DROUGHT AND SALT DAMAGE IN UZBEKISTAN

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Yulia Shirokova received her Ph.D. in agriculture from the Central Asian Scientific Research Institute for Irrigation (SANIIRI) (in Uzbekistan) after successfully defending her thesis, "Using drainage water to leach saline soils." Her scientific interests include improving the monitoring and desalinization of saline-irrigated soils. She has worked as a deputy director of scientific research. She is currently head of the Soil Research and Ameliorative Processes Laboratory at Uzbekistan's Scientific Research Institute of Irrigation and Water Problems.

ABSTRACT

The Republic of Uzbekistan located in the centre of Central Asia and occupies 447.4 thousand km^2. The population is about 29 million, 51% of whom are urban residents, 49% of Uzbekistan's population lives in rural areas. The territory of Uzbekistan is a combination of flat and mountain terrain. More than 2/3 of the territory is covered by plains (Turan plain, Fergana Valley, Valley of the rivers Amudarya, Syrdarya and Zarafshan rivers and their tributaries), and 1/3 made up of mountains and foothills (spurs of Tyan-Shan, Gissar-Alay). The highest point of Uzbekistan's mountains is 4,643 meters asl, the lowest point, in Aral Sea area, is 53 m. The climate of Uzbekistan is sharply continental. The growing of agricultural crops is impossible, without artificial irrigation since the ratio of precipitation to potential evaporation is around 0.1-0.3 and less.

According to the Ministry of Agriculture and Water Resources (MAWR) irrigated land occupies 4,200 thousand hectares. According to the State Committee of the Republic of Uzbekistan on statistics, in 2012, the total cropped land in Uzbekistan amounted to 3583.9 thousand hectares (include 44.8% under grain crops, 36.5% under cotton and 17% —potato, vegetables, melons and fodder crops) (as for July 1, 2012)[1].

Irrigated lands of the Republic of Uzbekistan are mostly prone to salinization. This is interlinked to the aridity of climate, geological and hydrogeological conditions of the irrigated territories. Salinization is one of the factors, which reduce soil fertility and productivity of irrigated lands significantly. Depending on the degree of soil salinity, crop losses could be from 15 to 80%. According to the land reclamation monitoring service of the MAWR saline soil represents more than 50% of the total irrigated land, including 32% of slightly saline, 15% of medium saline, 3.5% of saline.

The main crops grown in Uzbekistan (cotton and wheat) are resistant to salt. Nevertheless, soil salinization is not a crucial factor for reducing yield of winter wheat considering relatively moist soil due to precipitation in winter. However, cotton, which is sown in spring, needs good soil moisture with a minimum of its salinity for ensuring of good growth and development of young plants. Therefore important agricultural approaches for cotton fields are increasing moisture reserves due to special irrigation as well as leaching salts from the land before planting.

Uzbekistan's soil is also very diverse due to differences in genetic, geological, hydrological and anthropogenically-historical nature. Mostly genetically fertile are foothill land and land of ancient irrigation. Depending on the zonal location, soils have different quality and uniformity of texture and fertility. There is also the notion of limitation of irrigation. In the arid climate of Uzbekistan are irrigated soils poor in humus and have high anthropogenic load. Such soil is prone to salinization, wind and irrigation erosion. According to the Committee on Land Resources of the Republic of Uzbekistan, 24% of irrigated land in Uzbekistan has low productivity.

Main part of Uzbekistan's water resources (80-90%) is use for irrigated agriculture's needs. Therefore main problems of rational use of water resources in Uzbekistan are connected with the efficiency of irrigation systems and water use in the fields.

Periodically, Uzbekistan is in conditions of water scarcity, as in recent years water availability on major rivers-Amudarya and Syrdarya- does not exceed 70% of the average annual norm. This situation creates difficulties in securing the necessary volume of water for irrigation. Technology of crop irrigation by furrows, prevailing at current, leads to filtering water into groundwater and, as a consequence, waterlogging and salinization. Irrigation of land situated in automorphic conditions ordinarily lead to a flooding of downstream-located land. Irrigated water lost from the canals by filtering is partially used on fields, partially irretrievably lost for evaporation (from bands of exclusion along the canals and fields). In addition, these water losses create an artificial pressure of groundwater what contributes to the development of

1. Source: The State Committee of the Republic of Uzbekistan on statistics, http://www.stat.uz/en/economy/

waterlogging and salinity processes (“pushing” brines from deep aquifers to surface soils);

To encourage farmers to water and resource saving, introduction of methods of reducing water consumption in agriculture, including advanced irrigation technologies (drip irrigation, sprinkler irrigation, which has so far not developed widely) is needed. Local conditions should be considered within the framework of the strategy in the water sector and in the implementation of investment projects on reconstruction of irrigation systems. Apart of this, implementation of above-mentioned advanced irrigation technologies is required.

