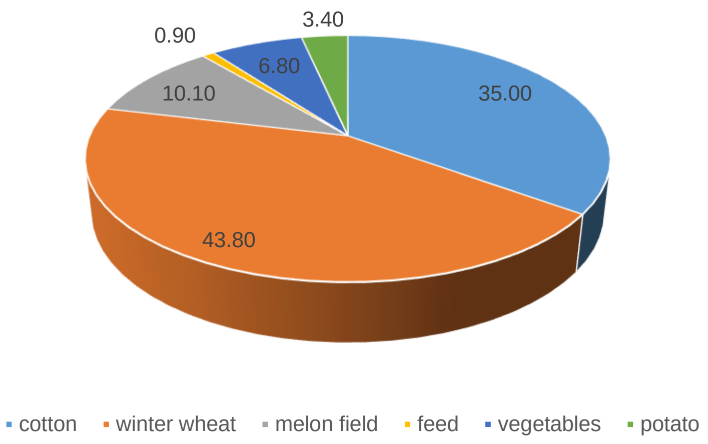


FIGURE 27. Yields of the main agricultural crops.

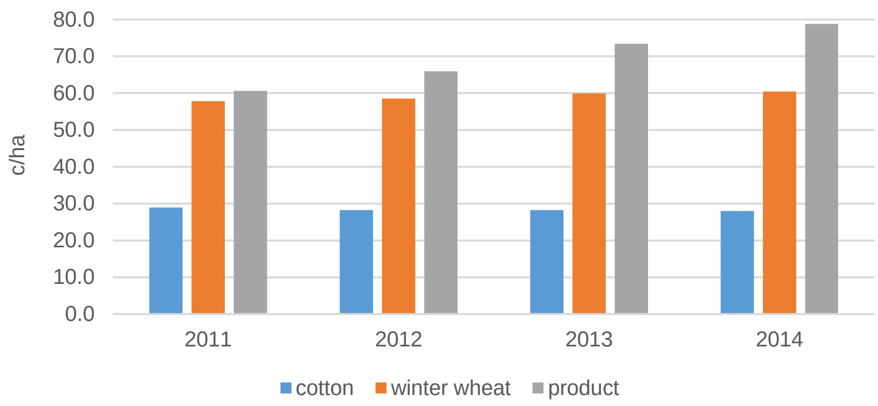
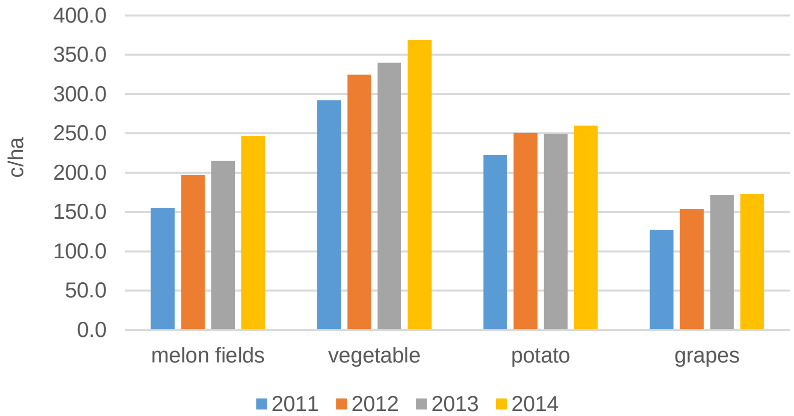


FIGURE 28. Yields of the main agricultural crops.



Organization of water use. The main watercourses, Big Fergana Canal (BFC), South Fergana Canal (SFC) and Big Andijan Canal (BAC) are managed by the Fergana Province Main Canals System Authority with JDC. SUE "Ferganasuvokova" provides the population with water for drinking and household needs. Water intake for this purpose is carried out from both underground and surface sources.

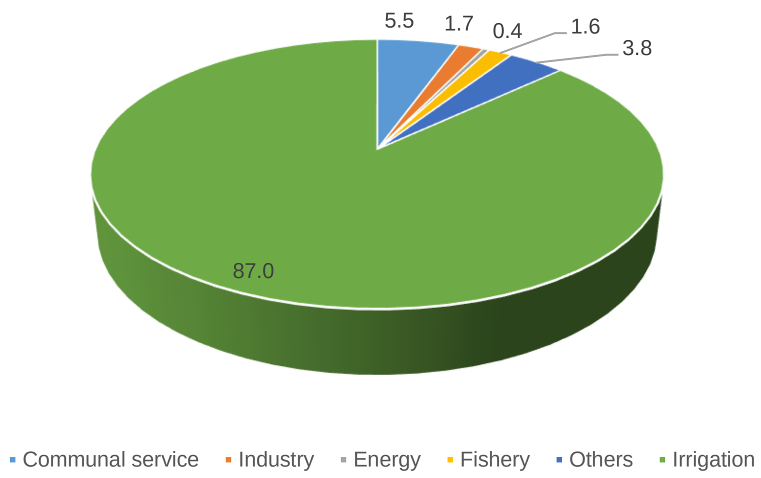
One hundred and twenty-seven (127) WCAs organize water use directly. In the province, WCAs carry out water intake on 4,357 water delivery points. All water delivery points from ISAs to WCAs are equipped with water control structures; 57% of water delivery points are equipped with water measurement devices.

WCAs carry out water allocation on 8,652 water delivery points. Only 43% of water delivery points from WCAs to farmers' fields are equipped with water control structures; 54% of water points are equipped with hydro-structures (so-called hydroposts). In such circumstances, it is difficult to adjust the water distribution quickly between water users and to keep water accounting; there are many organizational water losses.

According to the WCAs' budget it was planned to collect 15,600 UZS/year per ha for the Irrigated Drainage Network (IDN) O&M on average in the province for 2015; actual collection rate on 1 July was 39% of the planned and 78% of the actual costs. These funds are not sufficient for O&M to maintain IDN operability. Due to the financial condition, WCAs are not able to hire qualified professionals. In the province, 14% out of 1,156 employees of WCAs have higher education. Only 7% of directors have professional education in hydraulic engineering.

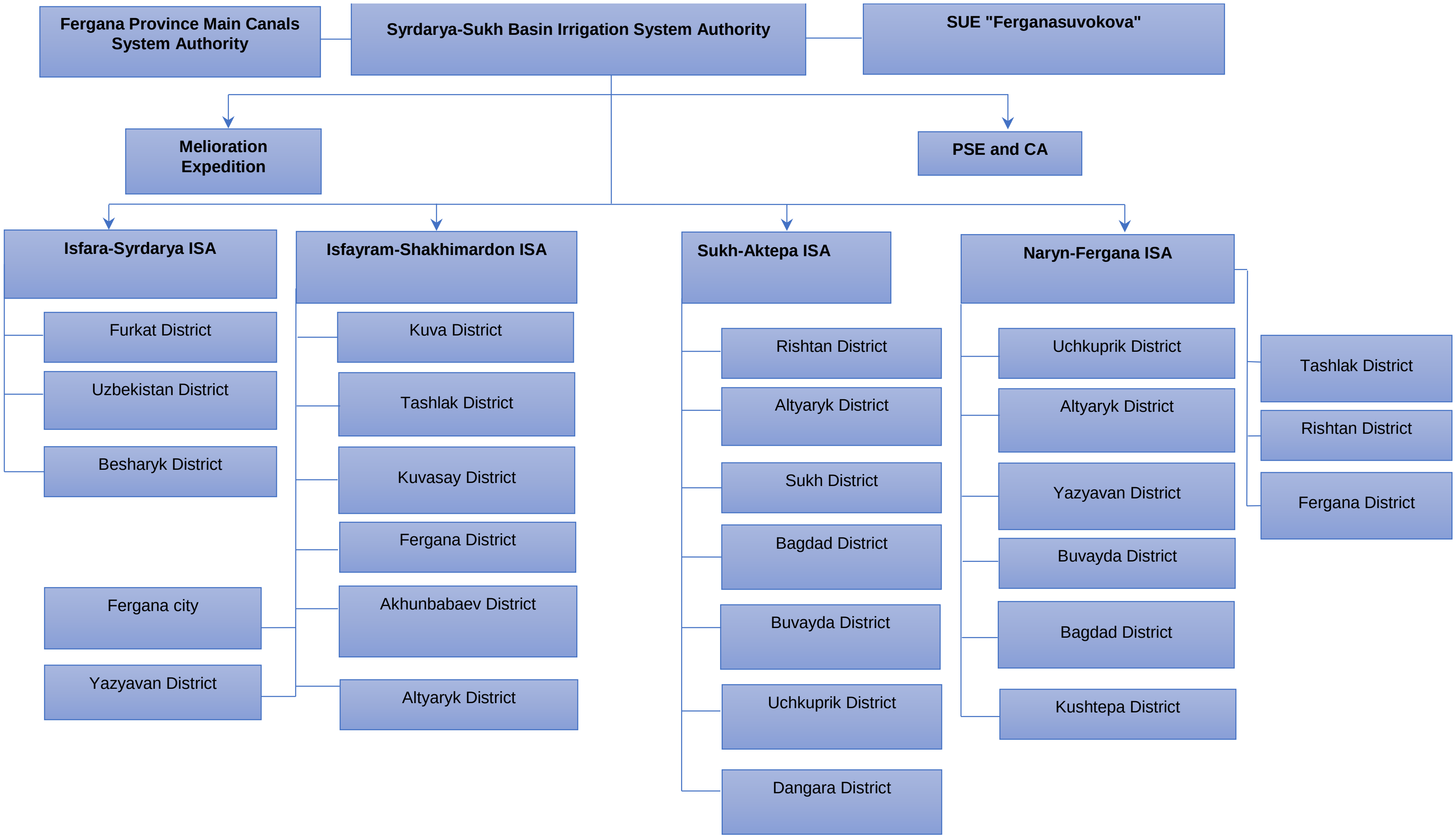
Water use. Some 87% of water is used for irrigation and 5.5% in the domestic sector in the province (Figure 29).

FIGURE 29. Water use by the sectors of economy %).



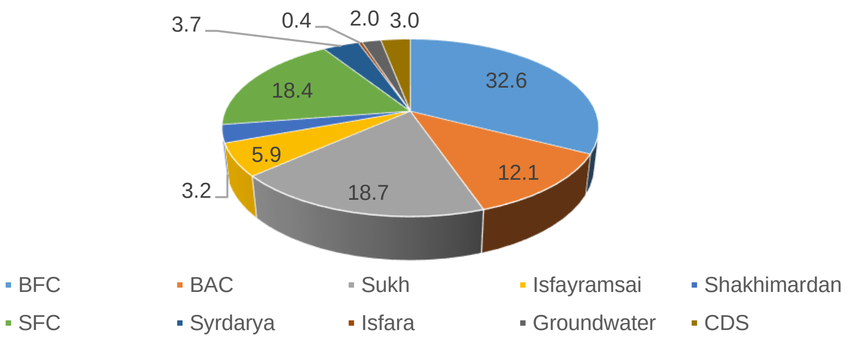
The organizational structure of water management in the province is shown in Figure 30.

FIGURE 30. Institutional water management structure of the Fergana Province.



Specific water supply to WCA boundary during the crop-growth period is 8,4-8,8 thousand m^3/ha; during the nongrowing period it is 3,3 thousand m^3/ha. Of the total water intake, 32,6 % is taken from the BFC; 18,7% from the Sukh River; 18,4% from the SFC; and 12.1% from the BAC (Figure 31).

FIGURE 31. Water intake structure (%)



Some 13-15% of the water withdrawn from the source is lost in the main canals; 13-16% of the water delivered to the district borders is lost in distribution canals. Total delivery losses from the river to the WCA intake points during the growing season are up to 27% of the total withdrawal, and up to 37% in the nongrowing period.

The estimated water productivity is 871,8 UZS/m^3, i.e., 1 m^3 of water diverted from sources produces an agricultural commodity return of 871,8 UZS.

The Isfarasai, Sukhsai, Shakhimardansai and Isfayramsai rivers are fed by snow and glacier, with maximum flow from July to August. The water demand for irrigation of the winter wheat increases in March and April. During this period, the water availability problems in the small rivers basins are observed in the province.

2.2.6 Findings of the Assessment of Fergana Province River Basins

The irrigated area of the province is 298,2 thousand ha of which 83,8 thousand ha are under pumped irrigation, where the water is lifted by 127 pumping stations. Currently, the following irrigation networks operate in the province: Syrdarya, BFC, BAC, SFC, Sukh, Isfayramsai, Shakhimardon (Table 5). Water intake and regulation are done by the main canals BAC, BFC, SFC, Naymansai, Kokansai, etc. Some 13-15% of the total water withdrawn from the source is lost in the main canals; 13-16% of the volume of water delivered to the district borders is lost in distribution canals. Water productivity is 871,8 UZS/m^3. Isfarasai, Sukhsai, Shakhimardonsai and Isfayramsai rivers are fed by snow and glacier, with maximum flow from July to August. The water demand of winter wheat increases in March and April months. During this period, the water availability problems in small river basins are observed in the province.

It is necessary to mention that all small rivers of Fergana Province are transboundary in character. Accordingly, all problems with regard to rivers are of transboundary nature (see Table 6). One of the major problem is the availability of water resources during the crop-growth period for the downstream of each river. Most of the basins have also natural disaster problem due to absence of proper cooperation between riparian States and of the early warning mechanisms of alerting each other on natural disasters – there are more and more cases of flooding in the basins. Furthermore, it is stressed that there are no formal governance structures in the river basins.

The Syrdarya-Sukh BISA, including its ISAs have adapted to the situation with regard to water scarcity. They are using water rotation methods in water distribution between WCAs and districts. Most of the rivers downstream readjusted their cropping patterns and the state massively promotes the use of water-energy saving technologies. Furthermore, the state is interested in building more capacities of the water consumers on effective management of water resources via demonstrating the innovative water-energy saving technologies.

The Syrdarya-Sukh BISA proposed initially Big Andijan Canal (BCA) as the basin to look to introduce basin water management planning. BCA flows from three provinces of Fergana Valley. However, after the explanation that the selection should be a river basin inside the country, BISA representatives proposed to consider the Isfayram River as the pilot basin for introduction of river basin management plans. However, the basin is transboundary and has quite a bit of problems especially those of the deterioration of the basin infrastructure. The problems of each river in the Fergana Province are listed in Table 6.

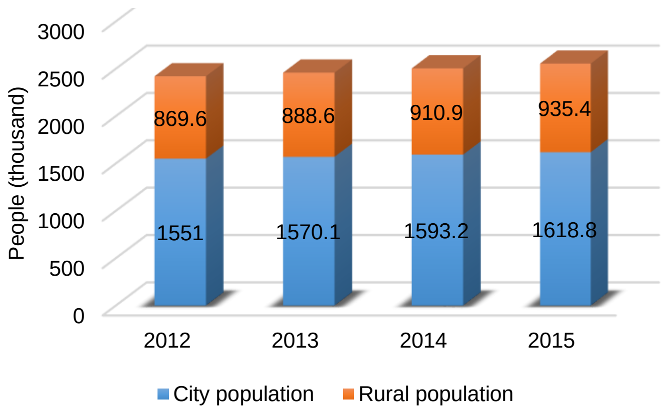
TABLE 6. List of current issues and problems in small rivers and sais of the Fergana Province.

Name	Identified problems	Negative consequences and risks	Causes	Activities
Isfara	• Lack of irrigation water • Mismanagement of the head water intake (transboundary character) • Nonequitable water distribution on the head water intake • Natural disasters	• It brings to the degradation of the land resources, low yields of agricultural crops, ecologic and social damages as well as threats to the community	• Transboundary problem, nonadherance to the agreed agreements, head vs tail problem • Head water intake is mainly managed by the upstream users. Down-stream users cannot get access to repair the head water intake • Mismanagement and also transboundary character doesn't allow properly manage the infrastructure • Absence of the early warning mechanisms to inform about natural disasters	Agriculture (irrigation cropping) Emergency situations
Shakhimardansai	• Lack of irrigation water • Deterioration of the irrigation system • Water pollution	• Occurrence of the conflicts between farmers, WCA and ISA • Non-rational use of water resources and very high losses of water resources. • Loss of yields, conflicts between water consumers, WCA and ISAs • Decrease of the biodiversity and vegetation and health problem of the communities	• Transboundary problem, nonadherance to the agreements, head vs tail problem • Lack of financial means for rehabilitation • Kadamjay plant for the production of metal surma in Kyrgyz Republic	Agriculture (irrigation cropping) Chemical Industry
Isfayramsai	• Lack of irrigation water • Deterioration of the irrigation system • Natural disasters	• Occurrence of the conflicts between farmers, WCA and ISA • Non-rational use of water resources and very high losses of water resources. Decrease of the biodiversity and vegetation	• Transboundary problem, nonadherance to the agreements, head vs tail problem • Lack of financial means for rehabilitation • Absence of the early-warning mechanisms to inform about natural disaster	Agriculture (irrigation cropping) Emergency situations
Sukh	• Water losses in the irrigation system • Lack of irrigation water • Natural disasters	• Loss of yields, deterioration of the social wellbeing of the communities. • Occurrence of the conflicts between farmers, WCA and ISA • Nonrational use of water resources and very high losses of water resources. Decrease of the biodiversity and vegetation	• Deteriorated infrastructure, left from the Soviet Union • Transboundary problem, nonadherance to the agreements, head vs tail problem • Absence of the early-warning mechanisms to inform about natural disaster	Maintenance of water infrastructure Agriculture (irrigation cropping) Emergency situations

2.3. Namangan Province

General information. Namangan Province is situated within the latitudes 40.3625 -- 41.5845 and longitudes 70.3012 -- 72.2312, and occupies an area of 7,900 km^2. The province is located in the southern part of the Fergana Valley far east of the country. The province is on the right bank of Syrdarya River and its neighbors are Kyrgyz Republic, and the Fergana and Andijan provinces of Uzbekistan. Namangan has a typical continental arid climate.

FIGURE 32. Dynamic of city and rural Population.



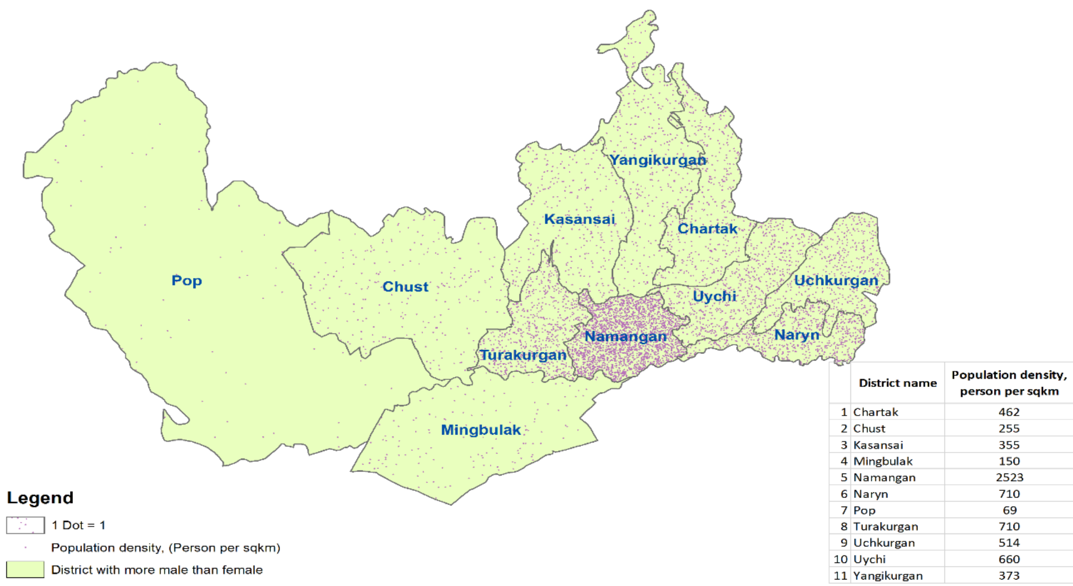
Source: The State Committee of the Republic of Uzbekistan on statistics, 2015.

There are 11 districts in the province – Chortok, Chust, Kosonsai, Mingbulok, Namangan, Norin, Pop, Turakurgan, Uchkurgan, Uychi and Yangikurgan with Namangan City as the administrative center. The population of the province is 2,554.2 thousand and the population density is equal to 343.3 people per square kilometer. The number of population increased slightly between 2011 and 2015, from 2,379.5 to 2,554.2 thousand inhabitants (Figure 32).

Namangan is a district with the highest population density. The average age of the population is 27.8 years. The proportion of male and female citizens is almost the same with slight excess of males.

In 2015, the population which lived in rural areas was about 36.7% (Figure 33) while the population in 2011 living in rural areas was 35.7% accordingly which shows a marginal decrease during this period.

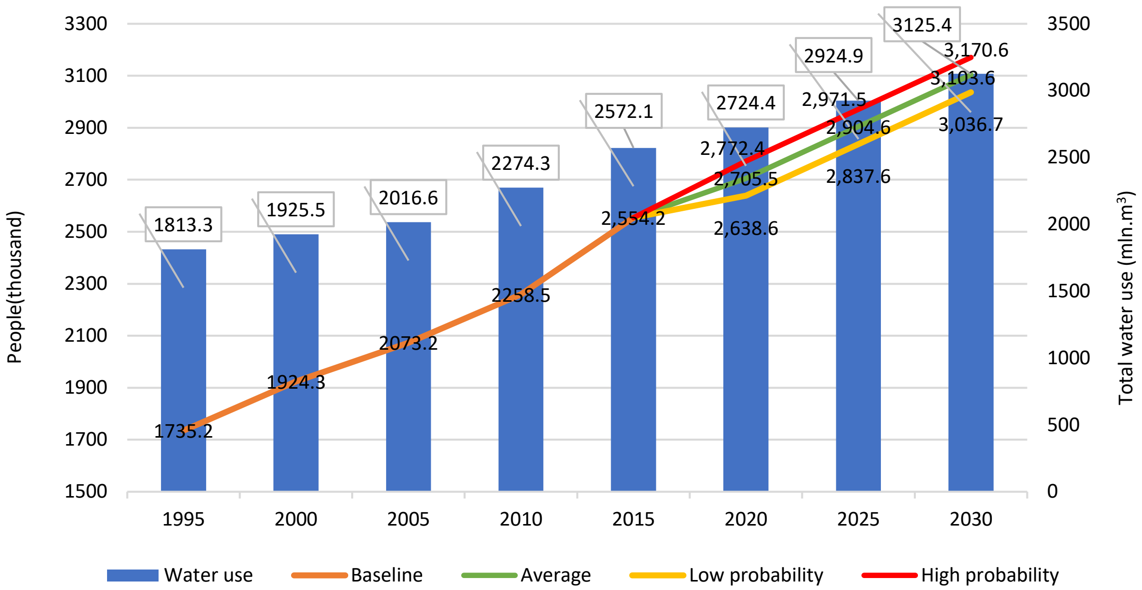
FIGURE 33. Population density and gender by district in Namangan Province.



	District name	Population density, person per sqkm
1	Chartak	462
2	Chust	255
3	Kasansai	355
4	Mingbulak	150
5	Namangan	2523
6	Naryn	710
7	Pop	69
8	Turakurgan	710
9	Uchkurgan	514
10	Uychi	660
11	Yangikurgan	373

Irrigated agriculture is the main economic activity in Namangan Province. The irrigated areas is equal to 234,8 thousand ha or 30% of the total area. The size of irrigated areas has not significantly changed between 2012 - 2015. The main water sources for irrigation are the Syrdarya, Kasansai, Padshatasai, Gavasai, Chartaksai, Chadaksai, Koksaraksai and Naryn rivers. The province is located in the Naryn-Syrdarya BISA and consists of four ISA: Zardarya ISA, Naryn-Hakkulabad ISA, Naryn-Namangan ISA and Padshata-Chadak ISA. The agricultural areas are irrigated by the surface water from the rivers and canals. The greater part of the of the area of the province is governed by the Naryn-Namangan and Padshata-Chadak ISAs, which constitute 82% of the total area. There are 134 functioning WUAs and their average area is 1,865 ha.

FIGURE 34. Forecast of population growth and total water use in Namangan Province for 1995-2030.



The forecast (Figure 34) of the population growth and total water use was developed to determine how much water would be needed in future. The forecast shows that the Namangan Region will face a substantial population growth and accordingly increased water demand in order to satisfy the needs of the people, based on past and current tendencies. While the population of the province is projected to grow by 549,4 thousand between 2015 and 2030, the amount of water demand is anticipated to be more than 553 thousand m^3. The existing information of the State Committee on Statistics (1995-2015) has been used as an input data for the calculation of the population growth. The total water use projections for the period of 2015-2030 are calculated according to water use per capita in 2015, which is equal to 1,01 m^3 per capita. In fact, in 2015 water consumption of the region was 2,572.1 million.m^3. As illustrated in the Figure 34, the population growth directly influences a sharp increase of the total water use, which indicates that more pressure on rational and effective water use will be induced.