An implementation of these technologies only on “very high” and “low” permeable lands occupying ~ 25% of irrigated lands would allow to: release of approximately 30-40% of all water resources used for irrigation in Uzbekistan; reduce the cost of energy at 15%; increase yields of agricultural crops by 30-50%; solve land reclamation problems on irrigation land as well as on 10% of land closed to irrigation land; increase almost in two times water productivity; switch to energy-saving land use technologies (minimal and zero tillage. which are unacceptable in furrow irrigation technology).

The Government of the Republic pays great attention to the problems of streamlining of water distribution, rehabilitation of irrigation and drainage systems in irrigated lands. There are a number of laws and presidential decrees and orders of Cabinet of Ministers successfully implemented by the MAWR. These are a law “On water and water use”, regulation “On limited water use”, a number of decisions on restructuring of agricultural sector such as e.g. establishment of farms, organization of water management based on basin principle, establishment of water user associations. A special role is played by the Government in the reclamation work by creating the special Reclamation Fund for an improvement of reclamation condition of irrigated lands through reconstruction and repair of large and small drainage systems. Already this year about 77 million US Dollar were spent on land reclamation of more than 1, 2 thousand hectares of cropland.

Partnership for international cooperation allows to bring new ideas and experiences from other countries, to raise qualitatively level of scientific research through exchange.

An example of successful project implementation and fruitful cooperation with scientific institutions in Uzbekistan is a project on “Measures against farmland damage from salinization in Uzbekistan” implemented by the Japan International Research Center for Agricultural Sciences (JIRCAS). The results of the project implemented in the Syrdarya region aimed at adaptation of farmers to more efficient use of water in their fields by known (simple) methods of land reclamation by high-precision land leveling, small repairs of drainage on the field and others. Due to project activities farmers’ awareness was raised on major resource-saving agricultural technics. Exactly this is the first step towards sustainable management of natural resources.

The project is one of the attempts to undertake measures against natural and man-made adverse conditions which aggravate efficient agricultural farming activates. The further following areas for cooperation in the field of use of water and land resources within the framework of joint scientific research projects may be noted:

- Development of strategies and methods on effective improvement of water and land management;
- Search and introduction of resource-saving water and soil protective technologies;
- Search of methods for soil water-salt regime regulation under conditions of shallow groundwater level, reducing water consumption and harmful effects of salts.

KEYWORDS

Irrigated land use; salinization, water efficiency; technology of irrigation; collaboration

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“About ways for improvement of water use in irrigation of Uzbekistan,”// Shirokova Y., Morozov A. in book “Adaptive and Integrated Water Management Coping with Complexity and Uncertainty” Pahl-Wostl, C., Kabat, P., Möltgen, J. (Eds.) 2007, XIV, 440 p. 72 illus., Hardcover ISBN: 978-3-540-75940-9.

JIRCAS International Symposium 2012 "Resilient Food Production Systems: The Role of Agricultural Technology Development in Developing Regions"

Drought and Salt Damage in Uzbekistan

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Structure of the presentation

1. General information about Uzbekistan (geography, aridity of climate, zonal altitute, soil)
2. Land resources and its use in agriculture
3. Water resources and its use
4. Problems linked to the water shortage
5. Reclamative state of irrigated land, causes and consequences (ground water level, soil salinity, causes of salinity)
6. Damages from salinity: yield losses, leaching of the soil, etc.
7. Ways for reduction of water losses in agriculture (increase of rational use, and with this connected reclamative state)
8. Directed state actions
9. Partnerships and cooperation

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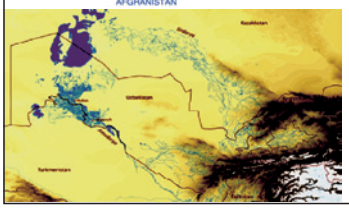
General information about Uzbekistan



- The Republic of Uzbekistan located in the centre of Central Asia and occupies 447.4 thousand km^2.
- The population is about 29 million, 51% of whom are urban residents, 49% of Uzbekistan's population lives in rural areas.
- The territory of Uzbekistan is a combination of flat and mountain terrain. More than 2/3 of the territory is covered by plains and 1/3 made up of mountains and foothills.
- The highest point of Uzbekistan's mountains is 4643 meters asl, the lowest point, in Aral Sea area, is 53 m.

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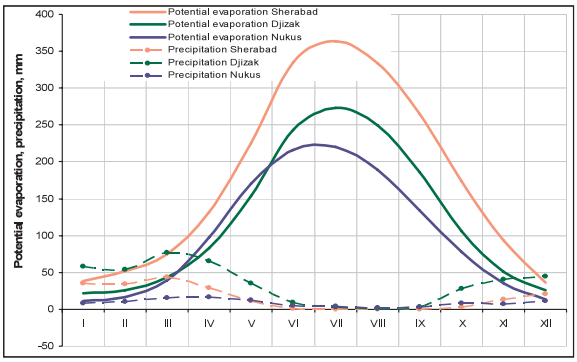

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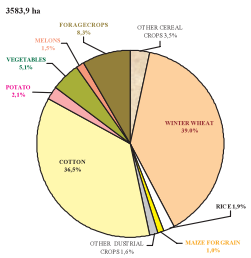
Land resources and its use in agriculture

•Agriculture is very important sector of Uzbek economy which supplies consumers with food and provides raw materials to the industrial sector.
•Uzbekistan is still largely rural: roughly 49 percent of Uzbekistan's population lives in rural areas.
• In Uzbekistan more than 85% of all arable lands is in transferred to over 66 thousand farms.
•In Uzbekistan cotton and grains production is mostly concentrated in farms, and peasant units provide 70% of the country's foodstuff. These semi-private farms produce almost entire Uzbekistan's' yield of cotton, 85% of grain crops, more than half of state yield of fruits and grapes, one third of vegetables and melons' yield.
•87% of cropland in Uzbekistan is irrigated land. The total area of the irrigated land served by the state irrigation systems exceeds 4300 thousand hectares.
http://www.gov.uz/ru/business/agriculture/3811
http://www.ifmr.uz/index.php?option=com_k2&view=item&id



Distribution of sown areas by agricultural crops in 2012

Total cropped land for the harvest of the current year in farms of all types on 1 July amounted to 3583.9 thousand hectares (include 44.8 % under grain crops, 36, 5% under cotton and 17% - potato, vegetables, melons and fodder crops)[1]
[1] Source: The State Committee of the Republic of Uzbekistan on statistics, http://www.stat.uz/en/economy/

In conditions of agriculture is based on irrigation, the limited availability of water resources is limiting in the use of land resources
In the prospects of Uzbekistan, consider two main processes: the high rate of population growth in the country and the increasing scarcity of fresh water and land resources. According to statistics, over the past 25 years, the area of irrigated land per capita decreased from 0.22 to 0.12 ha.

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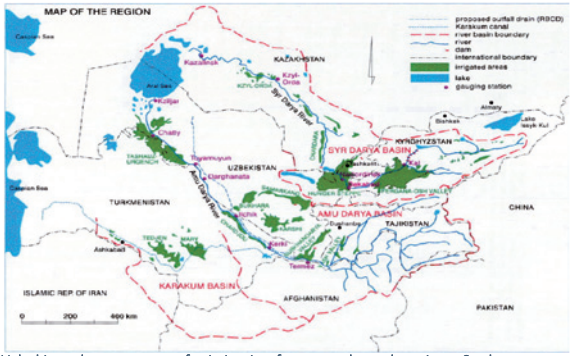
Water resources and its use



Uzbekistan become water for irrigation from transboundary rivers Syrdarya (3019 km) and Amudarya (2540 km) 6,2/ 5,1

•Major water consumers are: agriculture - 85%, industry - 12%, municipal sector - 3%