2.3.1 Climatic and Hydrometeorological Conditions

Climatic conditions of a foothill zone were estimated for the hilly areas using data from the weather station located in Kasansai at an altitude of 800 m, for the plain areas from the station in the Namangan City and for the desert zone from the station in the Kokand and Pap towns (Table 7).

TABLE 7. Main climate indicators of Namangan Province (long-term average annual data).

Weather station	Period: months IV-IX					Period: months III-X		Frost-free period, days
	Air temperature, °C	Relative humidity, %	Precipitation, mm	Evaporability, mm	Moisture deficit, mm	Precipitation, mm	Evaporability, mm	
Pap	23.1	49	71	1,049	976	79	225	
Namangan	22.3	49	59	1,012	953	129	274	219
Kasansai	21.2	48	129	982	853	171	301	219

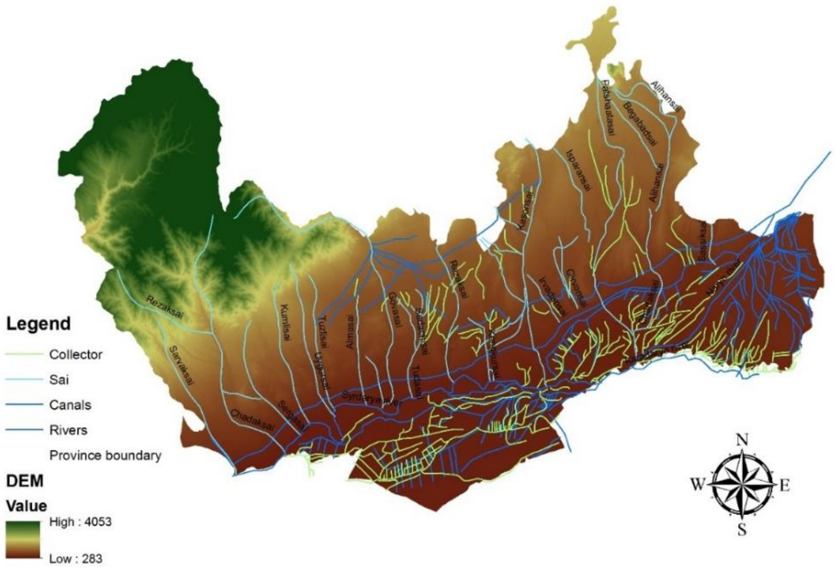
Source: Uzbek Academy of Agricultural Sciences, 1992.

Analyses of the long-term data showed that the last spring frost is observed in the valley part (Namangan) on March 20 and at the foothills (Kasansai) in late March or early April. The sum of effective temperatures in the foothills of the province reaches 2,220 °C, and in the valley – 2,434 °C Are these 22.2 and 24.34 °C, respectively? The duration of frost-free period is 211 days. The average long-term data show that the annual precipitation in the foothills (Kasansai) is 300 mm, and in the desert zone only 60-150 mm. Most of the precipitation for all districts falls in winter and spring. Relative humidity in the growing season in sierozems is 48-51%, and in the desert zone it is 40-53%. At the same time, evaporation from the water surface reaches 1,110-1,283 mm a year. As a result, moisture deficit during the growing season with 91-78 mm is quite significant. The analysis of a long-term agroclimatic data shows that the climate of the province is warm and extremely continental, favoring a cultivation of cotton and many other crops. Thus, according to soil and climatic conditions, the Namangan Province can be divided into the desert and serozem zones that differ in soil, temperature, evaporation and other climatic parameters.

2.3.2 Topographic Map of the Namangan Province

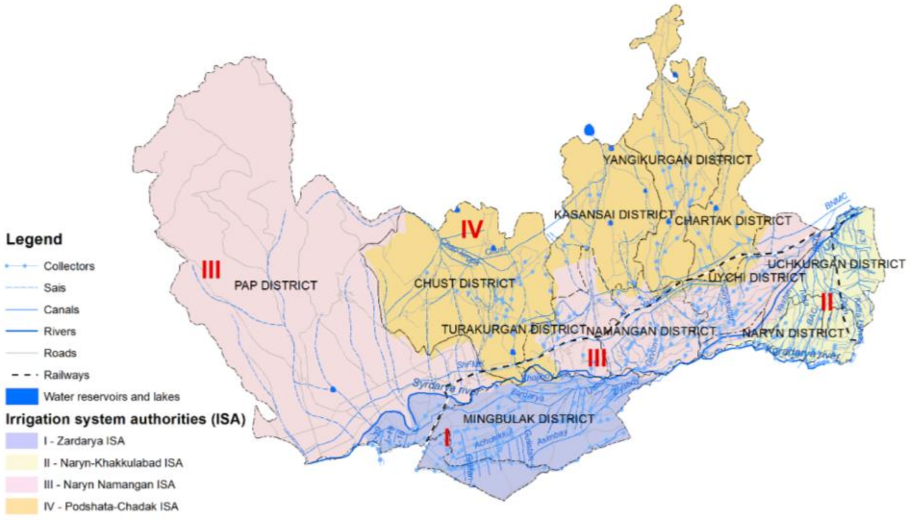
The topography of the province is heterogeneous. To the north of the Chatkal Ridge, there are spurs, which merge with hills and plains. In the northeast of the province, Chatkal and Kurama ranges tower up. To the south and southeast towards the Syrdarya River, mountains gradually decline and change into the foothills and then to the valleys of Syrdarya and Naryn (Sadykov, 1975). The terrain is mostly plateau zone. The earth's surface lowers from north to south and from west to east. The province is located at an altitude of 350 to 880 meters above mean sea level (Figure 35).

FIGURE 35. Digital elevation model and irrigation network for Namangan Province.



Foothill depressions are flat, sometimes sloping plains. The surface is dissected with numerous shallow valleys and ravines. Figure 36 shows a map of the Naryn-Syrdarya BISA command area.

FIGURE 36. Map of the Naryn-Syrdarya BISA command area.



2.3.3 Irrigation Networks

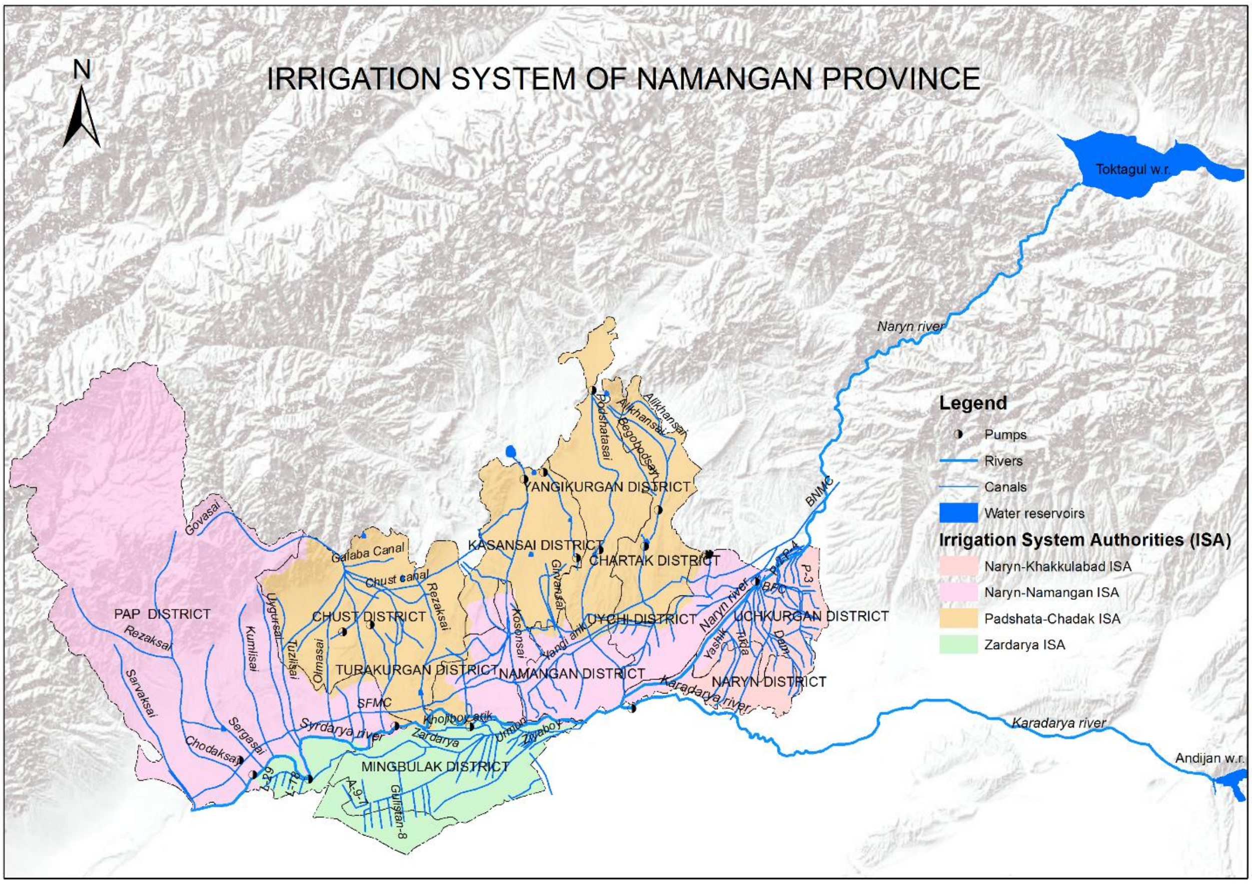
The main source of irrigation in the province is the Syrdarya River, formed by the confluence of the Naryn and Karadarya rivers. Of a large irrigation importance are right-bank tributaries of Syrdarya, including mountain rivers Padshatasai, Kasansai, Gavasai, Chartaksai, etc.

By origin, rivers that irrigate Namangan Province are divided into three groups: snow-fed rivers - Karadarya; mixed snow- and glacier- fed rivers Naryn, Padshatasai, Kasansai, Chartaksai, Sumsarsai; spring-fed rivers Almazsai, Kokteraksai, and Chadaksai.

The period of maximum flow of the Naryn River is from June to July and flow in Karadarya River from April to May - June. For the remainder of the year, water supply in these irrigation sources is very limited, and during maximum water consumption of cotton and other crops (especially July and August), there is frequently a deficit of water on these systems. Instability and lack of water availability in the individual systems is regulated by the Kasansai, Jiydaliysai and fifteen other small reservoirs (Figure 37).

Projected operating reserves of fresh groundwater are 38,3 m^3/s; approved reserves constitute 42,7 m^3/s. Groundwater is used mainly for household uses and industrial water supply.

FIGURE 37. Irrigation system of Namangan Province.



Some 136,324 ha of irrigated areas in the province require artificial drainage. In fact, all 100% of these areas are provided with artificial drainage and the total length of collector-drainage network under the provincial Amelioration Expedition is 1,813.78 km. The total length of collector-drainage network in WCAs is 3,259.4 kilometers, including 29.6 km of subsurface drainage (Table 8). The length of CDS per ha of irrigated area is 17.9 lm[2]/ha.

Drainage and field wastewater are discharged by the main collectors Karakalpak, P-2, and Sariksuv. CDW is discharged into the Syrdarya River and the Karakdarya and Achchikkul lakes.

[2] Linear meter is the same as a standard meter and is 39.37 inches long. Linear measurements are a way to emphasize that only one dimension of an object or space is being described. One linear meter contains 100 centimeters (Source:reference.com)

TABLE 8. Key indicators of the Namangan Province rivers.

Region	River	River source	River characteristics	Irrigation System Authority (ISA)	Districts crossed	Irrigated zone, ha	Transboundary river (yes/no)	Water use million/m^3			
								Irrigation	Industry	Domestic	Other
Namangan Province	Kasansai	Originates from the southern slope of the Chatkal ridge	Length 127 km, basin area 1,780 km^2	ISA Padshata-Chadak	(Kyrgyz Republic), Kosonsay, Turakurgan, Chust	19,048	Yes	170,8	-	23,2	-
Namangan Province	Chartaksai	Springs and mud-floods	Length 35,6 km, basin area 1.42 km^2	ISA Padshata-Chadak	Chartak, Uychi, Namangan	4,415	No	6,7	-	-	-
Namangan Province	Padshaatsai	Formed in the glaciers of the Central Tien Shan	Length 130 km, basin area 443 km^2	ISA Padshata-Chadak	(Kyrgyz Republic) Yangikurgan, Namangan, Chartak	33,274	Yes	112,3	-	8,6	-
Namangan Province	Gavasai	Originates from the southern slope of the Chatkal ridge	Length 92 km, basin area 443 km^2	ISA Naryn-Khakkulabad	Chust, Pap	8,443	Yes	229,9	-	2,1	-
Namangan Province	Namangansai	Originates from the southern slope of the Chatkal ridge	Length 20 km, basin area 250 m^3	ISA Padshata-Chadak	Yangikurgan, Namangan	402	No	2,6	-	-	-
Namangan Province	Kokserekssai	Originates from the southern slope of the Chatkal ridge	Length 8 km, basin area 0,16 km^2	ISA Padshata-Chadak	Chust	670	No	3,6	-	-	-

Source: Akromov 2008 and Authors' survey.

2.3.4 Reclamation State of Irrigated Lands

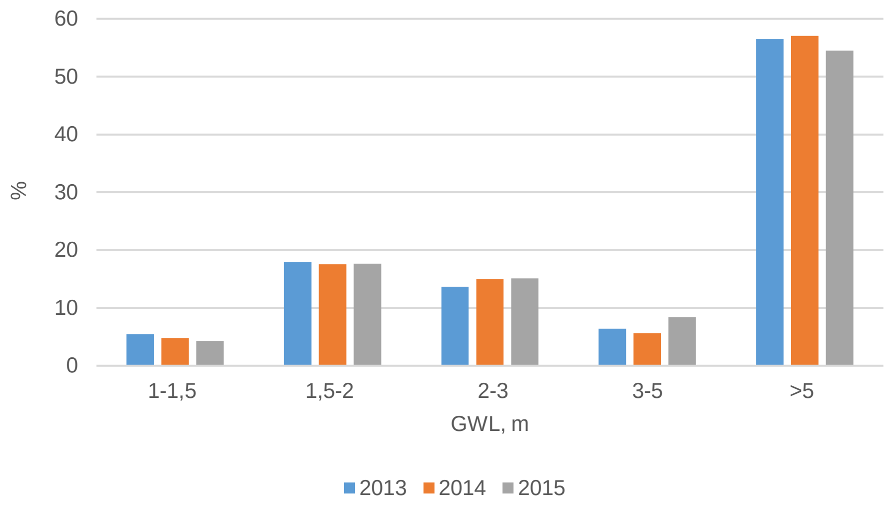
In general, the natural conditions are favorable for irrigation activities. Groundwater regime is regulated by both the horizontal and vertical drainage. There are 272 VDWs in the province.

Annual drainage runoff is 2,456.04 – 2,627.82 million m^3, and the specific drainage flow is 8,7-9,3 m^3/ha. The share of VDW pumped water is 7% of the total drainage flow. Drain flow is 85,6% of the total water intake at the border of the province. The main causes include poor irrigation technologies, low efficiency of irrigation techniques for large slopes and irrational organization of water use. In the province, fields with steep and very steep slopes make up more than 20%.

Of the total CDW, 81,9% is discharged into the Syrdarya and Karadarya rivers, 2.8% to the canals and 11.1% to the Achchikkul Lake.

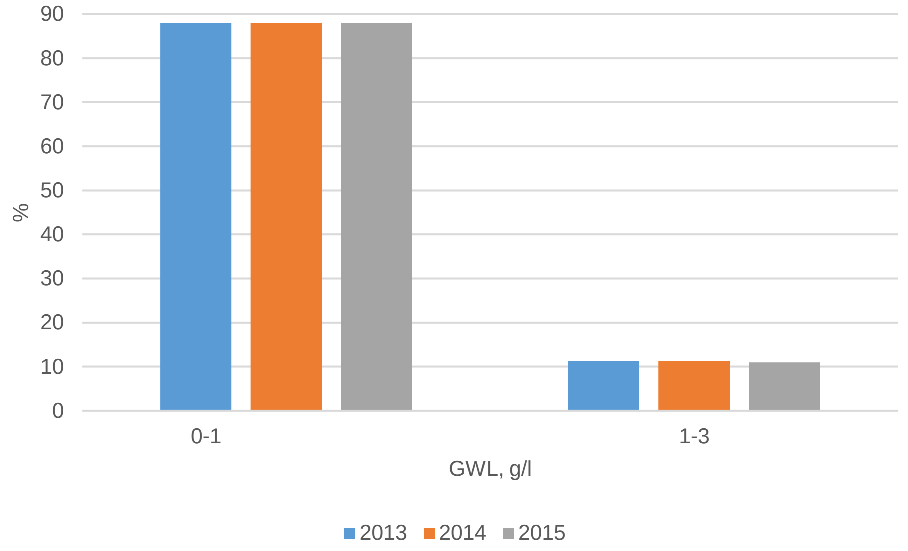
Recently, there have been no significant changes in groundwater regime. In the province, areas with groundwater level over 5 m prevail (Figure 38).

FIGURE 38. Distribution of average vegetation GWL depths in Namangan Province.



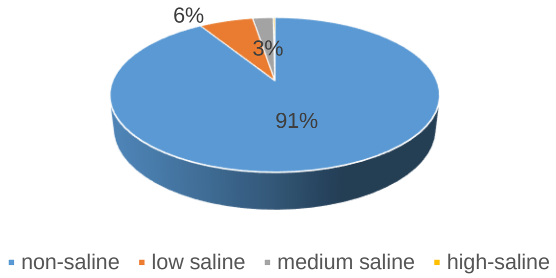
Spring water and water from 810 irrigation wells, 272 vertical drainage wells and collector waters are also used for irrigation. In the growing season, mineralization of irrigation water ranges between 0.2 and 0.7 g/l; in vertical drainage wells between 0.27 and1.12 g/l and CDS and between 0.19 and 0.31 and 0.90 1.07 g/l On 87%, GWL is less than 1 g/l (Figure 39).

FIGURE 39. Distribution of the areas by groundwater mineralization during the growing season in Namangan Province.



No significant changes in the dynamics of soil salinization have been observed. In the province, more than 91% of land falls into the nonsaline category (Figure 40).

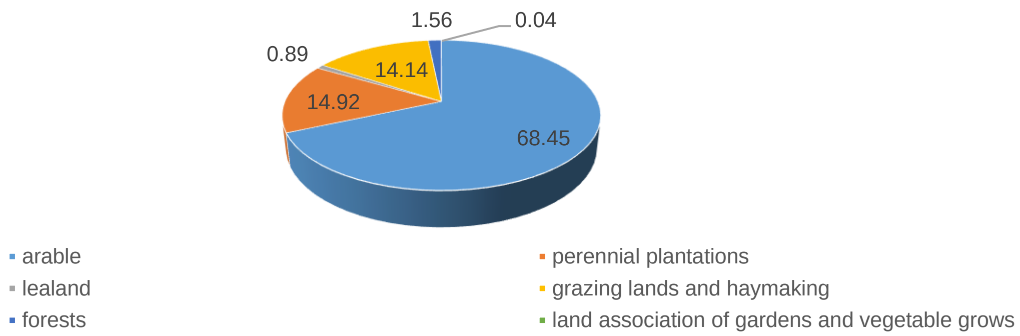
FIGURE 40. Distribution of irrigated lands by soil salinity in Namangan Province.



2.3.5 Water and Land Resources Use

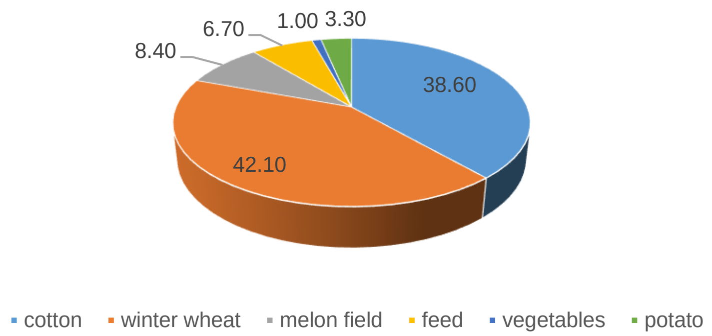
Use of land resources. The land resources of the province constitute 718,1 thousand ha of which 282,1 thousand ha are irrigated land. The structure of the irrigated land is shown in Figure 41.

FIGURE 41. Irrigated land structure (%).



Due to the diversification of agricultural production over the past 5 years, the area under cotton has decreased by 4,5 thousand hectares, while the areas under wheat have increased by 1,4 thousand hectares, under vegetables by 1,3 thousand hectares and potatoes by 0,5 thousand hectares. Crop pattern including backyard households for the year 2014 is shown in Figure 42.

FIGURE 42. Crop pattern including backyard households (%).

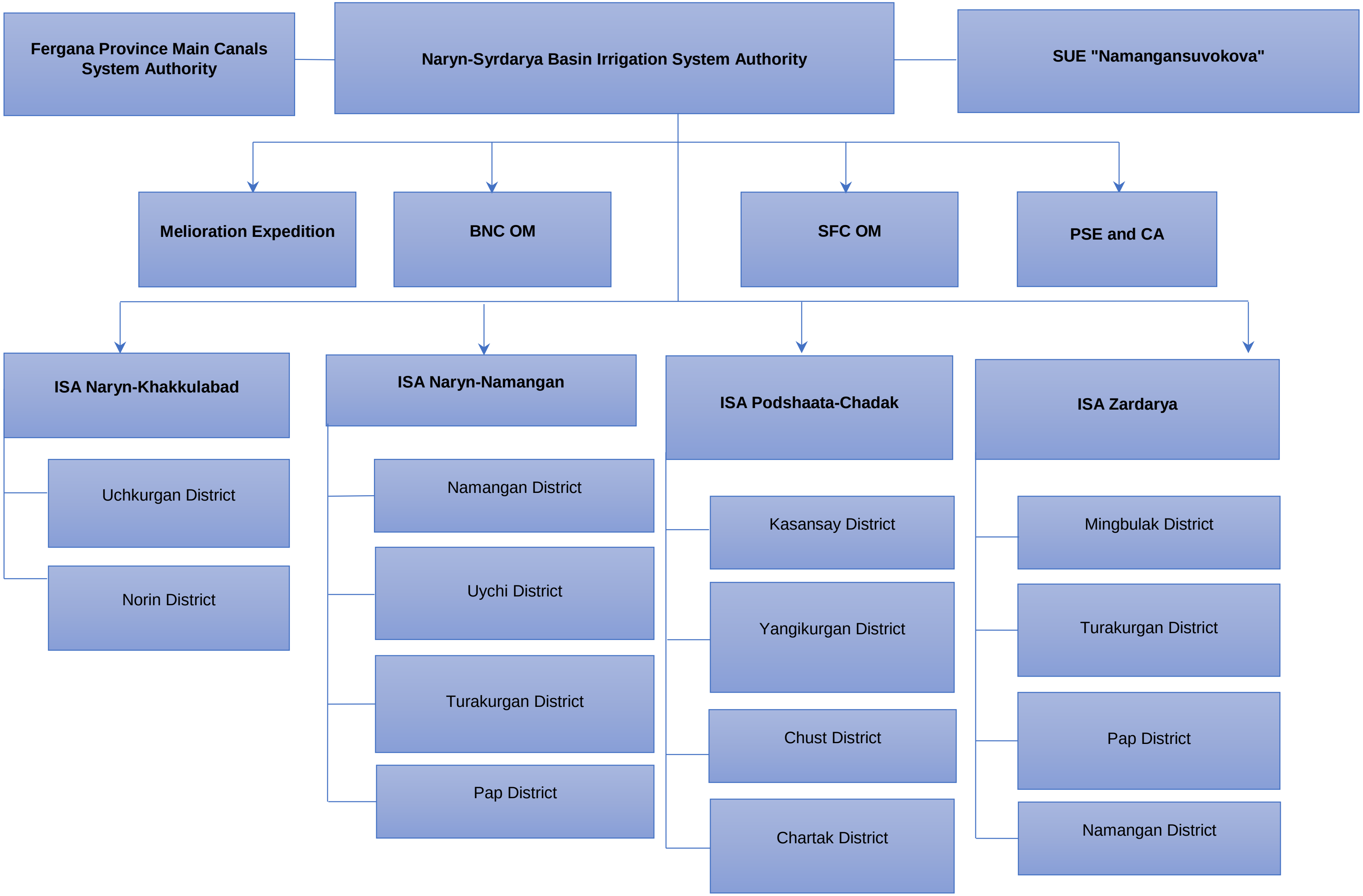


The land productivity is estimated at 10.2 million UZS/ha, i.e., one ha of irrigated land produces an agricultural return of 1.2 million UZS.