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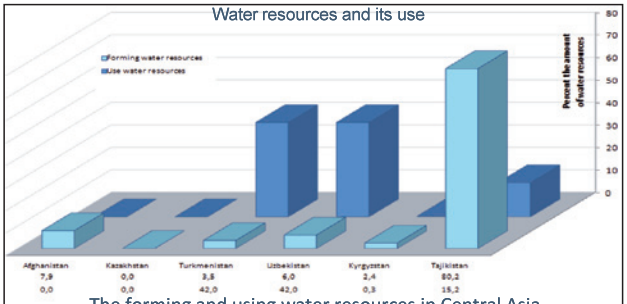
Water resources and its use



The forming and using water resources in Central Asia

- The figure shows that the downstream countries (Kazakhstan, Uzbekistan and Turkmenistan) have shortage of their own water resources
- Share Uzbekistan's (own) water resources is 10-15% at using, depending on the dryness of the year
- The volume of water resources in Uzbekistan decreased 20-25 years, from 64 km^3 (mid-1980s) to 53 km^3 (average for the period 2006 to 2010)*

**Source:Integrated Water Resources Management in Uzbekistan Rakhimov Sh.Kh., Kuchkarov SZ //Abstracts. Water Cooperation Central Asia - 20 years: past experiences and challenges future 20-21 September 2012 Almaty, Republic of Kazakhstan*

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Water resources and its use

Water management of Republic of Uzbekistan is a maze of hydro land reclaiming systems serving nearby

- 4300 thousand hectares of irrigated land,
- including more than 180 thousand km of canal networks,
- 140 thousand km of drainage,
- nearby 160 thousand constructions,
- from which are over 800 large, 1588 pump stations with an annual capacity of 8,2 milliard kW,
- 55 water reservoirs with entire capacity of 19,8 milliard m^3 and
- more than 4100 wells

The volume of irrigation water use in the Republic depends on the dryness of the year. So in in 2011 for crop irrigation was used 46.6 km^3 surface water, groundwater 0.54 km^3 and 1.6 km^3 of return water (surface discharge from the fields, drainage and waste water in dustrial and utility companies)

Sources:

1.Report Mr. Shavkat Khamraev, Deputy Minister of Agriculture and Water Resources, Republic of Uzbekistan, international conference"Towards the 6th World Water Forum – Cooperative Actions for Water Security (Tashkent, 12-13 May, 2011) http://agro.uz/agriculture/9/69/
2.Integrated Water Resources Management in Uzbekistan Rakhimov Sh.Kh., Kuchkarov SZ //Abstracts. Water Cooperation Central Asia - 20 years: past experiences and challenges future 20-21 September 2012 Almaty, Republic of Kazakhstan

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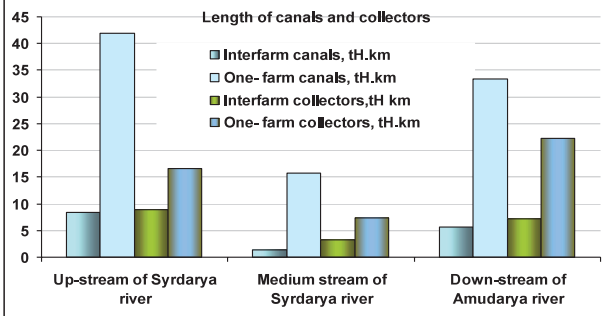
Water resources and its use

INFRASTRUCTURE FOR WATER MANAGEMENT



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Problems linked to the water shortage

•Water resources, and, accordingly agriculture, are the most vulnerable sectors of economy as they depend on fluctuations of an annual water flow and on frequency of recurrences of droughts that influences water-security of land during the vegetation period. Both events – changeable water flow and repeated draughts- make agriculture risky and less effective

• Examples of such years were 2000, 2001 and 2008 when special deficiency of water was created in Aral Sea zone leading to significant problems

On Amudarya basin over the last 23 years, was observed 10 years of normal hydrological and a high water content, of which the highest water content was noted in 1991-1992, and it was -80.9 km3. 13 years of water content was below normal,the lowest water content was observed in 1988-1989, 2000-2001, 2007-2008 and 2010-2011 hydrological years

Source: BWO "Amudarya" - 20 years in the ICWC Kdyrniyazov B. *//Abstracts. Water Cooperation Central Asia - 20 years: past experiences and challenges future 20-21 September 2012 Almaty, Republic of Kazakhstan*

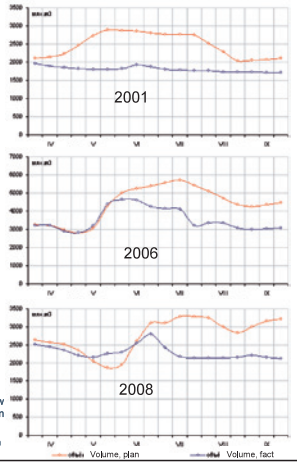

Diagram of volumes of Tuyamuyun reservoir Illustrate the flow of water shortage in the lower reach of Amu Darya river in the vegetation season.

Source: http://www.cawater-fo.net/analysis/water/2008/tuy_veg.htm

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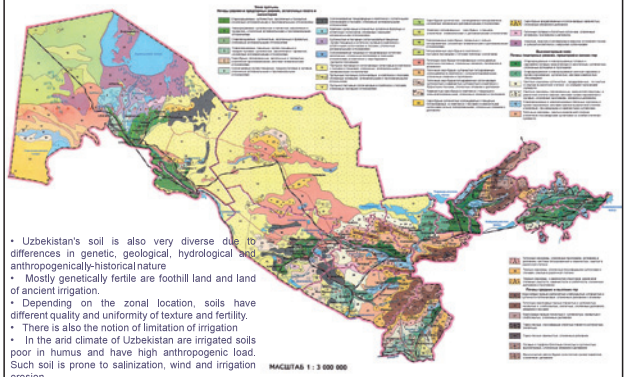
Soil map of Uzbekistan



- Uzbekistan's soil is also very diverse due to differences in genetic, geological, hydrological and anthropogenically-historical nature
- Mostly genetically fertile are foothill land and land of ancient irrigation.
- Depending on the zonal location, soils have different quality and uniformity of texture and fertility.
- There is also the notion of limitation of irrigation
- In the arid climate of Uzbekistan are irrigated soils poor in humus and have high anthropogenic load. Such soil is prone to salinization, wind and irrigation erosion.
- According to the Committee on Land Resources of the Republic of Uzbekistan, 24% of irrigated land in Uzbekistan has low productivity

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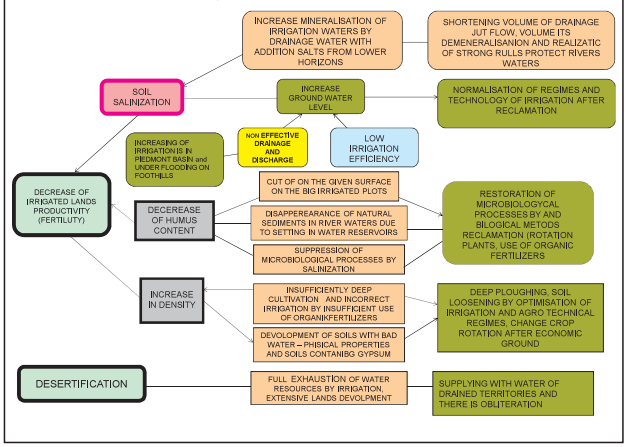
Main problems of soils in Uzbekistan



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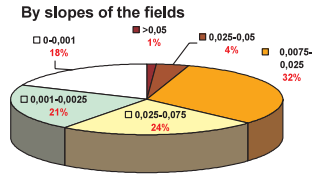
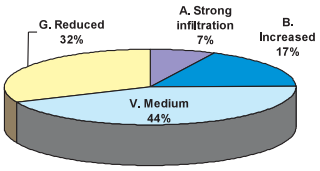
Distribution of irrigation area, about 4.3 mln.ha



High and very high permeable land accounts for 24%



By the steady of infiltration intensity

	mm / hour
A. Strong infiltration	10-20
B. Increased	6-10
V. Medium	3-6
G. Reduced	2-3
D. Low infiltration	1-2