Organization of water use. In the province, the Naryn-Syrdarya BISA delivers water to WCAs. The BISA includes OM SFC and OM Big Namangan Canal (BNC). The BFC and BAC are managed by the Fergana province Main Canals System Authority with Joint Dispatching Centre. The organizational structure of water management in the Namangan province is shown in Figure 43.

SUE "Namangansuvokova" provides population with water for drinking and household needs. Water intake for this purpose is carried out from both underground and surface sources.

FIGURE 43. Water management structure in Namangan Province.

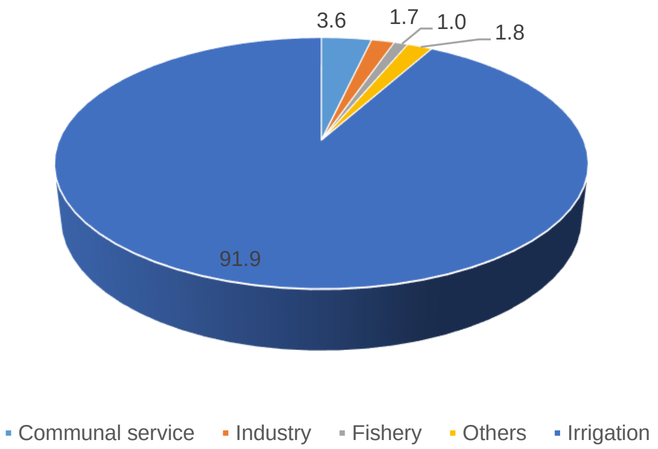


One hundred and thirty-four (134) WCAs are established to organize water use directly to farmers. The WCAs carry out water intake from ISAs on 2,454 water delivery points; 65% of those are equipped with water control structures, 93% with hydroposts. WCA distributes water to farmers on 6,525 water distribution points, 31% are equipped with water control structures, 35% with hydroposts.

According to the WCAs' budget, it was planned to collect 19,400 UZS/ ha per year for the IDN O&M. Actual collection rate as of July 1, 2016 was 18% of the planned and 85% of the actual costs. These funds are not sufficient for O&M to maintain IDN operability. Due to the financial condition, WCAs are not able to hire qualified professionals. In the province, 4% out of 710 WCA employees have higher education. Only 3% of WCA directors have special education in hydraulic engineering.

Water use. In the province, 91.9% of water is used for irrigation (Figure 44).

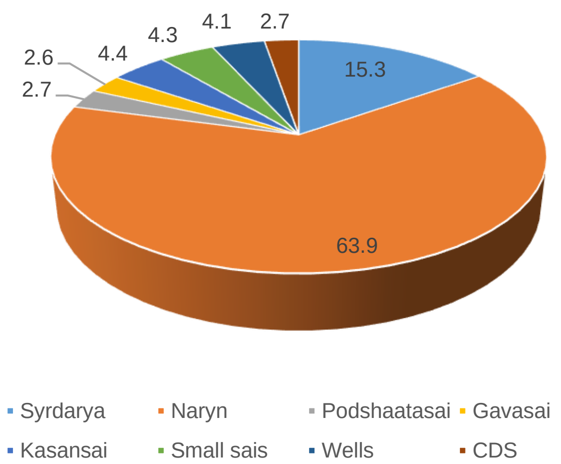
FIGURE 44. Water use by economic activity (%).



Specific water supply to the WCA border during the growing season is 8,8 thousand m³/ha, during the nongrowing period it is 2.3 thousand m³/ha. The water use ratio during the growing season is 0,96, and duringnongrowing season it is 0,93.

Of the total water intake, 63.9% is taken from the Naryn River, 15,3% from the Syrdarya (Figure 45). Water productivity is 490 UZS/m³, i.e., 1 m³ of water diverted from sources produces an agricultural commodity return of 490 UZS.

FIGURE 45. Water intake (%).



The reservoirs Kasansai on the Kasansai river, Jiydaly on Chadaksai River and Chartak on Chartaksai River have sufficient capacity to regulate sais' flow.

The irrigated area is 234,8 thousand ha of which 95,5 ha are under pumping irrigation where water is lifted by 198 pumping stations.

Irrigation systems have mixed supply. Thus, Kasansai basin is fed from BNC via pumping station "Bulokboshi"; BNC is fed from NFC via pumping station "Kyzyl Ravat-2"; irrigated areas from Havas, Kaksereksai, Isparan-Shavanda and other small sources are fed from Kasansai.

Water intake and regulation are carried out through main canals SFC, BNC, BFC, Zardarya (named after Akhunbabaev) and BAC. Total length of the canals in the conduct of public water management organizations is 2,304.0 km, including 889.3 km with concrete lining.

2.3.6 Findings of the Assessment of Namangan Province River Basins

The rural area of Namangan play an important role in the economy of the province. According to the State Committee on Statistics, the rural population comprised 36,4% in 2014 as well as 36,62% in 2015. The majority of the rural population is involved in agriculture.

The analysis of a long-term agro-climatic data shows that the province climate is warm and extremely continental. It favors cultivation of cotton and many other crops. The main source of irrigation in the province is the Syrdarya River, formed by the confluence of the rivers Naryn and Karadarya. Of high importance for irrigation are the right-bank tributaries of the Syrdarya River, including mountain rivers Padshatasai, Kasansai, Gavasai, Chartaksai, etc. Spring water and water from 810 irrigation wells, 272 VDW and collector waters are also used for irrigation. The Table 9 shows the list of current issues and problems in the small rivers and sais of the Namangan Province. It is noticeable that due to criteria indicated in Annex 1, most of the study attention has been focused on the medium-large small rivers. The province has more than 282.1 thousand ha of irrigated areas, more than 68% of which is considered as arable. Accordingly, around 91,9% of water of the province is used for irrigation.

Maximum flow of local rivers Padshaata, Kasansai, Chartaksai, Havas and other small sais is formed in April and May, during snowmelt and intensive precipitation (in the form of heavy rains), often leading to mudflows. In March and April, when winter wheat water demand is increasing, frequent water availability issues in some places arise.

Seven % of the total water withdrawn from the source is lost on the main canals; 21% of the volume of water delivered to the district borders is lost in distribution canals. In general, delivery losses from the river to the WCA borders during the growing season is up to 26%; during nongrowing seasons up to 41% of the water is diverted from the source.

All small rivers in the Namangan Province are transboundary, which directly affects the availability of water resources during the crop growth period. BISA representatives pointed out that the head water intake points of most of the rivers are mismanaged and consequently contribute to the natural disasters in the basins. The cooperation between the riparian States needs to be improved. In particular, there is a high interest to work out/install early warning mechanisms.

The BISA, jointly with MAWR, promotes the massive use of water-energy saving technologies in order to effectively manage the scarce water resources, particularly during the crop-growth period. All rivers are transboundary and do not meet the criteria of the project (Annex 1). However, BISA has proposed to consider the canal command zone of the Zardaryo canal as the pilot area. Zardaryo is not a river, but rather a canal that provides water for irrigation in the desert zone of the Namangan Province.

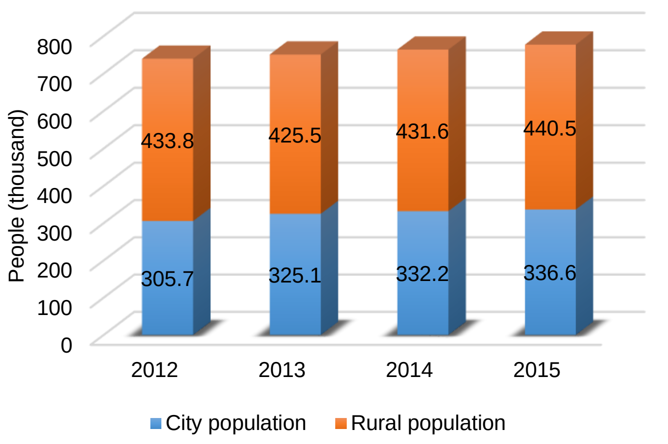
TABLE 9. List of current issues and problems in small rivers and sais of Namangan Province.

Name	Identified problems	Negative consequences and risks	Causes	Activities
Kasansai	• Lack of water resources during the vegetation period • Deteriorated head water intake • Natural disasters: floodings	• Low yields of agricultural products, floodings, migration of the manpower	• Transboundary character of the basin, • Difficult to conduct repairmen works in the riparian country • Absence of the early-warning mechanisms to inform about natural disaster	Agriculture (irrigation cropping)
Chartaksai	• Natural disasters: floodings	• Low yields and loss of the irrigated lands humus	• Lack of the flood protection facilities as well as absence of the early warning mechanisms	Emergency situations
Padshaatasai	• Lack of irrigation water • Natural disasters: floodings	• Drying up of the irrigated lands, loss of the agricultural yields, huge expenses after the natural disasters, migration	• Transboundary problem, nonadherance to the agreements, head vs tail problem • Head water intake is mainly managed by the upstream users. Downstream users cannot get access to repair the head water intake • Absence of the early warning mechanisms to inform about natural disaster	Agriculture (irrigation cropping) Emergency situations
Gavasai	• Lack of irrigation water during the vegetation: reduction of the river flow • Huge losses in the system • Natural disasters	Drying up of the irrigated lands, loss of the agricultural yields, huge recovery expenses after the natural disasters, migration	• Transboundary problem, nonadherance to the agreed agreements, head vs tail problem • Head water intake is mainly managed by the upstream users. Downstream users cannot get access to repair the head water intake. • Low coefficient of efficiency of the irrigation canals	Agriculture (irrigation cropping) Emergency situations
Chadaksai	• Lack of irrigation water: water flow reduction	• Low yields of agricultural crops • Huge recovery expenses after the natural disasters, migration	• Transboundary problem, nonadherance to the agreements, head vs tail problem • Head water intake is mainly managed by the upstream users • Downstream users cannot get access to repair the head water intake	Agriculture (irrigation cropping) Emergency situations
Naryn	• Lack of irrigation water during the vegetation • Increase of the winter flow	• Low yields of agricultural crops • Huge recovery expenses after the natural disasters, migration	• Transboundary problem, nonadherance to the agreements, head vs tail problem • Head water intake is mainly managed by the upstream users. • Downstream users cannot get access to repair the head water intake	Agriculture (irrigation cropping) Emergency situations

2.4. Syrdarya Province

General Information. The Syrdarya Province is located in the latitudes 40.1342 to 41.0435 and longitudes 68.0297 to 69.1453, occupying an area of 5,100 km². The Syrdarya Province is located on the left bank of the Syrdarya River, bordered by Kazakhstan and Tajikistan. The province mostly consists of the Steppe area. The province is located in the subtropical/subdesert zone, and has a continental arid climate. There are nine districts in the province - Akaltyn, Sardoba, Boyovut, Guliston, Mirzaabad, Saykhunabad, Syrdarya, and Khavas. The Guliston City is the administrative center of the province. The population of the Syrdarya Province is 777,1 thousand, the density is equal to 181,6 inhabitants per square km. The population increased slightly between 2011 and 2015 from 750,6 to 777,1 thousand (Figure 46). Boyovut is the district with the highest population density.

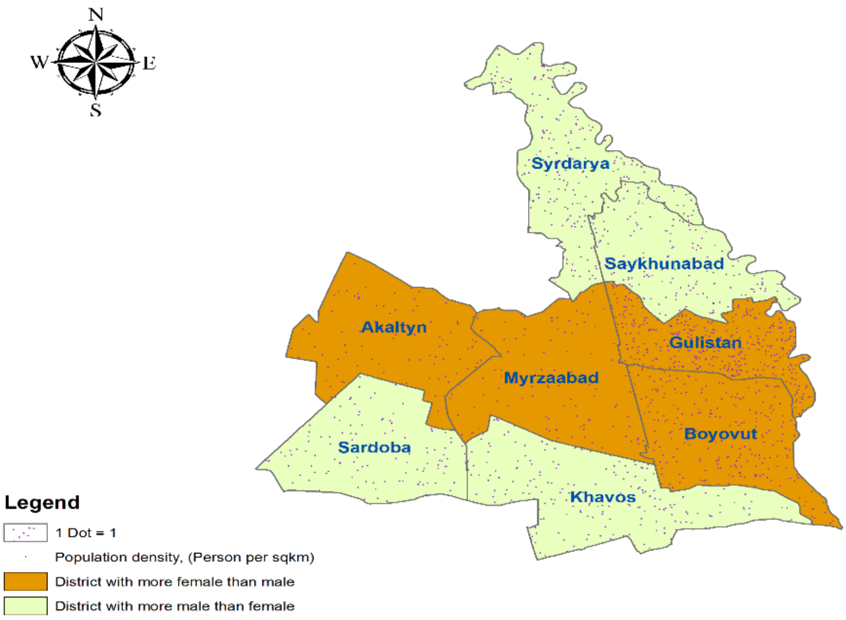
FIGURE 46. Dynamic of city and rural population



Source: The State Committee of the Republic of Uzbekistan on statistics, 2015.

The average age of the population in the province is 26,8 years. The proportion of male and female citizens is almost the same with a small excess of male population despite the fact that the female population in Akaltyn, Myrzaabad, Boyovut and Gulistan districts is slightly more than male. In 2015, more than half (56%) the population of the province lived in the rural area and increased to 58,5% in 2011, which shows a marginal increase of rural population during the considered period (Figure 47).

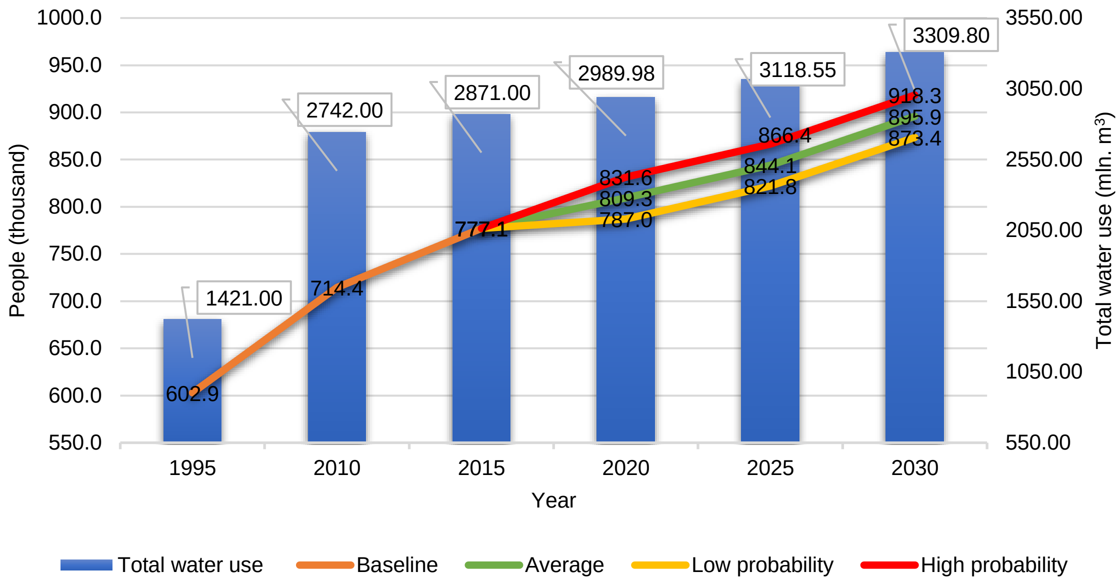
FIGURE 47. Population density and gender by district in Syrdarya Province.



	District name	Population density, person per sqkm
1	Akaltyn	87
2	Boyovut	254
3	Gulistan	405
4	Khavos	192
5	Myrzaabad	101
6	Sardoba	117
7	Saykhunabad	159
8	Syrdarya	219

Irrigated agriculture is the main economic activity in the Syrdarya province. The irrigated areas are equal to 266,3 thousand ha or 52% from the total. The size of irrigated area in the province has not changed significantly between 2012 and 2015. The main source of water for irrigation is the Syrdarya River and the river was formed from the Naryn and Karadarya rivers, which nourished snow and glaciers. The province is located in the Kuyi-Syrdarya BISA and consists of the four ISAs: Boyovut-Arnasai ISA, Khavos-Zamin ISA, Shuruzak-Syrdarya ISA and Uchtom ISA. The agricultural areas are irrigated by surface water from the canals. The greater part of the province is located in the Boyovut-Arnasai and Shuruzak-Syrdarya ISAs, consisting of 80% of total area. There are 106 functioning Water Consumers' Associations with an average area of 2,393 ha.

FIGURE 48. Forecast of population growth and total water use in Syrdarya Province for 1995-2030.



The forecast (Figure 48) of the population growth and total water use was developed to determine how much water would be needed in future as projections. The forecast shows that the Syrdarya Province will face a substantial growth of population and accordingly water use is planned in order to satisfy demand, based on past and current tendencies. While the population in the Syrdarya Province is projected to increase by 118 thousand between 2015 and 2030, the amount of water needed is anticipated to increase by more than 500 million.m^3. Calculations of the population growth were done using the information from the State Committee on Statistics (1995-2015) as an item of input data. The total water use projections for the period of 2015-2030 are calculated according to water use per capita in 2015 taken as equal to 3,7 m^3 per capita. In fact, in 2015 water consumption of the region was 2,871.0 million.m^3. As illustrated in Figure 48, the population growth directly influences a sharp increase of total water use, which indicates that more pressure on rational and effective water use is expected.

2.4.1 Climatic and Meteorological Conditions

The climate of the province is sharply continental with an annual precipitation of 330 mm, most of which takes place in winter and spring. The average annual temperature is 13-15 °C, particularly extreme with the highest temperatures in July (45 °C), and the lowest in January (-29 °C). The frost-free (growing) periods are between 205-230 days in the southern part and between 193-194 days in the north (Table 10).

TABLE 10. Main climate indicators of the Syrdarya Province (long-term annual average data).

Weather station	Average annual air temperature, °C	Period: months IV-IX					Period: months III-X		Frost-free period, days
		Air temperature, °C	Relative humidity, %	Precipitation, mm	Evaporation, mm	Moisture deficit, mm	Precipitation, mm	Evaporation, mm	
Akaltyn	13.2	22.2	51	96	960	864	199	227	205
Syrdarya	12,6	21,6	55	64	865	801	196	164	194
Khavast	15,1	24,4	38	126	1366	1240	186	327	230

Source: Uzbek Academy of Agricultural Sciences, 1992.

By precipitation, the southern part of the Syrdarya Province differs significantly from both the middle and the northwestern parts. The greatest precipitation occurs in the Khavas District (312 mm), the lowest in the

Syrdarya District (260 mm). In the middle part of Syrdarya Province, precipitation ranges between 270 and 295 mm.

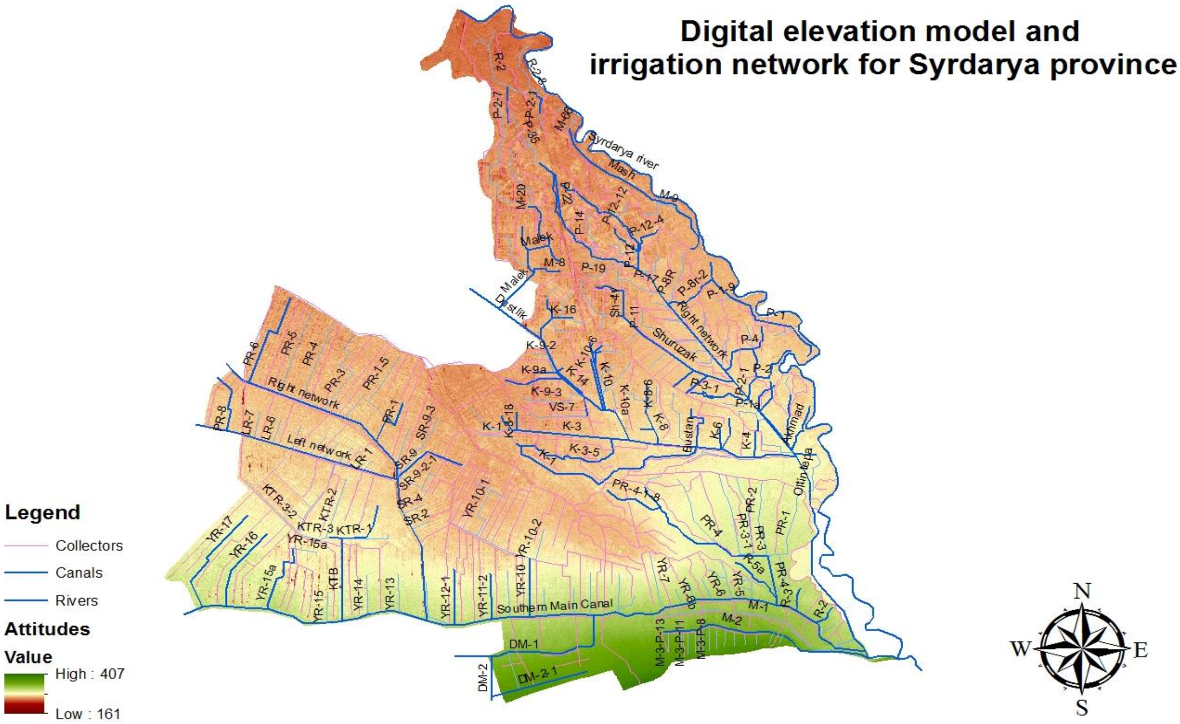
Humidity is important during the movement of moisture and soluble salts. The relative humidity is highest in the winter and lowest in the summer. The relative humidity in winter is more even in different parts of the territory and changes little during irrigation.

2.4.2 Topographic Map of the Syrdarya Province

From the geomorphological prospective, the Hungry Steppe, where the Syrdarya Province is located is a vast intermountain depression, surrounded by the foothills of Turkestan, Chatkal and Kurama ranges on the south and east and widely disclosed in the northwest. The main slope of the surface is observed on the same direction (Sadykov, 1975).

The topography of the modern Syrdarya Province is marked by two terraces of floodplain and first above floodplain (lake). The height of the lake terrace bench above the floodplain does not exceed 2-3 m. The species composition of the lake terrace deposits is very diverse. The upper fine-clastic part in section is presented by interlaid loam, sandy loam and clay. At a depth of 1 to 5 meters beneath these sediments, there are sand deposits extending to a depth of up to 5-12 m; and underlain below down by bench gravel.

FIGURE 49. Digital Elevation Model and irrigation network of Syrdarya Province.



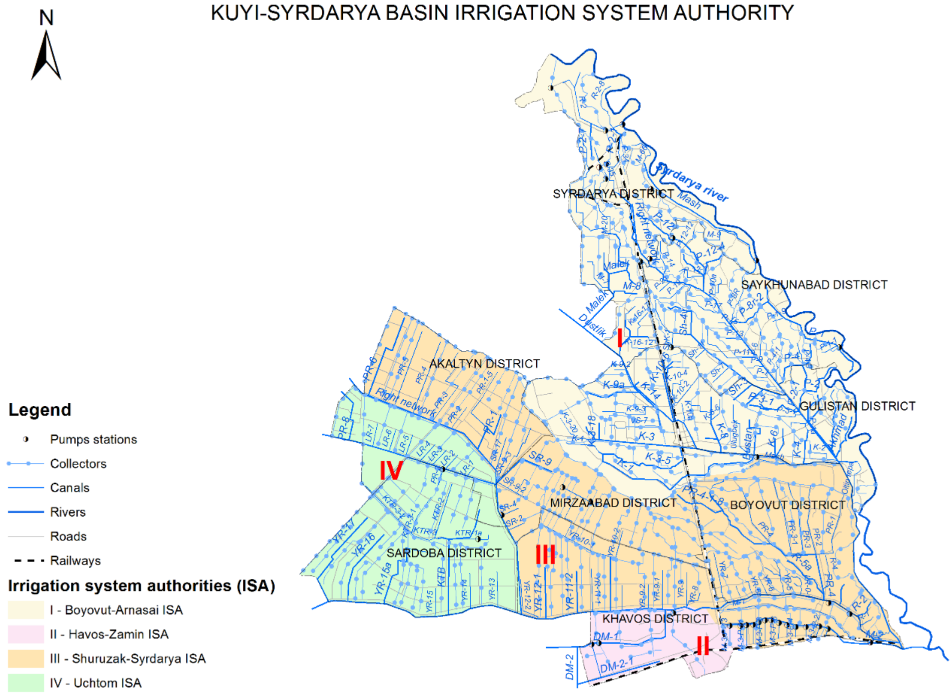
The central part of the Hungry Steppe – up to Karoyskoy depression – is made of powerful layered, mostly clay deposits of interbedded sands and sandy loams. In the north, the layering becomes thin-platy that is typical of the peripheral parts of alluvial fans. The Shuruzak depression in the central part is composed of layered clay, underlain by sand and gravel on the 10-15 m depth, which slide closer to the surface in the northern part of depression (Figure 49). Right slope of the Shuruzyak depression as well as the second terrace above the floodplain, are composed of heavy loams and clays with interlayers of sandy loam and sand ranging from 10 to 20 m. Below, inequigranular sands, gravels and bench gravel lie up to 50 m and underlain by dense clay. Syrdarya is composed of alluvial sediments of different texture, underlined by sand on a small depth.

2.4.3 Irrigation Networks

The main source of irrigation in the Syrdarya Province is the Syrdarya River (Table 11). Two large main canals originate from Syrdarya through a diversion canal of Farkhad Hydro Power Plant (HPP): Doustlik and the Southern Hungry Steppe Canal (SHSC). The Doustlik canal provides irrigation water to the irrigated areas of the Jizzakh Province. In addition, irrigation water from 142 wells, drainage wells and collecting water is used for irrigation.

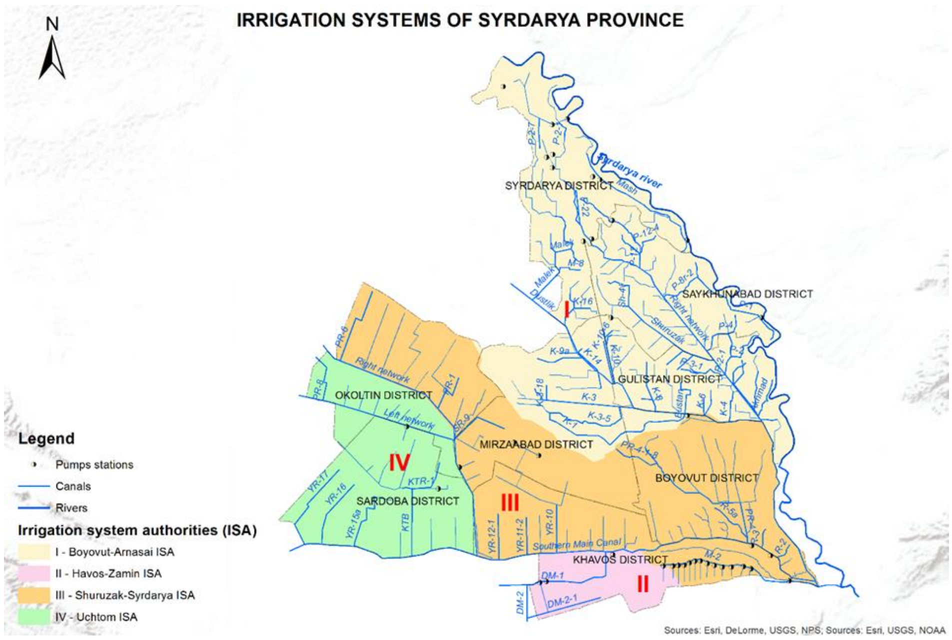
Mineralization of irrigation water is 1.18-1.64 g/l, of the irrigation wells it is - 0.8-1.2 g/l, vertical drainage it is 2.4-4.3 g/l in the old irrigation zone and 5.4-7.8 g/l in the new irrigation zone, CDS is 2.2-3.0 g/l in the old irrigation zone and 3.74-6.77 g/l in the new irrigation zone.

FIGURE 50. Map of the Lower-Syrdarya BISA command area



The irrigated area is 266,3 thousand ha of which 37,8 ha are under pumping irrigation; water is lifted by the 10 pumping stations. The total length of the canals under public water management organizations is 628 km, of which 293,7 km are for concrete lining. The total length of the irrigation network in WCAs is 5,861 km of which 413.7 km are for concrete lining, 2,035 km for flume network, and 86.3 km for closed network (Figure 50). The length of irrigation network per ha of irrigated area is 22.5 pm/ha. The irrigation network scheme of the province is shown in Figure 51.

FIGURE 51. Irrigation network scheme of Syrdarya Province.



All irrigated areas in the province are equipped with an artificial drainage. Total length of the drainage network under supervision of Amelioration Expeditions is 4,762.5 km, of which 2,814.27 km are a subsurface drainage. The total length of the drainage network in WCAs is 11,427.29 km, of which 5,896.40 km are a subsurface drainage. The length of CDWs per ha of irrigated area is 56.3 lm/ha (Is this km/ha?).

TABLE 11. Key indicators of the Syrdarya Province rivers.

Region	River	River source	River characteristics	Irrigation System Authority (ISA)	Districts crosses	Irrigated zone, ha	Transboundary river (yes/no)
Syrdarya Province	Syrdarya	Formed by the confluence of the Naryn and Karadarya; is fed by snow and glacier	Length -2,212 km, Syrdarya River Basin area - 462,000 km^2, water flow - 227 m^3/s	BWO Syrdarya	Andijan, Namangan, Fergana and Syrdarya provinces	12,615	Yes

Source: Akromov 2008 and Authors' survey.

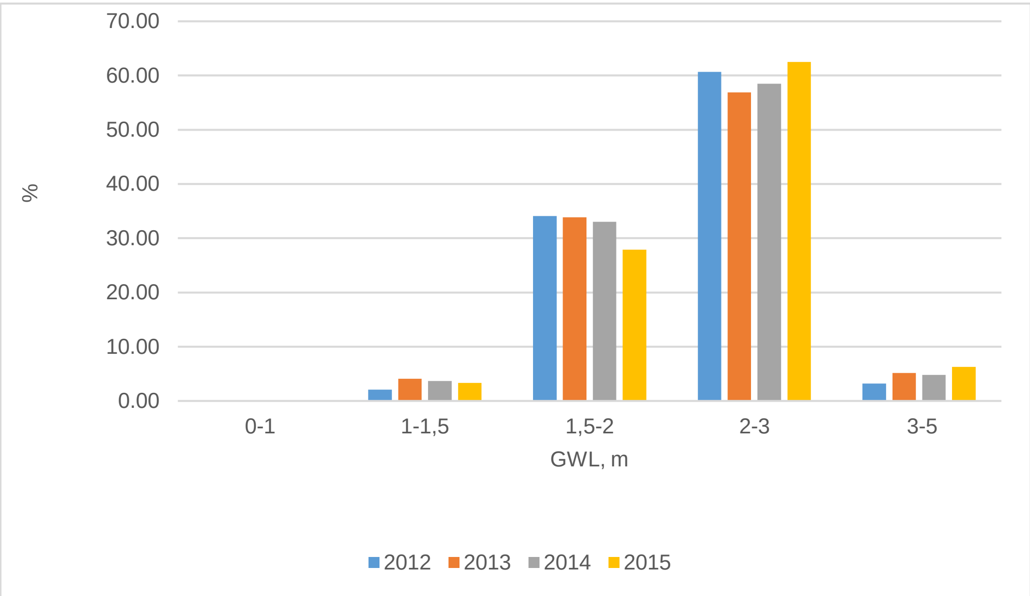
2.4.4 Reclamation State of Irrigated Lands

Complex ameliorative state of the irrigated areas in the province is caused by natural conditions. Difference between inflow and outflow of groundwater in the southeast is ± 0.142 l/s per ha, in the east it is 0.026 l/s ha. In the old irrigation zone, the piezometric levels of artesian water exceeds groundwater level. According to the hydrogeologic-reclamation conditions, vertical drainage is used in the old irrigation zone. In the new irrigation zone, the groundwater regime is regulated by horizontal drainage.

Vertical drainage is a perfect engineering construction allowing quick regulation of the groundwater level in the distribution of artesian waters. Unfortunately, increased operating costs due to electricity price increase in the province have led to a decrease of VDW number from 869 units in 1990 to 480 units by 2015. The work ratio of VDW of the current system is very low, not exceeding 0.5. If until 2000 the volume of water pumped by VDWs was up to 15% of the total drainage flow, currently it has decreased to 3%. Low work ration does not allow quick regulation of the groundwater levels, especially in spring when a quick drawdown of leaching water is required and need to ensure optimum soil moisture for cotton sowing.

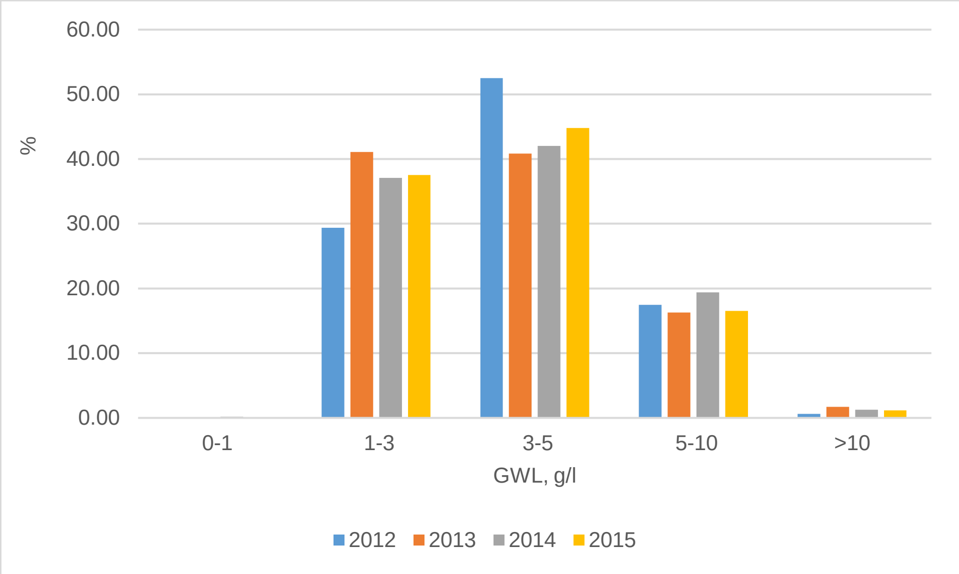
In the last years, there has been a slight decrease in the area of groundwater levels of 1-1.5 m during the crop growth season due to increased areas with GWL of 3-5 m (Figure 52). The area of medium GWL vegetation depth of 2-3 m in the province is 62.5%.

FIGURE 52. Distribution of average GWL in Syrdarya Province during the crop growth season.



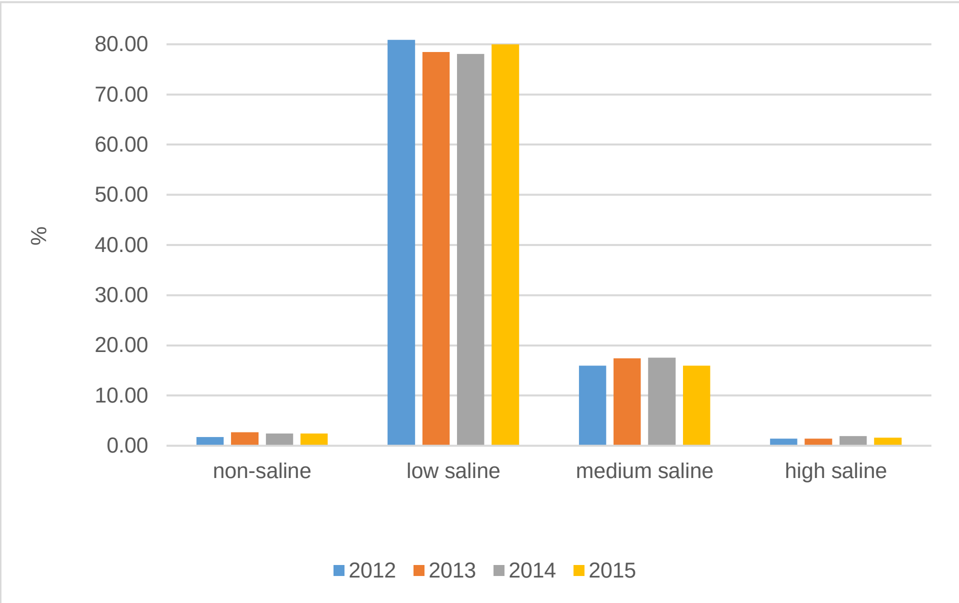
No significant changes in the distribution of areas with groundwater mineralization during the growing season are observed in the province. On 45% of the province area, groundwater salinity is 3-5 g/l; while on 16.5% of the area, groundwater salinity is 5-10 g/l (Figure 53).

FIGURE 53. Distribution of the areas with GWL during the growing season in Syrdarya Province.



In recent years, changes in the dynamics of soil salinization were not observed in the province. Eighty % (80%) of the area constitutes slightly saline soils and 16% of medium saline soils (Figure 54).

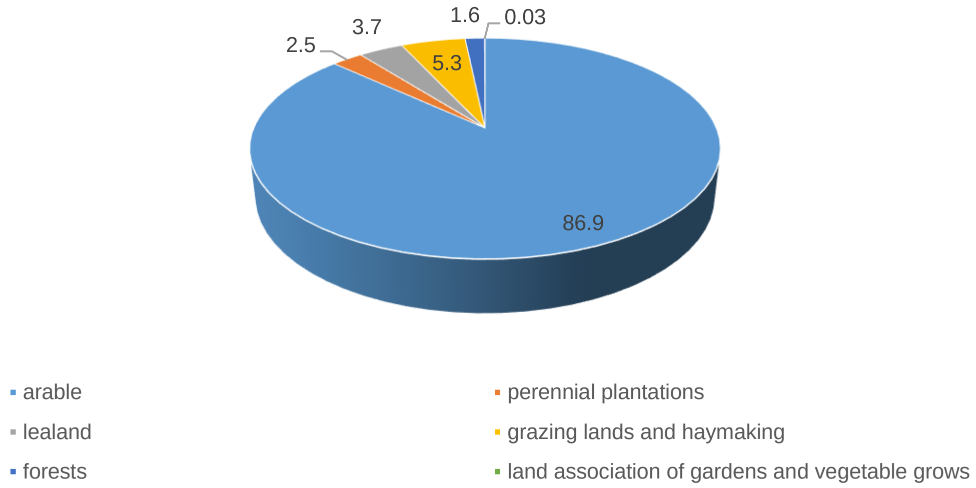
FIGURE 54. Distribution of irrigated areas by soil salinity in Syrdarya Province.



2.4.5 The Use of Water and Land Resources

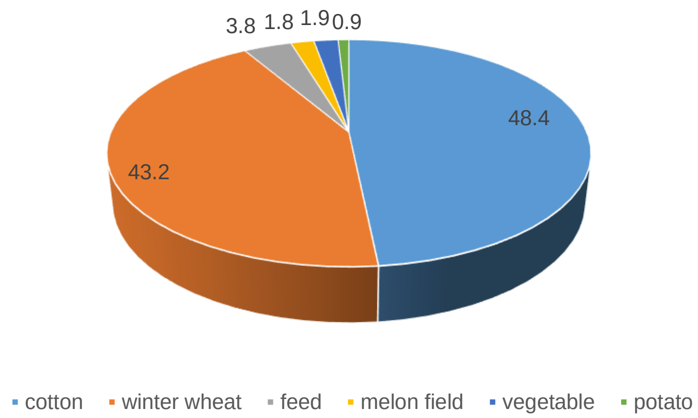
Use of the land resources. The land resources of the province constitute 427,6 thousand ha of which 287,5 thousand ha are irrigated. The structure of the irrigated land is shown in Figure 55.

FIGURE 55. Irrigated land structure (%).



Due to the diversification of agricultural production over the past 5 years the area under cotton decreased by 2 thousand ha, area under grains increased by 5 thousand ha and the area under melons by 2 ha. The crop pattern including household backyards for the year 2014 is shown in Figure 56.

FIGURE 56. Crop pattern including household backyards (%).

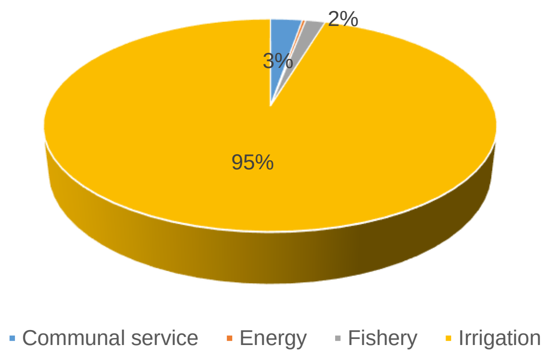


The land productivity is 5.09 million USZ/ha, i.e., one ha of irrigated land produces an agricultural commodity return of 5.09 million UZS.

Organization of water use. Operation and maintenance of the transboundary main canal Doustlik and the head site of interprovincial SHSC are under the BWO "Syrdarya". Two ME, two PSE and CA for the Syrdarya and Jizzakh provinces operate under Lower-Syrdarya BISA. ISAs conclude contracts for water intake with MCOM SHSC and PSE and CA. SUE "Syrdaryasuvokova" provides the population with water for drinking and household needs. Water intake for these purposes is carried out from both underground and surface sources.

Water use. Over 95% of water is used for irrigation (Figure 57).

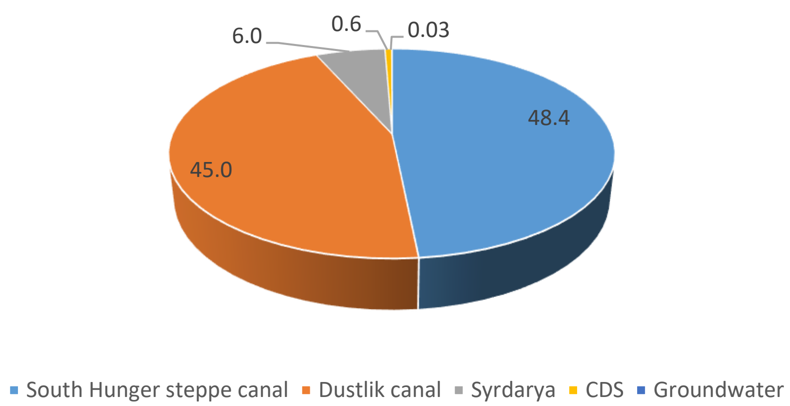
FIGURE 57. Water use by industry (%).



Specific water supply to the WCA border is 6,6-8,4 thousand m³/ha during the growing season; in the nongrowing season it is 5-5.9 thousand m³/ha. The water use ratio during the growing season is 0,86-0,97 and, during nongrowing season, it is 0,72-0,84.

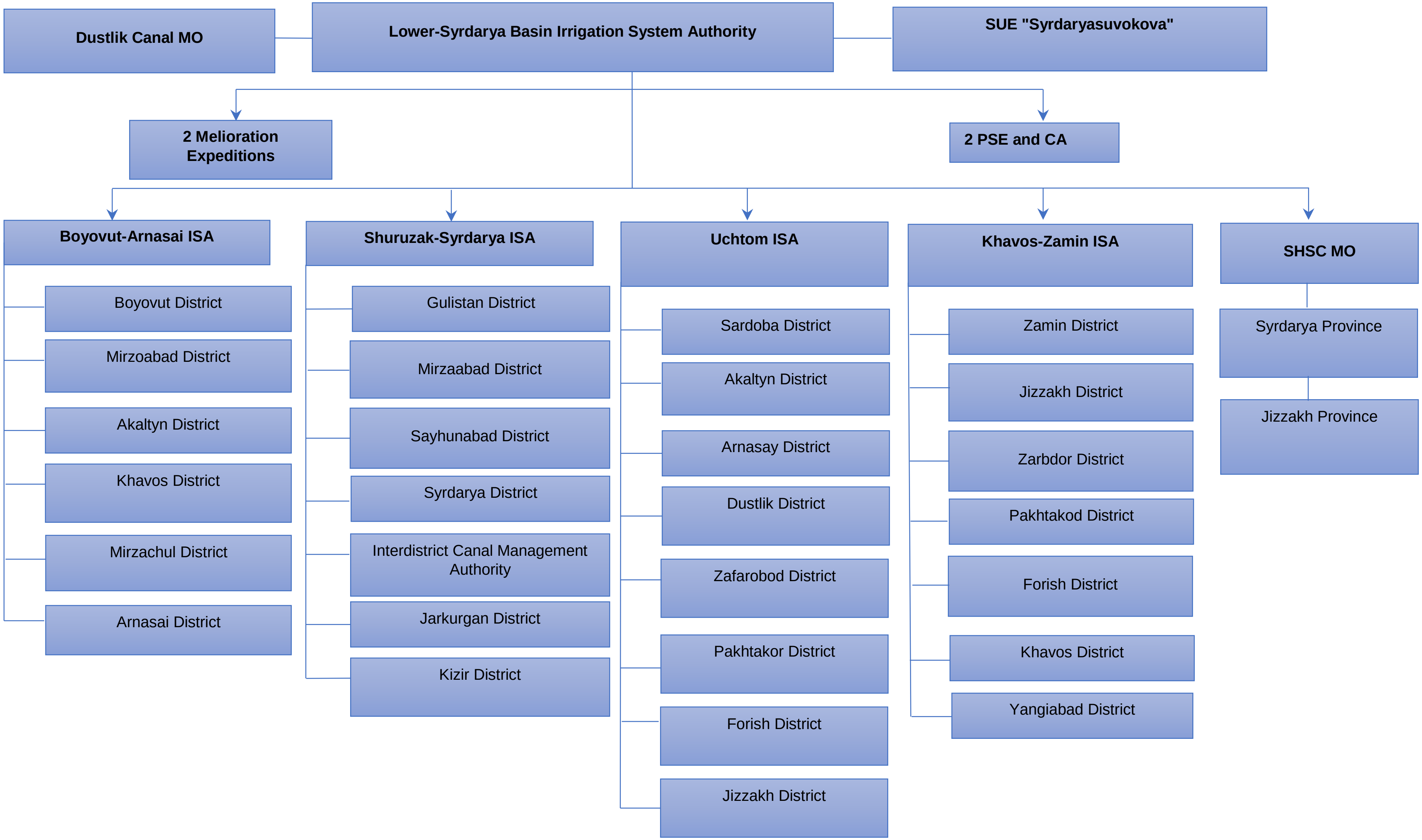
Of the total water intake, 48.4% are withdrawn from the SHSC system, 45.0% from the Doustlik system, 6.0 from the Syrdarya, 0.6% from CDS and 0.03% from groundwater (Figure 58).

FIGURE 58. Water intake structure (%).



Some 10-12% of the water withdrawn from the source is lost in main canals; 6-8% of water delivered to the district borders is lost in distribution canals. Water productivity is 490 UZS/m³, i.e. 1 m³ diverted from sources produces an agricultural return of 490 UZS. It should be noted that due to the transition of Toktogul Reservoir to energy-production regime, in winter and spring, floodplain inundation causes harm to farmlands on the lower reaches of Syrdarya. Collectors remain in the poor conditions and the quality of saline soil leaching deteriorates due to violations of the optimal leaching time. The organizational structure of water resources management in Syrdarya Province is shown in Figure 59.

FIGURE 59. Institutional water management structure of Syrdarya Province.



2.4.6 Findings of the Assessment of the Syrdarya Province River Basins

The irrigated area of the province is 266,3 thousand ha, including 37,8 thousand ha under pumping irrigation where water is lifted by 10 pumping stations. The main source of irrigation in the province is the Syrdarya River. Two large main canals originate from the Syrdarya through diversion canals of Farkhad HPP: Doustlik and the SHSC. Currently, 142 wells operate in the province for irrigation, drainage and collection of water. It should be noted that over the past 5 years the area under cotton decreased by 2 thousand ha due to the diversification of cropping pattern; area under grains increased by 5 thousand ha and melons – by 2 thousand ha. Water availability and quality of irrigation water during growing seasons in the lower reaches of the Syrdarya River depend on the operating regime of Toktogul Reservoir. Unilateral change of regimes of the Toktogul Reservoir from irrigation to energy can lead, especially in the lower and middle reaches of the Syrdarya, to severe negative water management and environmental consequences: in summer to the irrigation water shortage and in winter – to flooding of irrigated lands, pastures and economic facilities. Collectors remain in the backwater and the quality of saline soil leaching deteriorate due to violations of the optimal time for soil leaching. Natural uneven distribution of water resources in the region leads to the exact opposite approaches with regard to the regime of hydraulic structures.