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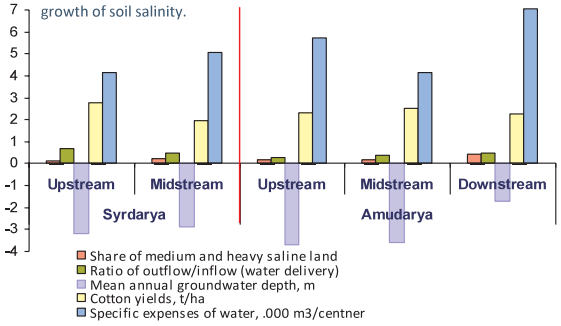
Reclamative state of irrigated land

- The most problematic zones in terms of water use in Uzbekistan are upstream of the river Syrdarya and downstream of the river Amudarya. In case of Syrdarya it is a huge drainage flow, and in downstream of Amudarya there are large volumes of withdrawal and outflow of water, high inputs of water per unit production under shallow groundwater conditions leads to a growth of soil salinity.



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Salinization of soils is factor of limited crops yield

- Irrigated lands of the Republic of Uzbekistan, for the most part, are prone to salinization. This is interlinked to the aridity of climate, geological and hydro geological conditions of the irrigated territories
- Salinization is one of the factors, which reduce significantly soil fertility and productivity of irrigated lands. Depending on the degree of soil salinity, crop losses could be from 15 to 80%
- According to the land reclamation monitoring service of the MAWR saline soil represents more than 50% of the total irrigated land, including 32% of slightly saline, 15% of medium saline, 3.5% of saline

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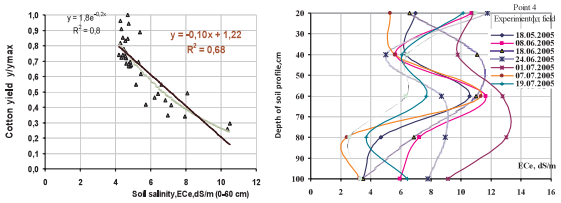
Damages from soil salinity

Decreasing cotton crop factors adopted by the institute "Uzerloyiha" are:
- in low salinity of 0.85 (15% loss)
- with an average salinity of 0.6 (40% loss)
- If a salinity of 0.4 (60% loss)
- In extremely strong salinity 0.3 (70% loss)

on the basis of these data and data on the distribution of salinity (in the autumn data), it is estimated that crop losses of soil salinity in the Republic (as on cotton and on wheat) at 30%. Given the spring data actually are lower, about half

In different condition this figure could be change



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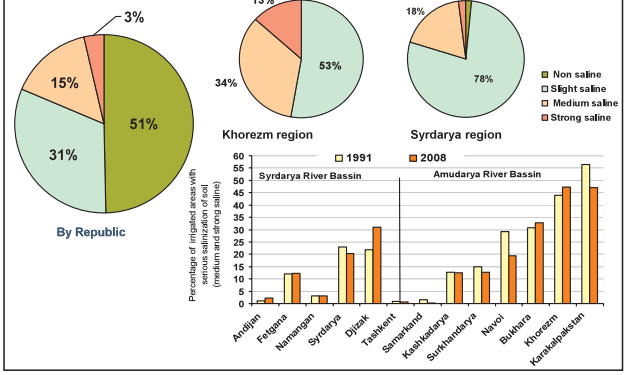
Distribution of saline soils

According of data of Ministry of Agriculture and Water Resources In additional oblasts serious (medium and strong) salinization occupies 30-50% of irrigated lands



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Problems of soil salinity

The main crops grown in Uzbekistan (cotton and wheat) are resistant to salt. Especially considering relatively moist soil due to precipitation in winter, soil salinization is not a crucial factor for reducing yield of winter wheat. However, cotton, which is sown in spring, needs good soil moisture with a minimum of its salinity for ensuring of good growth and development of young plants. Therefore important agricultural approaches for cotton fields are increasing moisture reserves due to special irrigation as well as leaching salts from the land before planting

Till now, the most effective way of desalinization of soil is autumn-winter leaching. It is rather labour-consuming process including many of mechanical works (a hand-made building of cells, small canals, supply and distribution of water, maintenance of the checks, land leveling etc.)