During the field trips dedicated to data collections, members of IWMI staff have taken the views of the local BISAs on potential area for development of the river basin management plans into consideration. Project team explained the criteria for the selection of the pilot river basin. As was indicated above, the Syrdarya Province does not have small rivers, generated within the territory of the province (Table 12). However, local stakeholders indicated that there are such canals that more or less follow the project selection criteria. It is the canal “Right network” or in Russian “Pravoberejniy” which originates from the Syrdarya River and located in the Shuruzak-Syrdarya ISA. Canal length is 55,64 km and provides irrigation water to 28,474 ha of three districts in the Syrdarya Province including the Guliston, Sayhunobod and Syrdarya districts. The following agricultural crops are the main consumers of the water from the canal: cotton around 13,142 ha, wheat around 10,550 ha and 4,781.3 ha other agricultural crops such as vegetables, orchards etc. The source of the canal is “Doustlik” canal at the survey stake # 25. Around 24 WCAs and two municipalities are the main users of the canal water. The canal has almost no lining, which leads to huge losses in the system, specifically around 30-35% of the annually required amount of water that is lost in the system.

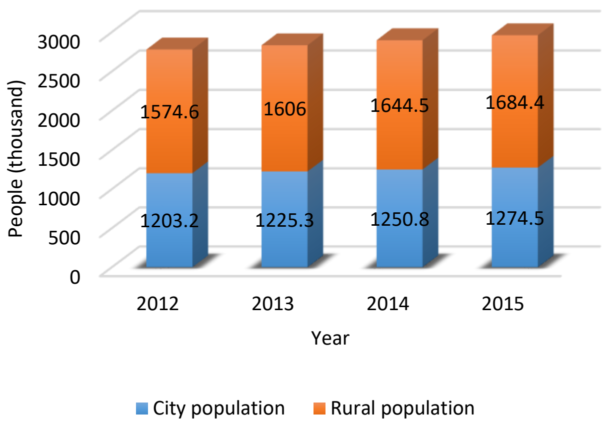
TABLE 12. List of current issues and problems in small rivers and sais of Syrdarya Province.

Name	Identified problems	Negative consequences and risks	Causes	Activities
Syrdarya	Deterioration of water River banks are lifeless and deserted. Lack of water resources during the crop growth period High water losses. Water in different parts of fixed organic compounds, metals, pesticides in quantities above the maximum permissible concentration.	Reduction of the number of fish and musk-rats in the river. Reduction of yields by the deterioration of life activities of the population.	Salinity of the river is high. The channels of the river excavation.	Agriculture (irrigation cropping) Fishery

2.5. Kashkadarya Province

General information. The Kashkadarya Province lies in the latitudes 37.9965 to 39.5904 and longitudes 64.2941 to 67.7180, and the total area is 28,400 km^2. The province is located in the southeastern part of the country, bordered with Samarkand, Surkhandarya and Bukhara provinces internally, and Turkmenistan and Tajikistan countries. Climate is typically continental and partly semitropical, arid zone. There are 13 districts in the province – Karshi, Kasby, Nishon, Mirishkor, Muborak, Koson, Chirokchi, Guzar, Dehkanabad, Kamashi, Yakkabag, Kitob and Shakhrisabz. Karshi City is the administrative center of the province.

FIGURE 60. Dynamics of urban and rural population

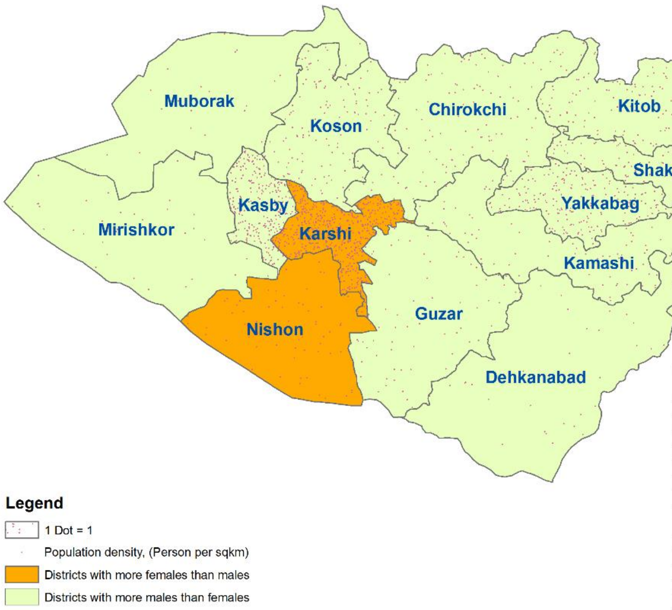


Source: The State Committee of the Republic of Uzbekistan on statistics, 2015.

The population of the Kashkadarya Province is 2,958.9 thousand and its density is 103,6 per square kilometer. The population increased slightly between 2011 and 2015, from 2,722.9 to 2,958.9 thousand. The districts with the highest population density are Karshi, Kasby, Yakkabag and Shakhrisabz.

In 2015, more than half (57%) the population of the province lived in the rural areas. Figure 60 shows the dynamics of city and rural population change over the years.The average age of the population in the province is 26.5 years. The proportion of male and female citizens is almost the same with a slight excess of males (Figure 61).

FIGURE 61. Population density and gender by districts in Kashkadarya Province.

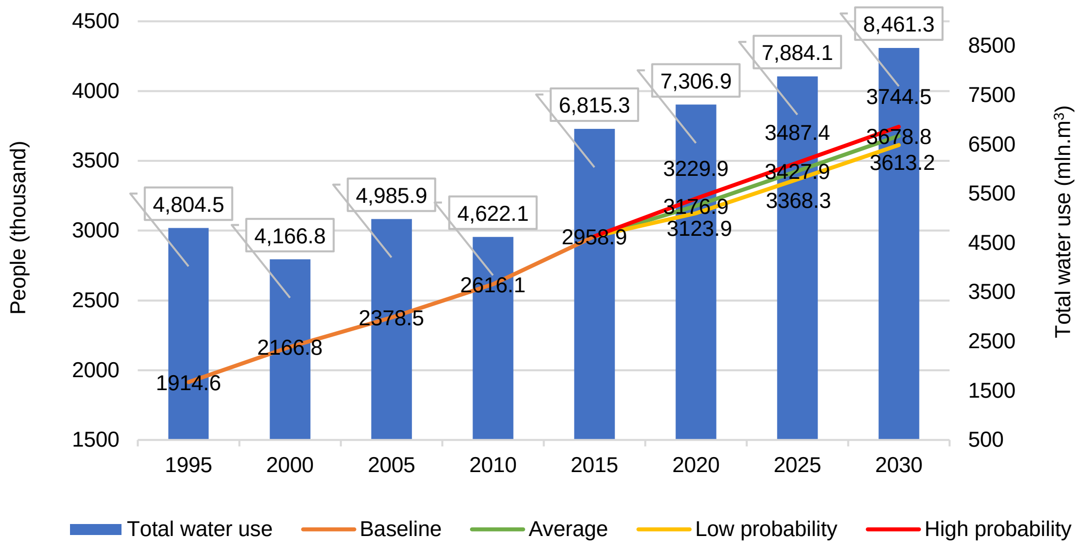


	District name	Population density, person per sqkm
1	Dehkonobod	33.16
2	Kamashi	94.33
3	Yakkabog	211.54
4	Shahrisabz	197.82
5	Kitob	136.47
6	Chirokchi	126.87
7	Guzor	70.30
8	Nishon	61.53
9	Muborak	25.61
10	Mirishkor	34.42
11	Koson	142.42
12	Kasbi	271.87
13	Karshi	549.10

Irrigated agriculture is the main economic activity of the Kashkadarya Province. The irrigated areas equal 457,6 thousand he which represent 16% of the total area. The irrigated area in the province has not changed significantly between 2012 and 2015. The main source of water for irrigation are the rivers Aksuv, Djindarya, Kashkadarya, Tanxozdarya, Katta Uradarya and Yakkabagdarya. The province is located in the Amu-Kashkadarya BISA and contains five ISAs: Mirishkor ISA, Karshi main canal (KMC) ISA, Aksuv ISA, Yakkabag-Guzar ISA and Eskiankhar ISA. The agricultural areas are irrigated by canals and small rivers. There are 152 functioning WCAs with an average area of 3,391 ha.

Water demand depends on the population size, demanded type of food and consumption volumes. Today, increasing population, its raising demand and need for agricultural products have put additional pressure, creating many problems associated with water use, in turn requiring the rational use of water resources.

FIGURE 62. Forecast of population growth and total water use in Kashkadarya Province 1995-2030.



Types of crops, crop yields and agricultural productivity also affect the demand for water, while climatic changes add uncertainty to the annual water distribution. The forecast (Figure 62) of the population growth and total water use was developed to determine how much water would be needed in the future. The forecast shows that the Kashkadarya Region will face a substantial population growth and, accordingly, demand for water in order to satisfy the needs based on past and current tendencies. While the population in the Kashkadarya Province is projected to increase by 720 thousand between 2015 and 2030, the amount of water demand is anticipated to be more than 1,646.0 million m^3. The total water use projections for 2015-2030 are calculated according to water use per capita in 2015 and equal to 2.3 m^3 per capita. In fact, in 2015 water consumption of the region was 6,815.3 million m^3. As illustrated in Figure 62, the population growth directly influences a sharp increase of the total water use, indicating a higher pressure on rational and effective water use. Currently, the viable solutions of the above problems must be found soon, and is a primary task of policy-makers, researchers and managers, aimed at the rational water use, analysis of river basins studies' and irrigation sources flow plans as well as proper planning.

2.5.1 Climatic and Meteorological Conditions

The Kashkadarya Province is located in the southwestern part of the country; mountain barriers do not protect its northern and western parts. As a result, cold airflows penetrate from the north, and greatly heated air masses from the west (the Karakum Desert), resulting in sharply continental, arid climatic conditions. Summers are hot and long, winters are short and cold, springs are relatively wet. Climate changes incrementally from the desert plains to the mountains. The sum of positive temperatures is up to 4,900-5,000 °C; the sum of effective temperatures is 2,519-2,980 °C. The frost--free periods are between 213 and 233 days (Table 13).

TABLE 13. Main climate indicators of Kashkadarya Province (long-term annual average data).

Weather station	Average annual air temperature, °C	Period: months IV-IX					Period: months III-X		Frost-free period, days	Total temperature above 10 °C
		Air temperature °C	Relative humidity,%	Precipitation mm	Evaporation, mm	Moisture deficit,mm	Precipitation, mm	Evaporation, mm		
Mubarak	15.6	25.4	33	40	1,580	1,540	104	309	213	2,980
Karshi	15.8	24.4	41	60	1,300	1,240	173	308	213	2,804
Guzar	16.2	24.5	35	70	1,440	1,370	230	401	233	2,879
Kamashi	15.7	24.3	39	90	1,340	1,250	237	356	-	-
Kitab	14.9	22.9	49	1-40	1,110	970	394	294	219	2,519

Source: Uzbek Academy of Agricultural Sciences, 1992.

The first autumn frost occurs in the period from October 14 to November 02, and the last on March 16-25. Steady average daily air temperature above 10 °C occurs on March 21 in the zone of typical serozem and on March 14-19 in the zone of light sierozem and desert soils.

The average daily temperature in the belt of typical and light sierozems during the growing season is 22.9-24.5 °C, in desert areas 25.3 °C. The average temperature in July is around 28 °C in the lower foothills of the middle reaches of Kashkadarya and 31.6 °C in its ancient delta. Maximum temperature in these areas reaches 47-50 °C. The average relative humidity during the growing season ranges within 33-49%. In July and August, relative humidity drops to 22%, and in the daytime to 15%, which at high wind activity leads to strong air drought (garemsil).

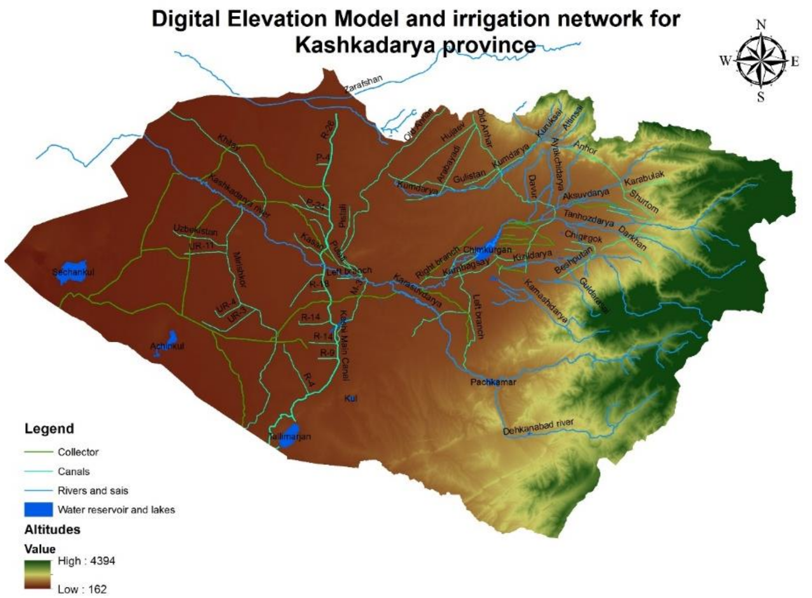
The wind activity is characterized by dominating moderate winds with a speed of 2-4 m/s, northern in the summer, and eastern in the winter. Stronger winds are observed in the desert area. Here, the number of days with wind speed of 15 m/s or more is between 6-7 m/s and in the western and southern parts of the Steppe between 10 and 12 m/s.

Rainfall is negligible: 40-140 mm during the growing season and 104-394 mm during the nongrowing season, while evaporation from water surfaces is 1,110-1,580 mm and 294-401 mm, respectively. This low precipitation rate results in a large moisture deficit, which in the growing season reaches 970-1,540 mm.

2.5.2 Topographic Map of the Kashkadarya Province

The topography of the Kashkadarya Province is diverse: In the northeast, east and southeast the province is bordered by the Zarafshan and Gissar mountain ranges, the highest points of which rise up to 3,750-4,400 m a.s.l. The territories of Shakhrisabz, Kamashi, Dehkanabad and partially Chirakchi rural districts refer to the mountainous areas (Figure 63). In general, altitudes degrade in the northwest, which define the main features of the territorial division of labor, specialization of agricultural production and the main features of agrogeography of the province. In the plain part, which occupies about half of the basin, there are three areas according to physical and geographical characteristics: Karshi Steppe; Sundukli Sands; areas of Kitab-Shakhrisabz Basin and Guzar-Karshi Oasis (Sadykov, 1975).

FIGURE 63. Digital Elevation Model and irrigation network of Kashkadarya Province.

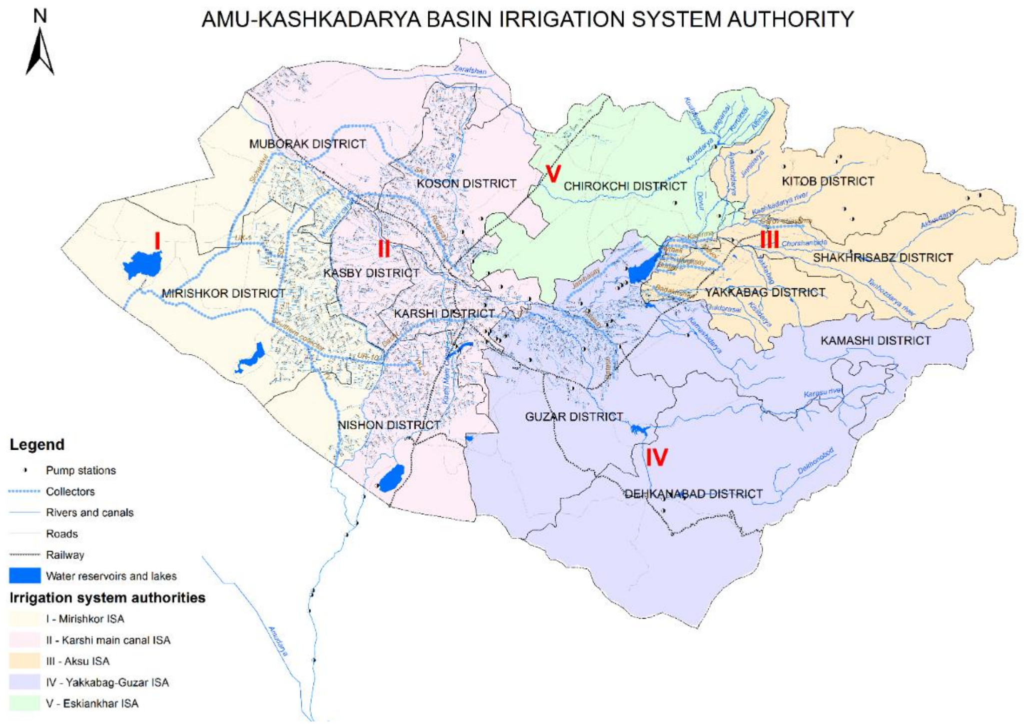


2.5.3 Irrigation Networks

The main source of irrigation in the Kashkadarya Province are Kashkadarya, Tanhozdarya, Lyangardarya, Akdarya (Aksu), Yakkabagdarya (Kyzyldarya), Guzardarya: Katta-Uradarya and Kichik-Uradarya, Djinnidarya rivers. Eskianhar Canal ts fed from the Zarafshan River, and Karshi pumping canal (Figure 63 and Figure 64). KMC with the help of seven pumping stations provides water to Tallimarzhan Reservoir, where water is delivered from the Amudarya River. The total canal length is 78,4 km. Regulatory water flow is 175 m^3/s, and the maximum water flow is 195 m^3/s. Karshi Main Canal begins on the territory of the Republic of Turkmenistan, and its operating part is focused on Tallimarzhan Reservoir. The canals provide water to the Karshi, Kasby, Koson and Nishan districts of the Kashkadarya Province. Karshi Main Canal irrigated area and its irrigation network are 9,911.67 km (Figure 65). Of these, 780 km are lined, and 4,090 km are concrete flumes. The remaining 4,313 km of land set aside for irrigation ditches irrigate 212,550 ha of land. Water-transmitting capacity of the main canal is 350 m^3/s.

All rivers of the province are fed by snow and rain, with a maximum flow rate in April-May and a sharp decrease in water in July and August. Such an unstable and insufficient water supply is regulated by Chimkurgan, Pachkamar, Gissarak and nine more small reservoirs.

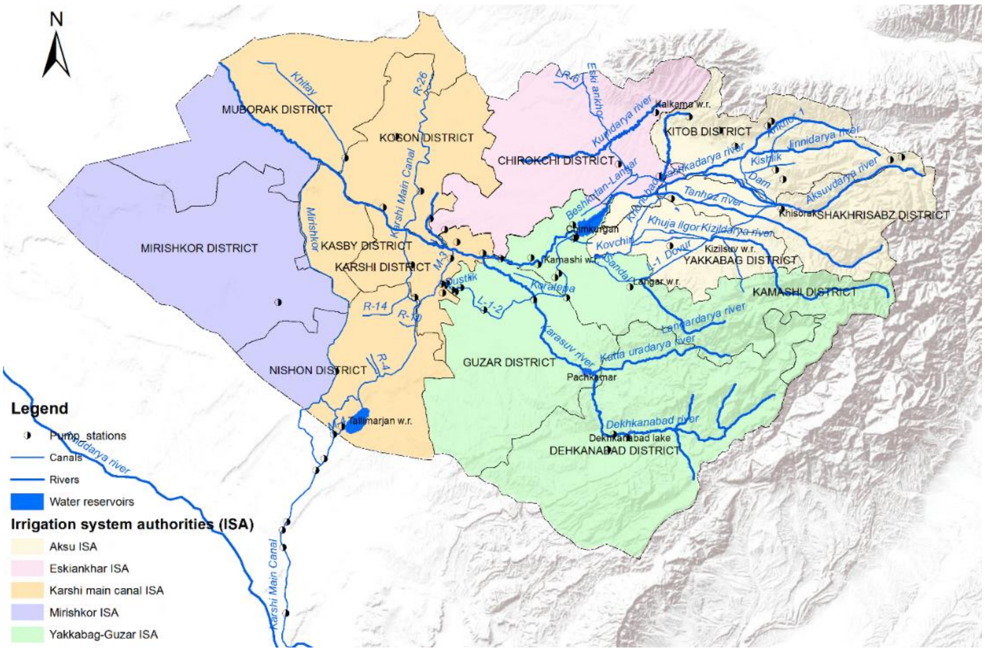
FIGURE 64. Map of the Amu-Kashkadarya BISA command area.



Almost 2/3 of the water used in agriculture is taken from the Amudarya river. At the same time, internal water sources, in particular, the Kashkadarya River, provide only 16.7% for agriculture; 7.5% of the water comes from the Zarafshan Basin through the Eskiankhar Canal. Mineralization of the Amudarya River water at the Kerki gauging station during the growing season ranges from 0.5-0.7 g/l; Kashkadarya - 0.4-0.5 g/l, irrigation wells 0.4-0.5 g/l, vertical drainage 2.7-3.4 g/l and 0.3-0.6 CDW in Kitab and Shakhrisazbz districts, 1-3 g/l in other areas of the sierozem zone and 4-10 g/l in the desert zone.

The Kashkadarya River originates at an altitude of 2,960 m a.s.l., in the western part of the Gissar Mountain. Major tributaries are Akdarya (Aksu), Tanhizydarya and Guzardarya. The length of the river is 378 km, the basin area is 12,000 km^2, the flow average modulus is 5.7 l/s km^2, and mean annual flow rate is 25,3 m^3/s (Chirakchi). The rivers are fed by snow melt and rainfall. Flooding is usually observed in April and May, when rivers also inundate. Currently, the Kashkadarya Basin is fed by water from the Zarafshan River Basin as well. The Chimkurgan Reservoir, Karshi control structure, headworks and KMC aqueduct were built on the riverbed to improve supply of water to the land within the river basin. Collector-drainage water is discharged into the Kashkadarya River and mixes with river water, which makes it possible to reuse it for irrigation. The flow volume is around 300-450 million.m^3, of which about 50-60 million.m^3 are discharged into undrained Deuhana Depression located on the territory of Bukhara Province; and 80-90 million m^3 in Sichankul collector.

FIGURE 65. Irrigation system of the Kashkadarya Province.



After the mountain ridge, on the territory of Gissar Ridge, the Djinnidarya, Aksuv, Tanhozdarya, Yakkabagdarya, Akdarya, and Guzardarya rivers are adjacent to the north and west part of the river. Djinnidarya is one of the full-flowing streams of the Kashkadarya Province, which originates at altitudes of Okot (2,918 m) and Shertau (2,696 m) mountains. Djinnidarya River is 61 km long; water catchment area is 367 km^2. Just above the Nushkent Village another overflowing stream, the Aksuv River, joins the Kashkadarya. Its length is 115 km and water catchment area is 1,050 km^2 (Table 14). The Aksuv River is formed by the confluence of the two rivers, Khonaka and Batirbay that originate from the Severtsev and Batirbay glaciers. At its highest reaches, the river is flowing in the mountains, where the height of the water distributors is 4,100-4,300 m a.s.l. The southern spurs of the river basin are distributed by deep small valley rivers; for this reason, the length of the basin on the left side is 12-24 kilometers and it is adjacent to the Philon, Kizilimchak, Tamshush, and Suvtushar rivers.

TABLE 14. Key indicators of Kashkadarya Province rivers.

Region	River	River source	River characteristics	Irrigation System Authority (ISA)	Districts crosses	Irrigated zone, ha	Transboundary river (yes/no)	Water use million/m³			
								Irrigation	Economy	Domestic	Other
Kashkadarya Province	Akdarya (Kashkadarya tributary)	Originates on the slopes of Gissar range, is fed by snow and glacier	The total length is 154 km, basin area is 1,280 km²	Aksuv ISA	Shakhrisabz, Kitab Yakkabag	48,771	No	341.89	1,90	28,85	-
	Guzardarya (Katta-Uradarya & Kichikdarya)	Originates in the western part of the Gissar range, from the Kharkush pass	The total length is 113 km, basin area is 1,410 km²	Yakkabag Guzar ISA	Dehkanabad, Guzar	-	No	14,56	0,30	3,00	-
	Tanhizydarya	Originated on western slope of Gissar range, is fed by snow and rain, partly glacier	The total length is 93 km, basin area is 1,910 km²	Aksuv ISA	Shakhrisabz, Yakkabag	6,62	No	23,86	0,3	4,09	-
	Kashkadarya	Originates in Zeravshan and Gissar ranges. Is fed by snow and rain	The total length is — 378 km, basin area is 12,000 km²	Aksuv ISA Yakkabag - Guzar ISA	Kitab, Shakhrisabz, Yakkabag, Chirakchi, Kamashi, Guzar, Karshi, Kasby Mubarak districts	129,01	No	64,14	0,30	19,9	-
	Yakkabagdarya (Kyzyldarya)	Originates on the western slope of the Gissar range	The total length is — 99 km, basin area is 11,800 km²	Aksuv ISA	Yakkabag	9,41	No	69,28	0,4	7,8	-

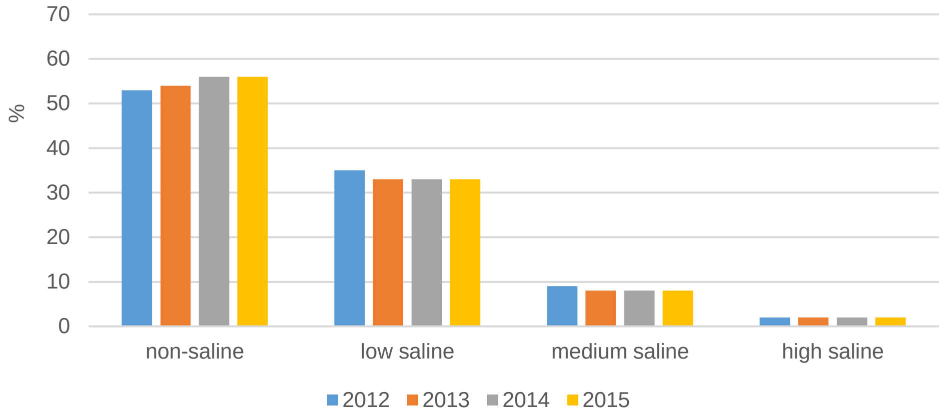
Source: Akromov 2008 and Authors' survey.

2.5.4 Reclamation State of Irrigated Lands

There are about 1 million ha of land suitable for irrigation in the Kashkadarya Province, because of the lack of water which is slightly more than 500 thousand ha of cultivated land. However, even with the most efficient use the water the amount is not sufficient for irrigation. Lack of water resources in the Kashkadarya Province jeopardizes an agricultural production more and more acutely every year.

While there is insufficiency of water in the province, in most cases farmers use excessive amounts of water for irrigation, whenever they have a chance, using well-established but largely inefficient irrigation techniques.

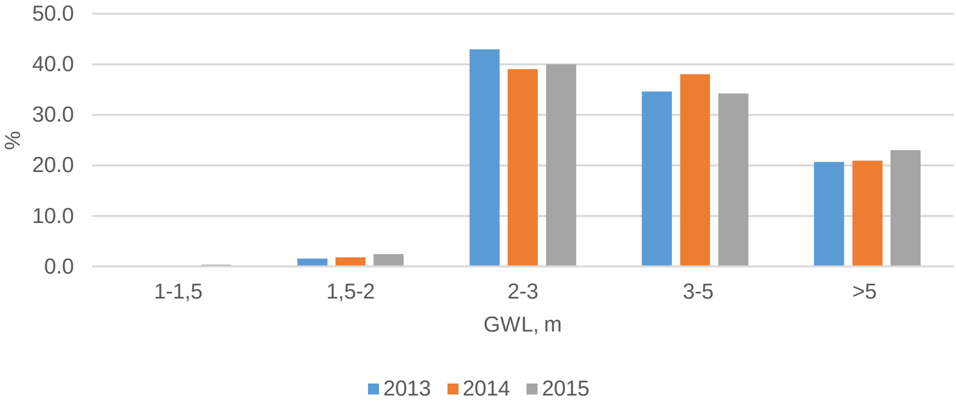
FIGURE 66. Distribution of irrigated areas by soil salinity in Kashkadarya Province.



Over-irrigation leads to the salinity increase due to rising, shallow groundwater levels. Saline areas constitute 45% including 34% of the slightly saline areas, 8% medium saline and 2% strongly saline (Figure 66). A significant part of the saline soils with a high groundwater level only in Guzar District alone reached 6,126 ha, or half of the plain irrigated lands.

Inefficient irrigation techniques contribute to soil salinity and create shortage of water resources.

FIGURE 67. Distribution of areas by GWL in Kashkadarya Province.

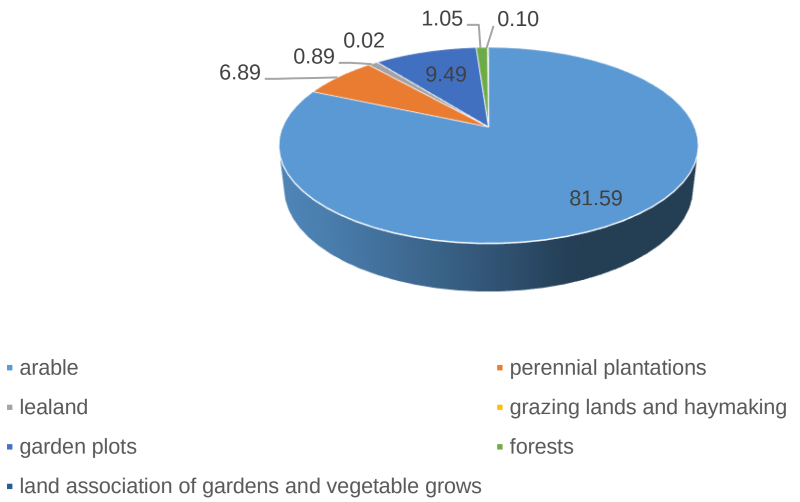


Natural conditions affect the ameliorative status of the irrigated areas in the desert and sierozems zones. The status is complex in the desert zone and relatively good in the zone of sierozems. The groundwater regime is mostly managed by horizontal drainage. Vertical drainage is implemented in the Karshi and Kasby districts in 18.8 ha of land; there are 306 VDWs. Annual drainage runoff is 1,456.42-1,338.23 million m^3. Specific drainage flow is 2.6-2.8 m^3/ha. Of the total CDW in the province, 24.4% is discharged in the river, 19% to the canals and 57% outside the irrigated area. In recent years, there have been no significant changes in groundwater levels. Areas with groundwater levels of up to 2 m are less than 3% (Figure 67). The intense evaporation of groundwater on the plain areas of the basin leads to a strong salt accumulation. In order to improve and increase soil fertility and crop yields, it is required to leach the soils and then to apply a set of agro-reclamation measures, leading to mitigation of secondary salinization processes.

2.5.5 Water and Land Resources Use

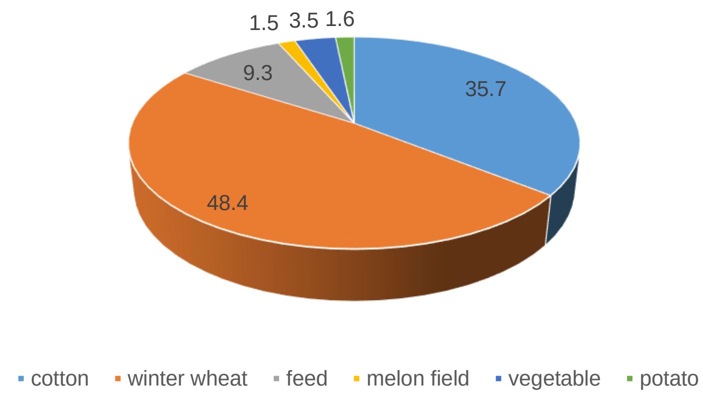
Use of the land resources. The land resources of the province constitute 2,856.8 thousand ha, including 457.6 thousand ha of irrigated land. The structure of irrigated lands is shown in Figure 68.

FIGURE 68. Irrigated land structure (%).



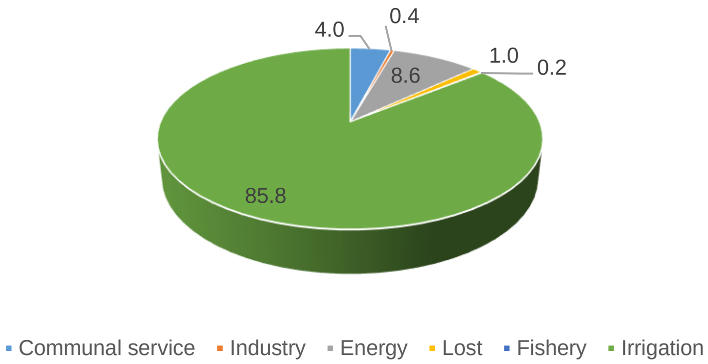
Over the past 5 years, the area under cotton decreased by 2,7 thousand ha, while the areas under winter wheat increased by 10,3 thousand ha, vegetables by 1,3 ha and potatoes by 1,0 thousand ha due to the diversification of agriculture in the province. Crop pattern in %age including household backyards for 2014 is shown in Figure 69.

FIGURE 69. Crop pattern including household backyards, %



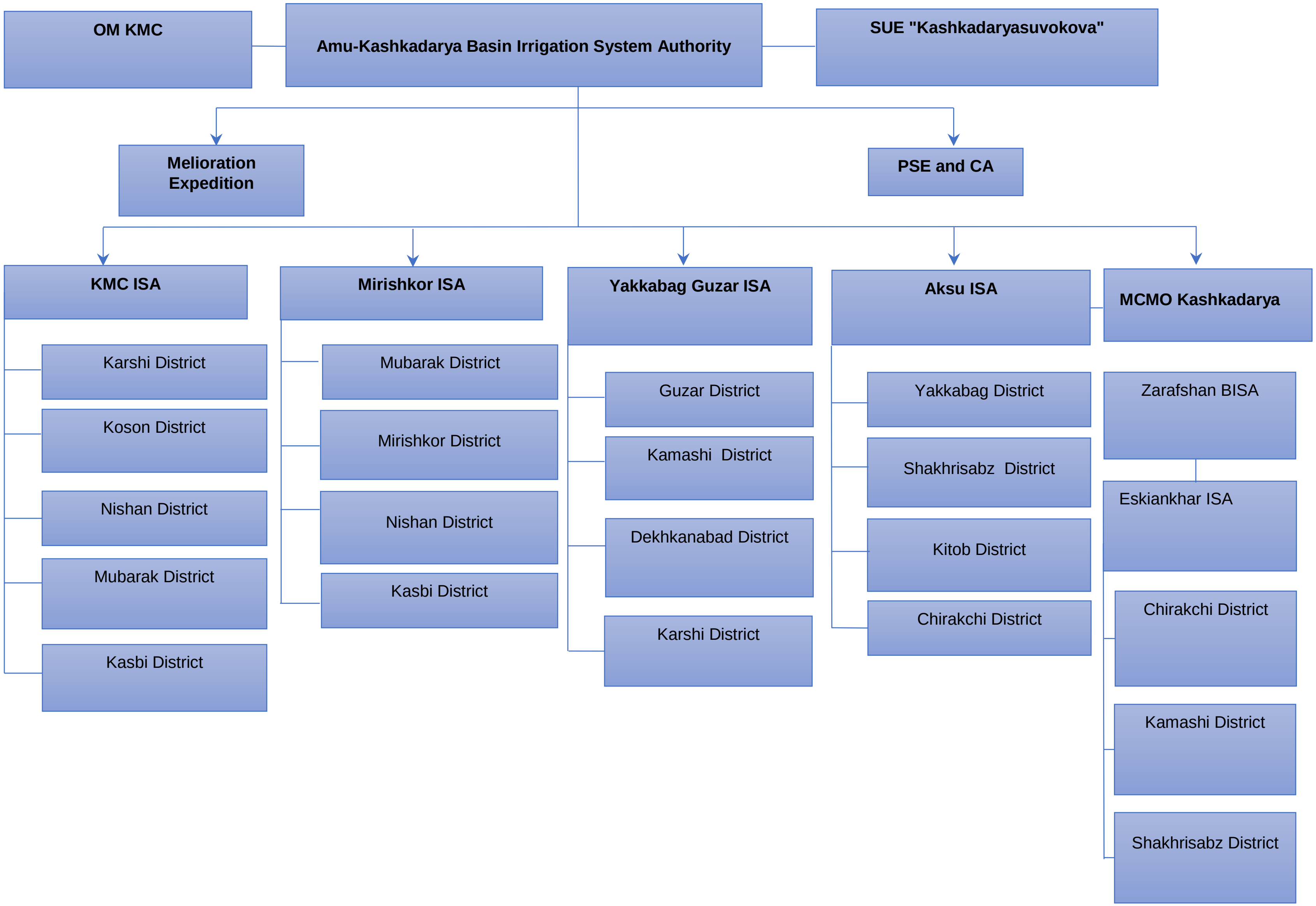
Organization of water management. The Karshi Main Canal Management Organization is under the Republican Association "Uzsuvtamirfoydalanish". In the province, water delivery to WCAs is implemented by four ISAs of the "Amu-Kashkadarya" BISA and “Eskianhar” ISA of the "Zarafshan" BISA from another province.

FIGURE 70. Water use by industry (%).



The organizational structure of water management in the Kashkadarya province is shown in Figure 71.

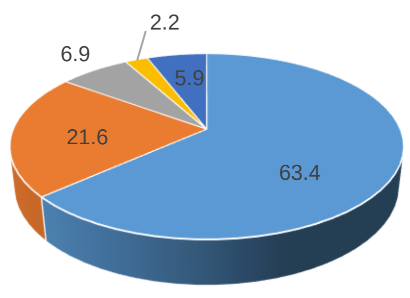
FIGURE 71. Institutional water management structure of Kashkadarya Province.



Water use. Some 85,8% of water in the province is used for irrigation. Other water consumers are energy production utilizing 8.6%, utilities using 4%, industry using 0.4% and fisheries using 0.2% (Figure 70). The organizational structure of the province water management is given in the Figure 71.

Specific water supply on the WCA borders is 7.37-8.10 m^3/ha during the growing season and 2.32-3.36 m^3/ha during nongrowing season. Utilization of water is 0.90-0.94 during the growing season and 0.93 during the nongrowing season. Of the total water intake, 63.4% is taken from the Amudarya River, 21.6% from Kashkadarya, 6.9% from Zarafshan, 5.9% from CDS and 2.2% from groundwater (Figure 72).

FIGURE 72. Water intake structure (%).



Some 14-19% of the total water diverted from sources is lost along the main canals; 10-11% of the total water delivered to the district borders is lost within distribution canals.

Water productivity is 566 UZS/m^3, i.e. 1 m^3 of water diverted from sources produces an agricultural commodity return of 566 UZS.

2.5.6 Findings of the Assessment of the Kashkadarya Province River Basins

Irrigated agriculture is the main economic activity in the Kashkadarya Province. The irrigated areas equal 457.6 thousand ha or 16% from the total area. Most of the area is located under Karshi Main Canal (KMC) and Eskiankhar ISAs, occupying around 60% of the area of the province. There are 152 Water Consumers' Associations with the average area of 3,391 ha. Main sources of irrigation water are Aksuv, Djinnidarya, Kashkadarya, Tanhozdarya, Guzardarya and Yakkabagdarya. Uneven distribution of water resources in Kashkadarya, uncertainty of the river water regime and river dryness require the use of additional water sources in the region (Table 15). The river system of the Kashkadarya Oasis can meet only 20% of the needs. One of the sources of water supply to the region is the Karshi Main Canal and its regional distribution system, which is important for the further development of agriculture. Almost 80% of the required water is delivered and adjusted from outside the province through the Eskiankhar main canal fed by the Zarafshan River and through the Karshi Main Canal fed by the Amudarya River, in particular.

The Karshi Main Canal provides water to Tallimarzhan Reservoir through the system of the seven pumping stations, lifting water from the Amudarya River. The Karshi canal originates on the territory of the Republic of Turkmenistan, and its operating facilities are located on the Talimarzhan Reservoir. The canal provides water to the Karshi, Kasby, Nishan and Koson districts of the Kashkadarya Province. Therefore, there is a high cost of irrigation water. In the Kashkadarya Province, the runoff of small rivers is also regulated by reservoirs. So, no significant problems with water availability are observed in the province. All on-farm open and closed horizontal drainages are, in general, in good condition, so that the groundwater level does not change significantly. In some areas, the bottom of the reservoir and GWL raise due to over irrigation, infiltration, and erosion of slopes. High GWL combined with poor drainage leads to excessive waterlogging of the root zone, deterioration of physical and chemical properties and secondary salinization of irrigated lands. The main problems include the lack of precipitation in July-September, high summer temperatures and intensive evaporation. These factors do not allow cultivating water-demanding crops without artificial irrigation. Inefficient use of water resources in the region leads to water waste. According to the ISA KMC the following factors lead to irrational water use: on-farm and interfarm canals do not meet hydraulic requirements, agricultural land is not leveled, and there is a lack of qualified hydro-technical staff.

The local BISA representatives suggested to choose KMC, which is generated from the pumping water from the Amudarya as the pilot basin. The project representatives explained that there is a criterion in selection of the pilot river basins. Based on the criteria described in the Annex 1, the Karshi Main Canal does not meet the criteria. There are around seven small rivers generated in the territory of the province. More investigation is required to select the small river in the Kashkadarya Province. The potential small rivers that can be selected are the Akdarya, Tanhazdarya and Guzardarya rivers.

TABLE 15. List of current issues and problems in small rivers and sais of Kashkadarya Province.

Name	Identified problems	Negative consequences and risks	Causes	Activities
Akdarya (tributary of Kashkadarya)	• Deeping (Is this deepening) of river bed • Water losses • Stream-bank erosion and deposits of river sediment	• Decrease of water levels in the river • Difficulties in the work of water intake facilities and irrigation networks • Low water availability in dry period • Emergencies on roads and railways as well as gas and water networks.	• Nonstandardized development of sand and gravel pits • Decreased groundwater level during dry years • Lack of funds for repair and protection works	Industry
Katta-Uradarya	• Lack of accurate accounting of water intake from the river for agricultural and other needs • Lack of irrigation water during growing season	• Lack of irrigation water • Decreased water flow to Pachkamar Reservoir • Reduced crop yields resulted in cancellation of state order for grain crops	• Lack of funds for protection works, irrigation works and lack of specialists for the operation • Natural climatic conditions of the region	Agriculture (irrigation cropping) Emergency situations
Kichik Uradarya	• Lack of accurate accounting of water intake from the river for agricultural and other needs • Low water supply of district center-Karashin • Lack of irrigation water during the growing season (April and May)	• Lack of irrigation water • Decreased water flow to Pachkamar Reservoir • Impossibility of improvement works in Karashin Village • Reduced yields of agricultural crops • Cancellation of state order for grain crops	• Lack of funds for protection works, irrigation works and lack of specialists for the operation • Lack of required number of irrigation facilities • Natural and climatic conditions of the region • Change in water content of the river	Agriculture (irrigation cropping) Water Infrastructure maintenance
Tanhazdarya	• Mudflows • Deepening of the river bed • Density of population • Lack of irrigation water in summer	• Erosion and overflow of Kattagan and Chakar waterworks (2012) • Decrease of water levels in the river • Difficulties in the work of water intake facilities and irrigation networks • Low crop yields	• Natural and climatic conditions of the region • Non-standardized development of sand and gravel pits • Lack of river recharge during summer due to glaciers melting	Emergency situations Industry Agriculture (irrigation cropping)
Kashkadarya	• Deepening of the river bed • Lack of irrigation water in summer • Erosion of supply beds of pumping stations and intake irrigation canal dams	• Decrease of water levels in the river • Difficulties in the work of water intake facilities and irrigation networks • Low crop yields • Difficulty in providing irrigation water • Water control	• Nonstandardized development of sand and gravel pits • Lack of river recharge during summer due to melting of glaciers • Lack of funds for protection works, irrigation works and lack of specialists for the operation	Industry Agriculture (irrigation cropping) Water infrastructure
Yakkabagd arya	• Lack of irrigation water in summer • Water shortage above Yakkabag hydro system	• Low crop yields	• Lack of river recharge during summer due to melting of glaciers • Natural and climatic conditions of the region	Agriculture (irrigation cropping)

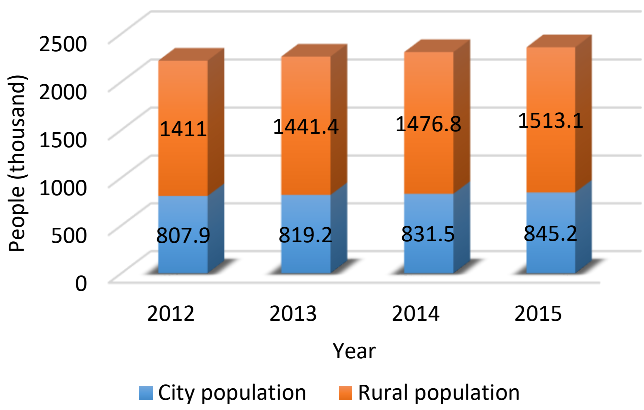
2.6. Surkhandarya Province

General information. The Surkhandarya Province lies in the latitudes 37.1392 to 39.1159 and longitudes 66.5131 to 68.4436, and occupies the area of 20,100 km^2. The province is located in the far southeast of the country, bordered with the Kashkadarya Province, and Turkmenistan, Afghanistan and Tajikistan. Climate is arid, continental. The southern part of the province is a semidesert ecoregion. There are 14 districts in the province: Altinsai, Angor, Boysun, Denov, Jarkurgan, Kizirik, Kumkirgan, Muzrabat, Sariosiyo, Sherabat, Shurchi, Termez and Uzun, Only 13 are mentioned. Termez city is the administrative center of the province. The population of the province is 2,358.3 and density is 117.3 inhabitants per square kilometer. The population increased from 2,175.1 to 2,358.3 thousand during 2011 and 2015 (Figure 73). The districts with highest population density are Devon, Altinsai, Angor and Kizirik (Figure 74).

It is noticeable that the population density is relatively higher in the irrigated than in the nonirrigated areas.

The average age of population in the province is 26.5 years. Proportion of male and female citizens is almost similar with a slight excess of males. In 2015, more than half (i.e.,) 63% of the population lived in rural areas (Figure 73).

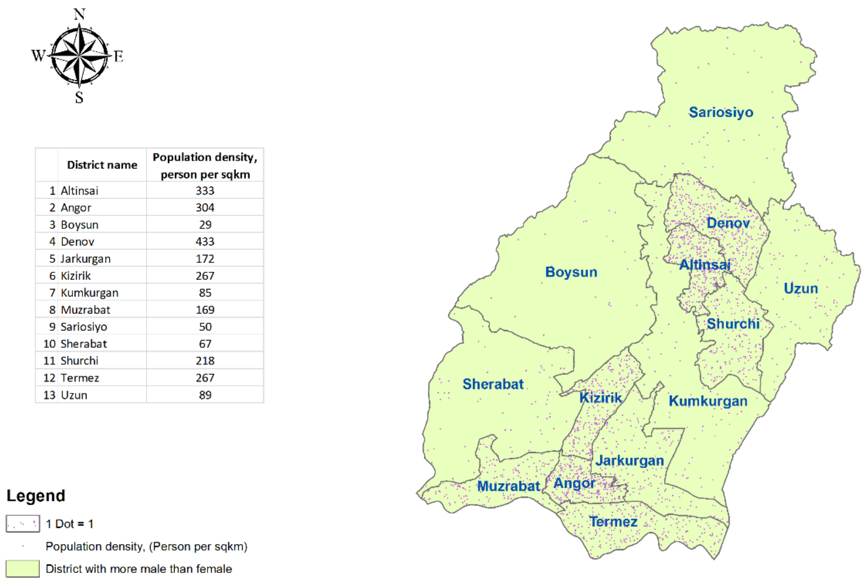
FIGURE 73. Dynamics of urban and rural population



Source: The State Committee of the Republic of Uzbekistan on statistics, 2015.

FIGURE 74. Population density and gender by district in the Surkhandarya Province

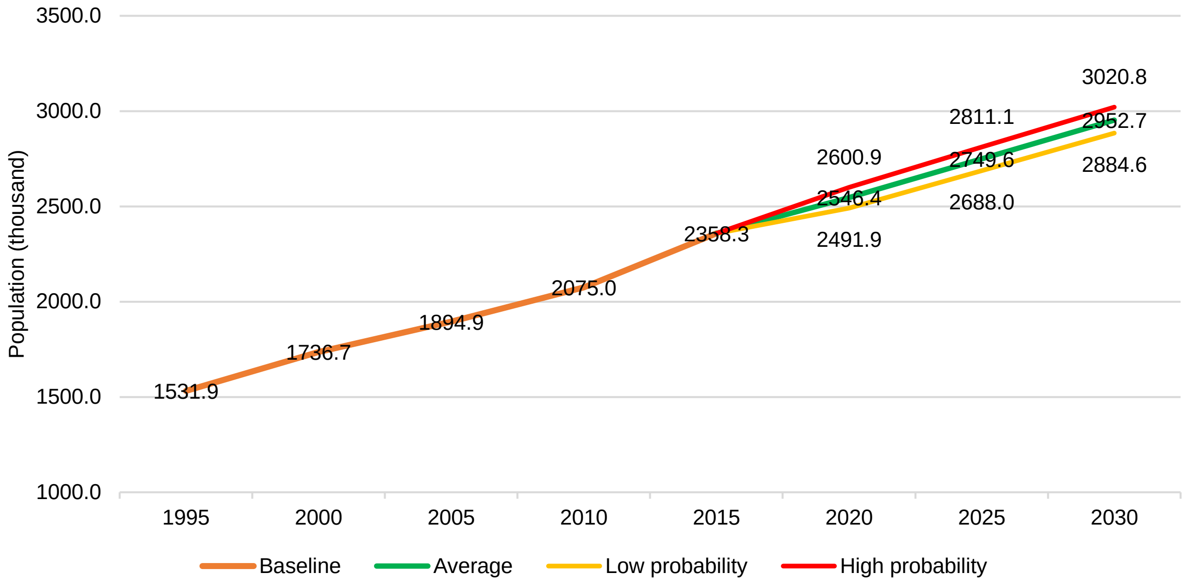
	District name	Population density, person per sqkm
1	Altinsai	333
2	Angor	304
3	Boysun	29
4	Denov	433
5	Jarkurgan	172
6	Kizirik	267
7	Kumkurgan	85
8	Muzrabat	169
9	Sariosiyo	50
10	Sherabat	67
11	Shurchi	218
12	Termez	267
13	Uzun	89



Irrigated agriculture is the main economic activity in the Surkhandarya Province. The irrigated area is 270.4 thousand ha or 14% of the total area. The irrigated areas have not changed significantly during the period of 2012 and 2015.

Main sources of irrigation water are the Amudarya, Sungardak, Surkhandarya, Sherabad and Tupalang rivers. The province is located in the Amu-Surkhandarya BISA and consists of the three ISAs: Tupalang-Karatag ISA, Amuzang ISA and Surkhan-Sherabad ISA. Most of the area is located in the Amuzang ISA and constitute 44% of the total area. There are 149 WCAs with an average area of 2,188 ha.

FIGURE 75. Forecast of population growth in the Surkhandarya Province for 1995-2030.



The forecast (Figure 75) of the population growth was developed to determine the tendency of population growth in the period of 1995-2030. The forecast shows that the Surkhandarya Region will face a steady population growth, which will put pressure on irrigation water use to meet the demand, based on past and current tendencies. The population growth is projected to increase by 593,8 thousand for the period between 2015 and 2030. Around 64% of the population live in rural areas and agricultural activities are considered the main source of livelihoods of the local population.

2.6.1 Climatic and Meteorological Conditions

Surkhandarya is characterized by sharply continental, arid climate, expressed by wide fluctuation amplitudes of annual, seasonal and daily temperature, as well as large dryness with moisture contrasts within the seasons.

The majority of annual precipitation volume falls in spring and winter, while autumn and summer are distinguished by an almost complete lack of precipitation, very low humidity and high evaporation. By soil and climatic conditions, the irrigated areas of the Surkhandarya Province can be divided into two distinct zones:

I. Belt of sierozems - foothills and piedmont plain zone. Situated at an altitude of 450-1,000 m above sea level. The average long-term air temperature is 15.6 -15.8°C; temperature during the growing season varies between 23.2-23.6 °C. Maximum temperature reaches 46 °C; minimum is 23 °C. The total effective temperature is 2,506-2,387 °C, frost-free period is 239-240 days. Rainfall during the growing period is 60-75 mm; annual rainfall is 178-233 mm. Relative humidity in the growing season varies between 46 and 58% and evaporation reaches 1,070-1,100 mm (Table 16).

TABLE 16. Main climate indicators of Surkhandarya Province (long-term annual average data).

Weather station	Average annual air temperature°C	Period: months IV-IX					Period: months III-X		Total effective temperatures, °C	Frost-free period, days
		Air temperature °C	Relative humidity,%	Precipitation, mm	Evaporation, mm	Moisture deficit, mm	Precipitation, mm	Evaporation, mm		
Sierozems belt										
Denau	15.6	25.2	48	75	1,070	1,000	233	354	2,506	239
Shurchi	15.8	23.6	48	60	1,100	1,040	178	325	2,387	240
Desert zone										
Sherabad	18.1	26.7	30	40	1,680	1,640	129	491	3,056	272
Termez	16.2	25.5	40	30	1,350	1,320	97	337	2,703	246

Source: Uzbek Academy of Agricultural Sciences, 1992.

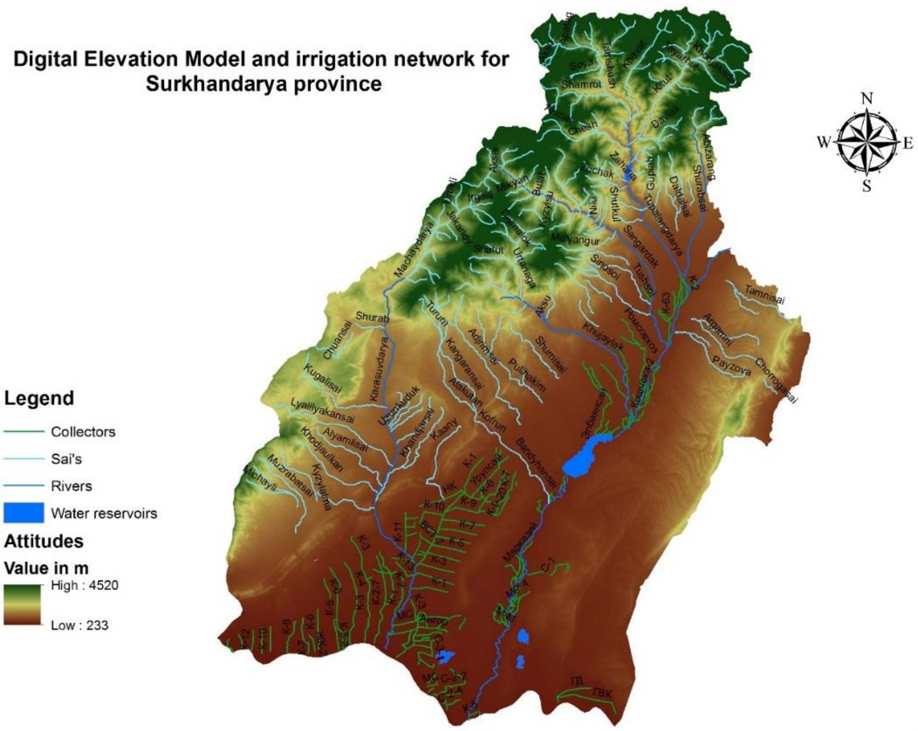
II. Desert zone - Desert lowland plains. One of the hottest zones of the province and the country. The average annual temperature ranges from + 16.2 °C in Termez to + 18.1 °C in Sherabad, and in some years reaches 19.1 °C. Growing season temperature in this zone varies between 25.5 and 26.7 °C. The average temperature of summer months is 29-32 °C; the average daytime temperature is 36-38 °C; the absolute maximum is 46.5-50 °C and the minimum is 20 °C. The period with air drought is 45-50 days per year on average. The sum of effective temperatures is 2,703-3,056 °C. The frost-free period is 246-272 days. Precipitation is 127-169 mm, and during the growing season it is 30-40 mm (Table 16).

In some months, relative humidity reaches 18-20%; and during the growing season 30-40%. The average period favorable for fieldworks is 305 days. Dry air and intense solar radiation cause strong evaporation. Evaporation from water surface (according to Ivanov) is 20 times the amount of precipitation. There are 35-37 days with strong, hot and dry winds (Afghan, garmsil) per year. Southwest wind manifests itself in the form of dust mist formed by uplift loess-like dust. Such phenomena are sometimes continued for a long time, increasing air dryness and causing a need for high water application to increase soil moisture.

2.6.2 Topographic Map of the Surkhandarya Province

Territory of the province is a vast intermountain plain called the Sherabad-Surhandarya Depression, elongated from north to south for 200 kilometers and surrounded on three sides by mountain ranges with some peaks up to 4,500 m.

FIGURE 76. Digital Elevation Model and irrigation network of the Surkhandarya Province.



Geological profile is composed of a thick (50-300 m) layer of quaternary deposits of loess loam, sandy loam, gravel and sand. Four floodplain terraces with a continuous gradient of 0.0015-0.0025 can be traced on both banks of the Surkhandarya River (Figure 76).

In the central part of the plain, from south to north, Haudag, Kokaido and Uchkyzyl heights are located along with dune sands of the Kattakum Desert that the separate narrow valley of the Surkhandarya River from the Sherabad Steppe (Sadykov, 1975).

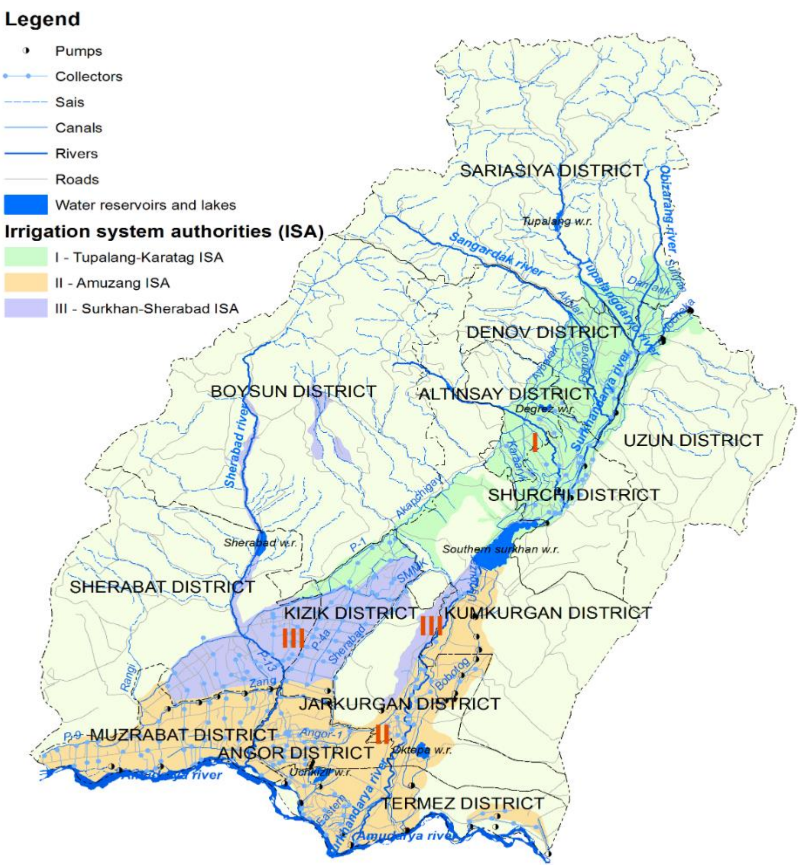
The northern part has a well-defined erosion-accumulative relief forms: flat alluvial cones of the Surkhandarya tributaries (Tupolang, Sangardak, Hodzhaipak, etc.) with marks of 630-430 and are composed of gravel-pebble material with a thickness of more than 300 m, covered with a little fine-grained sediment layer. There is a hilly piedmont plain made of loess-like loams on both sides of the merged alluvial cones.

The southern part of the depression is occupied by the alluvial cone of the Sherabad River that borders the Kyzyrykdara Steppe on the northeast, foothills on the west, and the Amudarya River terrace on the south. The topography of this part has a width of 40-80 km.

2.6.3 Irrigation Networks

Irrigation networks of the Surkhandarya Province are fed by both surface water and groundwater sources. Surface waters are divided into glacier-fed rivers, *karasu* (streams that feed mainly from groundwater), a water reservoir and irrigation network.

FIGURE 77. Map of the Amu-Surkhan BISA command area.

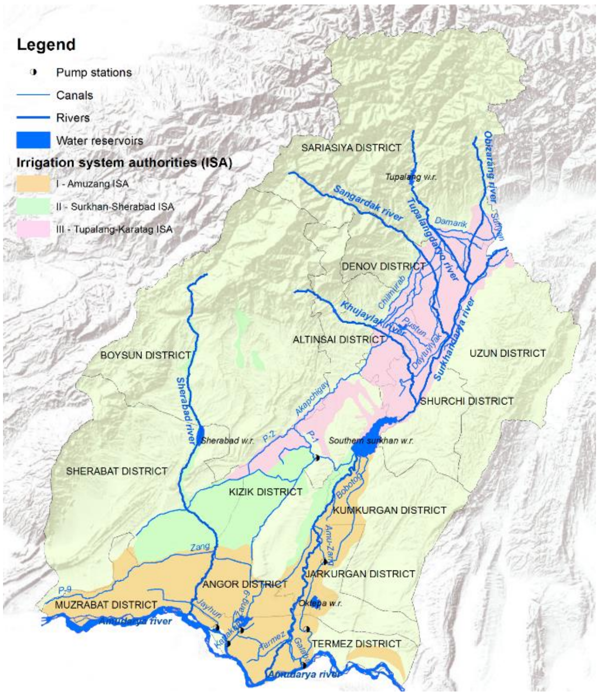


A characteristic feature of many rivers in the province is the minimum and more or less fixed runoff in October and February. The waterflow rises from March to a reaching a maximum in May, and a rapid decline from June. Such a large dispersion of runoff does not meet the requirements of the effective cultivation of most crops.

The irrigated area is 325.7 thousand ha, of which 208.5 thousand ha receive water through pumping by 110 pumping stations. A map of the Amu-Surkhandarya BISA command area is shown in Figure 77.

The main water source is the Surkhandarya River that is 200 km long and is formed by the confluence of the basin's largest rivers Karatag and Tupalang. The annual total flow is 20 and 46% of the total runoff of the Surkhandarya River. Their catchment areas, located on the southern slopes of the Gissar Ridge, are 634 to 2,200 km^2. On the right side, the Surkhandarya River receives two tributaries with constant inflow: Sangardak and Hodzhaipak, with catchment areas of 901 and 762 km^2, respectively. Tributaries are fed by snow and glacier. After leaving the mountains, they are used for irrigation, and runoff reaches the main river only during floods. The Surkhandarya River is also partially replenished with discharge collector water, small *sais* and thinning in the river and its tributaries (Figure 78).

FIGURE 78. Irrigation system of the Surkhandarya Province.



Another source of irrigation in the province is the Sherabad River. The river is 177 km long, and its basin is located on the west, in the spurs of the Gissar Ridge (Table 17). The river is snow-fed with a catchment area of approximately 2,950 km^2. In the upper reaches it is called Magiandarya, in the middle reaches Sherabad, and in the lower reaches, Karasu. After leaving the valley, its flow is completely used for irrigation, and the karasu acts as a drain. Spring water and water from 73 irrigation wells and collectors are also used for irrigation.

Projected operating reserves of fresh groundwater are 3,373.75 m^3/day, or 39.05 m^3/s. Groundwater is mainly used for household and industrial water supply. During the year, the water intake plan does not match the volume of water taken from the sources. The largest water flow falls in March-June. In this period, the volume of water is 61% of the annual total: 22% in July-September, and 17% in October-February, respectively.

TABLE 17. Key indicators of the Surkhandarya Province rivers.

Region	River	River source	River characteristics	Irrigation System Authority (ISA)	Districts crosses	Irrigated zone, ha	Transboundary river yes/no
Surkhandarya province	Surkhandarya	Formed by the confluence of the rivers Tupalangdarya and Karatag flowing from the southern slope of the Gissar Range	Length is 175 km, basin area is 13 500 km^2	Tupalang-Karatag ISA	Kumkurgan District	111, 660	No
	Sherabad	Originates from the Baysuntau Ridge, is fed by snow and rain	Length is 177 km, basin area is 2,950 km²	Amuzang ISA and Surkhan-Sherabad ISA	Karasu, Derbent, Dara, Sisanga, Hodzhabulgan, Munchak, Sherabad districts	1,899	No
	Sangardak	Formed by seasonal glaciers and groundwater	Length is 114 km, basin area is 889 thousand km²	Tupalang-Karatag ISA,	Sarasia,Denov	3,221	No
	Tupalang	Formed by seasonal glaciers	Length is 112 km, basin area is 2,200 km^2	Tupalang-Karatag ISA	Denov, Shurchi and Kumkurghon districts	73,326	No

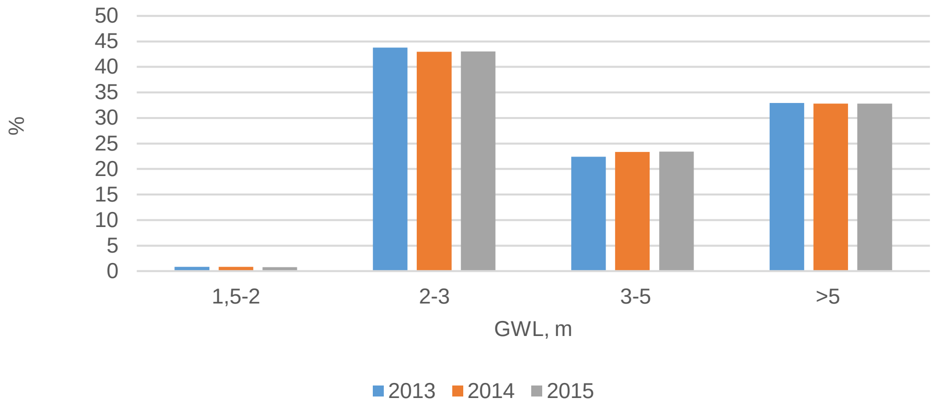
Source: Akromov 2008 and Authors’ survey.

2.6.4 Reclamation State of Irrigated Lands

In general, the ameliorative conditions of the irrigated lands of the area are considered satisfactory. Groundwater level is regulated by surface drainage network. A vertical pump drainage is operated in the Sherabad district only.

The annual drainage discharge is 864,86 - 907,84 million m^3, and the specific drainage is 2,6-2,8 m^3/ha. From the total CDW discharge on the area of 82,0% in the Surkhandarya and Sherabad (Karasu), 8,0% is used for irrigation.

FIGURE 79. Distribution of the areas with average GWL during crop growth season in the Surkhandarya Province.



No significant changes in the dynamics of groundwater level and salinity have been observed in the last years. The areas with GWL of 2-3 m and >5 m constitute 43 and 33%, respectively (Figures 79 and 80). Distribution of the irrigated areas in the Surkhandarya Region by soil salinization is shown in Figure 81.

FIGURE 80. Distribution of the areas with GWM on average for the crop growth period in the Surkhandarya Province.

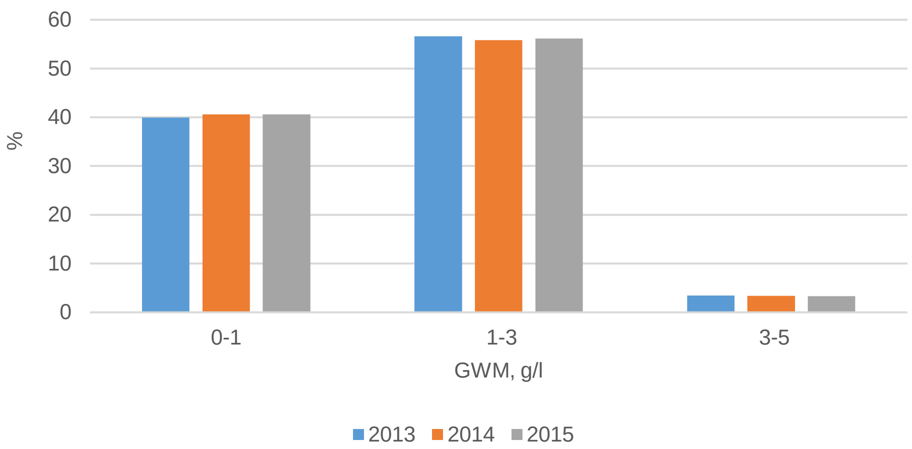
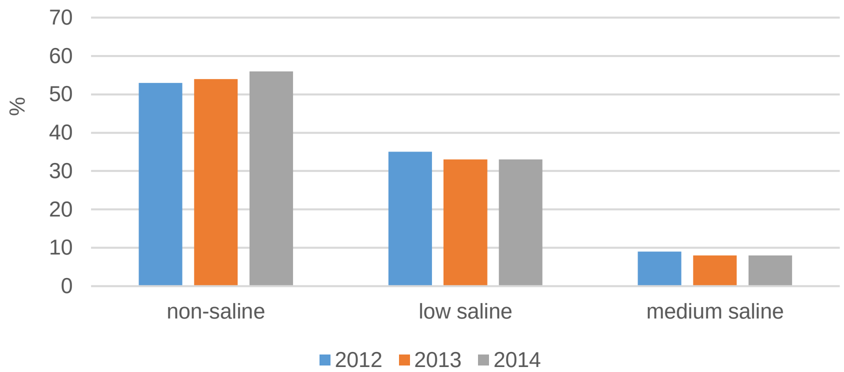


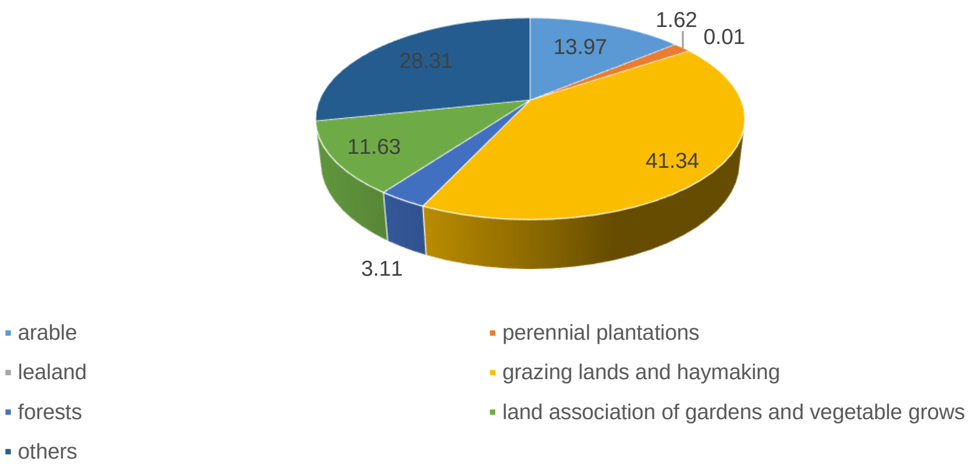
FIGURE 81. Distribution of the irrigated areas in the Surkhandarya Region by soil salinization.



2.6.5 Water and Land Resources Use

Use of the land resources. There are 2,009.9 ha of the total land resources in the province, including 325.7 thousand ha of irrigated areas. The land use structure is shown in Figure 82.

FIGURE 82. Structure of the land resources (%).

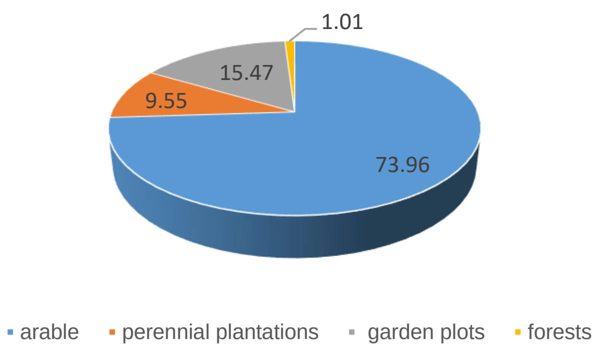


Cotton production is a prevailing economic activity, the effectiveness of which has decreased significantly in recent years, mainly because of irrational use. With the continuous increase of costs for labor and resources, yields have been decreasing in many farms of the province.

Currently, the grain crops grown in Surkhandarya Province are wheat, barley, rice, millet, corn, white durra and legumes. Most of them are located on dryland. Due to adverse climatic conditions (low rainfall, frequent droughts) grain yield is relatively low. Inefficient agro-technologies also do not provide for high yields. Until now, the agricultural production system on nonirrigated areas has not been well developed. In this regard, the total grain production in food and fodder balance of the province is minor. The structure of irrigated lands is shown in Figure 83.

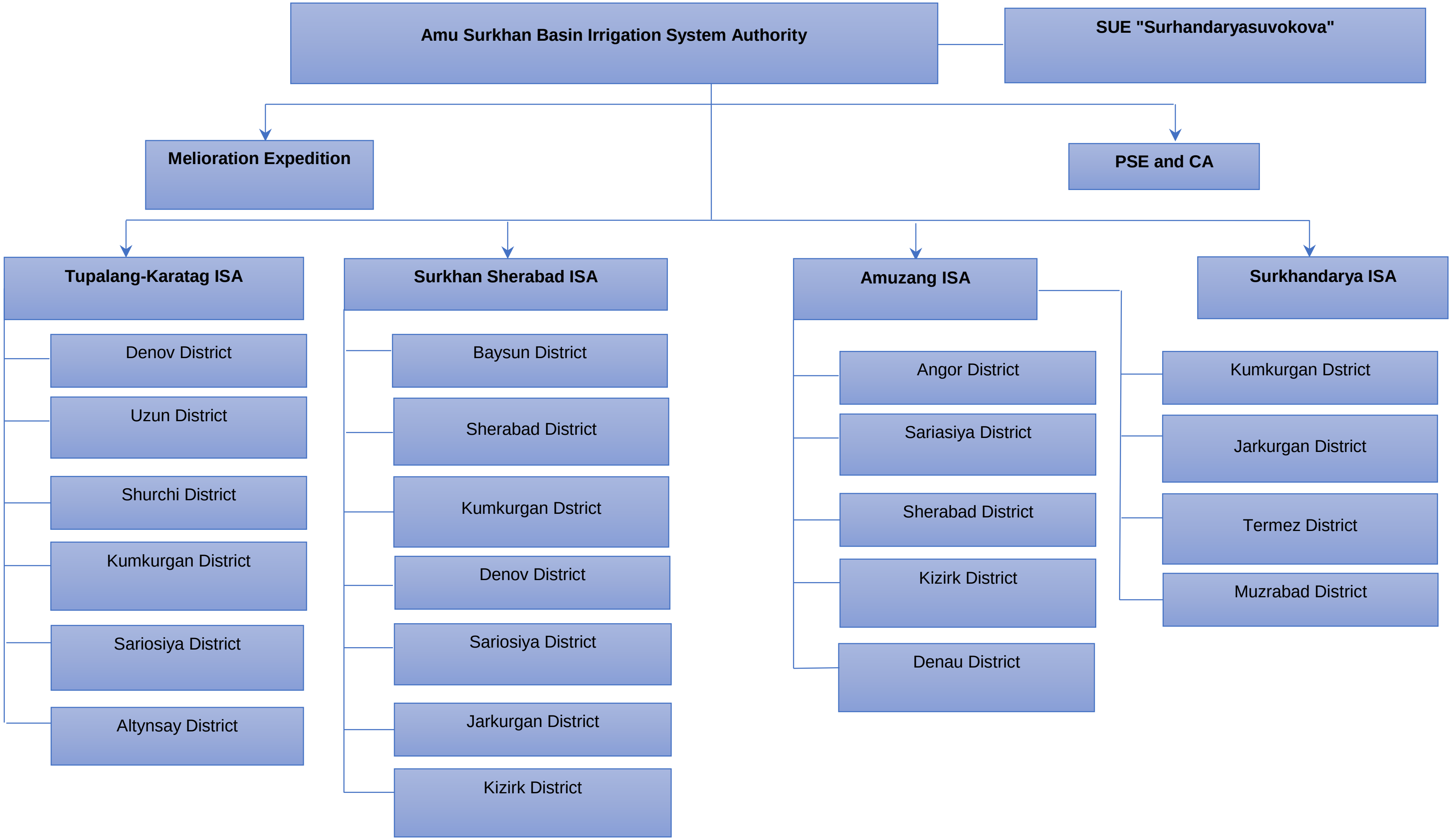
Over the last 5 years, the diversification of agriculture has led to increased area under winter wheat by 5.0 thousand ha and orchards by 1.3 thousand ha.

FIGURE 83. Irrigated land structure. (%).



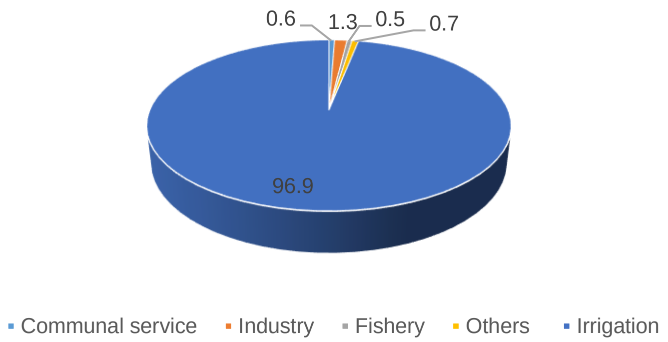
Organization of water use. Organizational structure of water management in the province is provided in Figure 84. The "Surhandaryasuvokova" SUE provides the population with water for drinking and household needs. Water intake for this purpose is carried out from both groundwater and surface sources. Direct water use is organized by 149 WCAs. WACs of the province carry out water intake on 3,840 water distribution points. Fifty-eight % of ISA water distribution points are equipped with water control structures, 61% of which have hydroposts. WCAs carry out water distribution on 6,354 water distribution points; 46% are equipped with water-control structures, 37% with hydroposts. In such circumstances, it is difficult to adjust the water distribution between water users quickly and to keep records of water supply; there are many organizational water losses.

FIGURE 84. Institutional water management structure of the Surkhandarya Province.



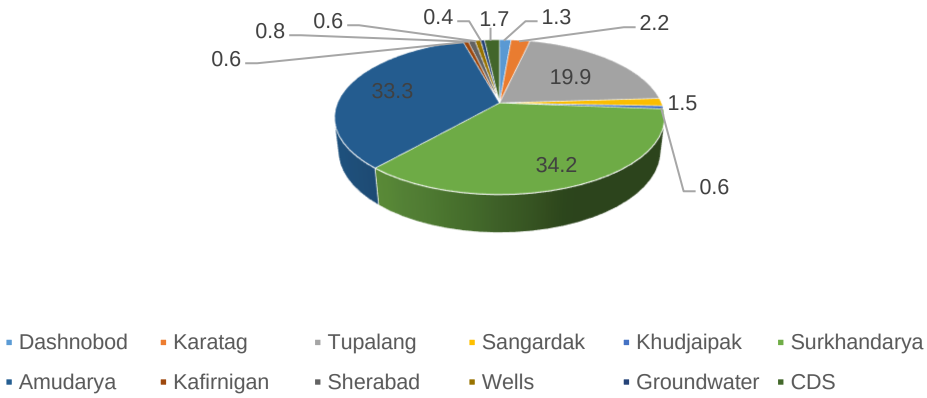
Water use. 96.9% of water in the province is used for irrigation . Water use by sectors is given in Figure 85

FIGURE 85. Water use by sectors (%).



Specific water supply to WCA boundary during the growing season is 10.1 thousand m³/ha and during nongrowing season 3.2 thousand m³/ha. Of the total water intake, 34.2% is taken from Surkhandarya and 33.3% from Amudarya (Figure 86).

FIGURE 86. Water intake structure (%).



From the water diverted from sources, 9% is lost within the main canal beds; and of the water delivered to the district border, 7% is lost in the distribution canals. In general, the delivery losses from the river to the WCA boundaries during the growing season are 14%, in the nongrowing season, 18% relative to the volume of water diverted from the source. Water productivity is 791.4 UZS/m³, i.e. 1 m³ of water diverted from sources produces an agricultural commodity return of 791.4 UZS.

2.6.6 Findings of the Assessment of the Surkhandarya Province River Basins

The small rivers in the province are also regulated. In addition, during the dry periods, the Surkhandarya Basin is fed from the Amudarya River and therefore, there are no problems with water availability in the province.

The main problem of improving of land and water use is a catastrophic shortage of surface water reserves in water-shortage periods. The disparity between limited water resources and the need to expand the irrigated areas has currently restrained the growth of agricultural production, which for a sufficiently steady and significant increase in the population, is a pressing social problem. The province has a considerable reserve of virgin land suitable for economic development. However, local water resources are insufficient for their development for irrigated agriculture.

Nevertheless, the most acute problem of land and water use in the province is an impact of reclamation on the environment. In some cases, land reclamation affects the natural processes clearly negatively: these are increased salinity of river water, reduced freshwater runoff into water bodies, water contamination with fertilizers and herbicides, processes of increasing salinization and waterlogging. Thus, in today's farming the major irrigation task is focused not only in providing water to all suitable areas, but also to ensure a balanced use of water. Another major problem is the pollution of the water resources in the rivers. Local stakeholders mainly pointed out the pollutions generated from the riparian parts of the country (Table 18).

During the discussion with the local stakeholders, the criteria for selection of pilot river basins have been explained. The BISA representatives have proposed to choose the Surkhan-Sherabad Irrigation System Authority, in particular the “Sherabad” River Basin. However, the Sherabad River itself is complex and feeds different canals within the BISA authority. Based on discussion, it was difficult to refer the river, based on the criteria given in Annex 1.

TABLE 18. List of current issues and problems in small rivers and sais of Surkhandarya Province.

Name	Identified problems	Negative consequences and risks	Causes	Activities
Surhandarya	• Atmospheric pollution in Sariosiya and Denau districts of Surkhandarya Province. • The most polluted tributary of Amudarya River is Surkhandarya	• In Sariosiya District walnut groves, orchards and vineyards died. • Population of village council relocated to other districts	• Emissions of the Tajik aluminum plant	In Sariosiya District walnut groves, orchards and vineyards died.
Sherabad	• The river contains a high concentration of salts. There are water shortages in spring and summer (April and July)	• Increased land salinity resulted in decreased yields. • Deteriorated livelihoods.	• Climate change • Irrational use of water resources	Agriculture
Amudarya	• The deterioration of water quality in the river. Discharge of industrial and household wastewater in the upstream countries (Tajikistan and Turkmenistan). The negative impact on flora and fauna	• Reduced yields resulting in land degradation as well as migration. Reduced number of fish in the river	• Amudarya water pollution begins with the Vakhsh nitrogen fertilizer plant in Tajikistan. Mineralization and hardness gradually increase	Agriculture and fisheries
Sangardak	• Lack of water in spring and summer (April and July).	• Reduced yields resulted in deteriorated livelihoods	• Climate change • Irrational use of water resources	Agriculture
Tupalang	• There is animal scarcity in the region due to limited availability of water. Decrease in the number of fish in the river and sewage discharge.	• Extinction of several rare species of fish. • Reduced yields resulted in migration.	• Water pollution	Agriculture and fisheries

Conclusions

1. Agriculture is the main freshwater consumer. Agricultural water consumption by province ranges from 85.8% in the Kashakadarya province to 96.9% in the Surkhandarya province. Consequently, huge water losses take place in the irrigated agriculture. The household sector consumes about 5% of water, and industry less than 2%. It should be noted that most of the industrial sectors use water from the vertical pump wells. The population growth will lead to increased water demand in the domestic sector as well as in irrigation. The growing demand for water will be efficiently met through reduction of water consumption in agriculture by reducing unproductive water losses in irrigation networks and introduction of water-saving irrigation technologies.
2. According to the reports of operating organizations in the pilot regions, total delivery losses from the river to the WCA borders range from 14% (Surkhandarya Province) to 30% (Andijan Province) of total diverted water.
3. Flows of the main rivers Naryn, Karadarya, Syrdarya, Kashkadarya, Surkhandarya and Amudarya are regulated to manage water depending on the water needs of agriculture during the growing season.
4. The unstable and insufficient water supply of small river basins in the Kashkadarya, Namangan and Surkhandarya provinces is regulated by small reservoirs.
5. Main irrigation networks in the Fergana Valley have mixed sources and to provide an even water availability during spring, summer and growing seasons in general, these systems are connected to each other.
6. In March and April, the winter wheat demand for water is growing. During this period, there is a problem with water availability in small river basins in the Andijan, Namangan and Fergana provinces.
7. It should be noted that the majority of the small rivers in all pilot regions are transboundary character. Consequently, all related problems of the basin are transboundary as well.
8. Some 6,500-7,000 million m^3 of good and satisfactory quality CDW are formed annually in the Fergana Valley provinces. For comparison, the mineralization of irrigation water in the Syrdarya Province is twice higher than the CDW in the Fergana Valley. It is advisable to use this water in places of formation.
9. WCAs are directly responsible for the organization of water use. However, for various reasons (institutional, financial, legal and technical) WCAs are currently unable to perform these tasks. One of the main WCA tasks is the maintenance of IDNs, land reclamation equipment and other hydraulic structures. Currently, WCAs only perform water delivery to farmers. Due to the lack of funds, maintenance works on irrigation and drainage infrastructure are not done. This has a negative impact on the performance and, as a consequence, on the water supply and land reclamation of irrigated areas.
10. In order to demonstrate the IWRM principles - accounting for all types of water resources and the interests of different sectors and levels of water management hierarchy, as well as the involvement of all stakeholders (agriculture, public utilities, environment, industry, energy, etc.) in decision-making should be achieved, it is recommended to select river basins in accordance with the project criteria.
11. Government has introduced the IWRM principles at the large basin levels with Decree № 320, 2003, which was mainly implemented on the level of ISA.
12. Each BISA has established Water Council by Decree No 320. Among the main objectives of Water Council is making recommendations on water intake limits to irrigation system administrations, as well as other water users and consumers of the particular province (Republic of Karakalpakstan) or interdistrict water bodies by source, territory and economy sector. The Water Council mainly consists of representatives of water management organizations.
13. It is appropriate to include into the Council not only the agricultural water users, but also the representatives of other water users: industry, utilities, ecology and other stakeholders from the point of public participation in the water governance. It would also be good if the Council Chairman were elected among the representatives of water users.
14. It is worth mentioning that drinking water is provided mainly to the population in each province by the “Suvokova” SUE, and not by BISAs.
15. Due to the diversification of agricultural production over the past 5 years, the area under cotton and wheat decreased in each selected region.

Representatives of each province provided information on the potential pilot basins in their respective provinces. However, the IWMI Team pointed out that the selected pilot canals or rivers will be defined after diagnostic analysis and only after consultation with National Working Group and Project Management Group.

During the consultation with each BISA, there have been provided following proposals:

1. Andijan Province

The Naryn-Karadarya BISA suggested to select the Shakhrikhon River as a pilot river basin for the introduction of the river basin Water Management Plan. The Shakhrikhansai River Basin fully coincides with the basin selection criteria given in Annex 1. River originates in the territory of Uzbekistan and is not transboundary. Hence, the Shakhrikhansai River has been selected as a representative river in the region.

2. Fergana Province

The Syrdarya-Sukh BISA initially suggested to select the Big Andijan Canal as a pilot basin planning area. This canal flows through all three provinces of the Fergana Valley and therefore, the BISA representative pointed out that it will involve all provinces in Fergana Valley. However, the criteria are that the selection should be a river basin originating on the territory of Uzbekistan (Annex 1) and not a canal, Hence, it was difficult to choose such a basin in the province. All rivers in the province are transboundary. Afterwards, the Syrdarya-Sukh BISA recommended the Isfayram River, which is transboundary, with the majority of problems being of a transboundary nature.

3. Namangan Province

The Naryn-Syrdarya BISA representatives proposed to select the Zardaryo main canal. BISA had in mind that by selecting this canal it will enable the project to solve issues related to high salinity and water management along the canal. However, according to the criteria, the selection should be a river basin originating in the territory of Uzbekistan (Annex 1). Hence, again it was difficult to select any basin in the province due to transboundary nature of the basins.

4. Syrdarya Province

The uniqueness of the Syrdarya Province is that it has only one transboundary river, by nature. Lower (Kuyi)-Syrdarya BISA took into account and adhere to the criteria in Annex 1 and considering the absence of small river basins, proposed the "Right network" main canal as the pilot river basin. It originates from the Syrdarya River and is located within the Shuruzak-Syrdarya ISA. The length of the canal is 55,64 km and provides water to 28,474 ha in the three districts of the Syrdarya Province, including the Guliston, Sayhunobod and Syrdarya districts.

5. Kashkadarya Province

The Amu-Kashkadarya BISA has an interest in improving the water delivery in the Karshi Main Canal. The BISA administration strongly recommended to help rehabilitate the tail-end hydro-units of the Main Canal and install a water information system on the canal territory. Therefore, the BISA has recommended selecting the Karshi Main Canal as the pilot basin to introduce water river basin management plans. However, the selection was not a river basin (Annex 1). It is obvious that attention should be given to small national rivers such as the Aksu (Akdarya), Tanhazdarya, and Guzardarya rivers. After consultation with the representatives of the Amu-Kashkadarya BISA, the Aksu River Basin that satisfies the criteria in Annex 1 was selected for project activities.

6. Surkhandarya Province

The Amu-Surkhan BISA recommended the territory of the Surkhan-Sherabad ISA as a potential area for piloting basin planning. During the discussion with local stakeholders, criteria for selection of pilot river basins were explained. The BISA representatives proposed to select the Sherabad river basin. However, the Sherabad River is not suitable as it has a complex nature, has many sources and mixes with different canals within the BISA. The discussion showed that it is not suitable to select this river basin according to the criteria.

The EU Program provides criteria for selection of two river basins in six pilot regions for the development of river basin management plans.

Out of the six pilot regions, three regions are located in the upper reaches of the Syrdarya River Basin and its tributaries. These are the Andijan, Namangan and Fergana provinces. The Syrdarya Province is located on the middle reach of the Syrdarya River. Two provinces are located in the upper reach of Amudarya and its tributaries. These are the Kashkadarya and Surkhandarya provinces.

The followings are considered appropriate:

a) To select the first pilot river basin in the upper reach of the Syrdarya River – i.e., one basin shared by Andijan, Fergana and Namangan provinces. From the research perspective, the Shakhrikhansai River, which serves the six districts of the Andijan Province with irrigated area of about 65,000 ha and a total length of 120 km, clearly fits the project pilot basin criteria.
b) The second pilot river basin should be selected in the upper reach of Amudarya River, which is in either the Kashkadarya or Surkhandarya Province. Irrigated agriculture is well-developed in these two provinces. Both provinces have small rivers, which are formed on the territory of Uzbekistan. However, it should be noted that the small rivers of the Surkhandarya Province have mixed irrigation sources compared to those in the Kashkadarya Province. The Amu-Surkhan BISA suggested to select the Sherabad River, but it does not fully meet the project criteria. The Aksu (Akdarya) River in the Kashkadarya Province has been suggested by BISA as potential pilot river for basin planning on the upper reaches of Amudarya. This river is representative and satisfies the criteria of the project.

It has been pointed out in the discussions and data collection that the selection of river basins will be based on consultation with local stakeholders and with the joint approval of National Working Group and Project Management Group. After Project Steering Committee on March 30, 2017, two river basins, i.e. the

Shakhrikhansai from the Andijan Province and the Aksu River from Kashkadarya Province have been selected as the pilot river basins to elaborate basin management plans in close cooperation with Uzbek peers (NWG) based on the EU WFD structure and experiences.

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Annex 1. Proposal for the Selection of Pilot River Basins.

It is advisable to select pilot river basins according to the following criteria:

1. A River basin should not be transboundary by nature;
2. A pilot river basin has to have more or less clear hydrographic boundaries;
3. A river basin should be formed in the territory of Uzbekistan;
4. A river basin should be representative for the pilot region by the water supply and eco-ameliorative state of irrigated areas;
5. A river basin should deliver water to at least two - three districts;
6. A pilot river basin has to have water supply from at least two water sources;
7. A river basin should be easily accessible by other neighboring BISAs and ISAs to study and gain experience;
8. ISAs responsible for river basin management should be interested in implementation of the river basin plan;
9. Data on the river basin should be readily available;
10. A pilot river basin has to have different water uses, including domestic, agriculture, power generation, fish farming, and environmental needs.
11. A river basin must be either a creek or a river canal;
12. Basin Water Authority has to be responsive, willing to change its practices and/or have innovative thinking and willingness to adopt innovations.

The main rivers in the pilot regions are the Naryn, Karadarya, Surkhandarya and Kashkadarya rivers.

Naryn River flows through the territory of the Issykul, Naryn, and Jalalabad provinces of the Kyrgyz Republic and the Namangan Province in Uzbekistan. The river originates at the confluence of Kashkasu and Maytara rivers and forms the Syrdarya River at the confluence with the Karadarya River. The length of the river is 807 km; the basin area is 59.9 thousand square kilometers. The river is fed by glacial-snow melting. Seasonal flow is from May to August. The average water flow above the Uchkurgan city is 480 m^3/s.

Karadarya River flows through the territory of the Osh Province in the Kyrgyz Republic, Andijan and Namangan provinces of Uzbekistan. Karadarya is formed by the confluence of Tar and Kara-Kuldja; it originates at an altitude of about 1,150 m and has a length of 180 km; the Basin area is 28.6 thousand km^2. Karadarya is fed by snow and glaciers melting. The average water flow near the Uchtepa settlement is 136 m^3/s.

Surkhandarya River is formed at the confluence of the Tupalangdarya and Karatag rivers flowing from the southern slope of the Gissar Mountains. The river is 175 km long (from the source. Karatag River 287 km); the basin area is 13,500 square kilometers (in the mountain area – 8,230 km^2). Average flow module of the mountain part is 14.6 l/s km^2. Feeding source is snow and glaciers melting. Seasonal flood takes place from June to August. The average flow rate at 6 km from the entry (Manguzar section) is 65.8 m^3/s. Currently, Surkhandarya Basin is fed by water from the Amudarya River.

Kashkadarya River at the initial section of the flow is called Obihunda; further Shinachasai; and in the lower reaches Maymanakdarya. The length of the river is 378 km; the basin area is 12,000 kilometers and mean long-term flow rate 25.3 m^3/s (Chirakchi Town). Feeding is snow. Seasonal floods take place in April and May. Currently, the Kashkadarya basin is fed by water from Zarafshan.

In addition to these rivers, many small rivers (sais) flow in the territory of pilot provinces.

In **Andijan Province**: Akbura and Aravansai (average annual flow rate is 6 m^3/s) flow through the territory of Kyrgyz Republic and Uzbekistan, and Maylisai and Tentaksai through the territory of Uzbekistan.

In **Namangan Province**: Padshatasai (irrigated area is 21,147 ha), Kasansai (average annual flow is 11 m^3/s; irrigated area is 21,555 ha), Chartaksai (1.79 m^3/s), Nmangansai (6 m^3/s), Gavasai (6 m^3/s, irrigated area 8,756 ha), Sumsarsai, Almazsai, Koktareksai, Chirchiksarsai, Chaddaksai (3 m^3/s, irrigated area is 450 ha), and Rezaksay (0.7 m^3/s).

In **Fergana Province**: Isfayramsai (average annual flow is 22 m^3/s), Sukh (41 m^3/s) and Shakhimardonsai (11 m^3/s) flow through the territory of Kyrgyz Republic and Uzbekistan, Isfara (15 m^3/s) through the territory of Kyrgyz Republic, Tajikistan and Uzbekistan.

In **Kashkadarya Province**: Djinidarya, Aksu, Yakkabag, Tanhazdarya, Guzardarya, Langar, Kyzyldarya.

In **Surkhandarya Province**: Tupalang, Karatag Sangardak, Khozhaipak, Sherabad.

Annex 2. List of the Necessary Information for the Analysis of Irrigation and Economic Conditions of the Pilot Regions.

#	Table	Organization providing information
1	Linear scheme of irrigation networks in the pilot regions	BISA
2	Weather data	Uzhydromet
3	Legend of land resources by districts	Provincial departments for land resources (land cadastre)
4	Information about operation of vertical drainage wells	PSE and CA
5	Information about operation of irrigation wells	
6	Use of water from vertical drainage wells	
7	Information about operation of pumping stations	
8	Area and gross harvest of agricultural products	Provincial departments for statistics
9	Area and gross fruit harvest	
10	Data necessary for assessing water needs	
11	Average monthly flow rate and mineralization of drainage water by districts	Provincial Hydrogeological and Melioration Expedition
12	Provision of irrigated land with drainage and presence of collector-drainage networks	
13	Distribution of area by soil salinity	
14	Average vegetation distribution of area by groundwater level and salinity	
15	Distribution of area by groundwater level and salinity on 01 April	
16	Distribution of area by groundwater level and salinity on 01 July	
17	Distribution of area by groundwater level and salinity on 01 October	
18	Use of CDW by districts	
19	Use of water from VDWs	
20	Average monthly salinity of the irrigation water	
21	Data on irrigation networks by districts	BISA
22	List and specifications of reservoirs	
23	Final reports on water use during the growing season	
24	Final reports on water use during the nongrowing season	
25	Average monthly water intake and water supply for the main canals	
26	Water intake and water supply by districts	
27	Use of CDW by districts	
28	Use of water from drainage wells	
29	Use of water by industries	
30	Information on WCA activities	

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