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Reclamative state of irrigated land



• By high level of ground water is leaching as mean for combating of seasonal salinity hardly effective due to low volume of zone of aeration and unsufficient drainage of irrigated land. In order to solve this problem a cleaning of existing drainage system is carried out

•After cleaning the drainage installations (collectors), a decrease in groundwater levels, and (in certain circumstances) may decrease salinity without leaching.
It is necessary to control the degree of soil salinity and improve agricultural technology on the field: more frequent irrigations, or use land improvement techniques, such as periodically deep ripping of soil to break the capillaries, which is pulling salts to the soil surface. May also to apply organic fertilizers, which reduce the harmful effects of salt on plants

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• In order to reduce damages to the crop yield and environment by use of water and land resources following measures are needed:
- Improvement of water resources management
- Search and implementation of responsive resource saving, water saving and soil protective technologies on the field level

• Surface irrigation practice is a common way in Uzbek irrigated agriculture:
-furrow (70% of irrigated area)
-bands (26%)
-check flooding (4%)
• Use of advanced irrigation methods is currently limited due to lack of funds and other reasons (such as free delivery of water to farmers, their lack of awareness and lack of special knowledge to operate new systems)

• The primary objects of advanced irrigation technologies (e.g. drip systems) must be:
-arrays, which are connected to the water supply by expensive water lifting machines;
-irrigated areas with high soil infiltration (or underlain by gravel, located at high elevations)

• In Uzbekistan was undertaken research to identify the effectiveness from implementation of water-saving technologies such as subsurface drip irrigation and sprinkler irrigation, both in cotton and in vineyards. The results of these research showed high effects both in water saving and in crop yield

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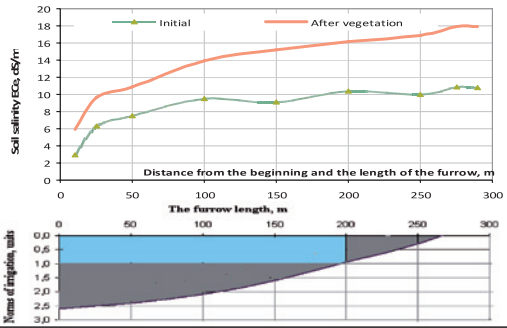
Furrow irrigation

• The main issue of rational water use is related to efficiency of irrigation systems and distribution of water on the fields. Using of furrow irrigation is reason of huge water loses on the field level
• Distribution of water along the furrows - uneven and it affects the yield and distribution of salinization in the field. Unevenly depends on the permeability of the soil, the length of the furrow, and the depth of the ground water



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Furrow irrigation

• A transition to water-saving irrigation techniques will allow to improve ecological situation in the Republic of Uzbekistan, increase uniformity of irrigation, save water and increase significantly crop yields. However, for the application of these technologies financial means are required that by manual furrow irrigation are minimal. In these conditions, scientists suggest to optimize furrow irrigation to achieve maximum uniformity of irrigation

Usually optimized length of furrows and discharges into the furrow in relation to water infiltration into the soil and sloping fields

Indicators of optimal parameters of furrow irrigation (normative)	Soil infiltration intensity			
	A	B	V	G
Surface discharge in share at given water	0,08	0,09	0,13	0,20
Filtration (lower root zone) share at given water	0,29	0,20	0,12	0,10

Source: N.T.Laktaev, Irrigation of the cotton. Tashkent, 1984

Slop of furrow	losses water on discharge,%
0,05-0,02	6-12*
0,02-0,01	15-23
0,01-0,005	15-24
0,005-0,002	9-12

*The first and second numbers correspond to - high and low permeability

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About improvement of furrow irrigation and water saving

• To improve the use of water in the field is required to optimize furrow irrigation (relatively low-cost, short-term actions)
• Apart of this, a qualitative land leveling of fields, right selection of furrow length and water discharge into a furrow, application of the counter (double –side) irrigation, consideration of an impact of groundwater level in its shallow location, use of siphons and irrigation through furrow are essential for an optimal water use

•Surface irrigation has problems with land leveling. Due to uniformity of irrigation occur water loses and yield decreases

•Farmers are more interested in cost-effective increase in yield than in water conservation. However, there are hidden damages from water losses in irrigation systems such as high cost of draining and flushing to combat salinization, damages from yield loss due to subsequent soil salinity and loss due to abandonment of saline lands. In addition, large amounts of drainage water are discharged into rivers or natural depressions deteriorating water quality in rivers or creating unstable (periodically drying) wetlands.

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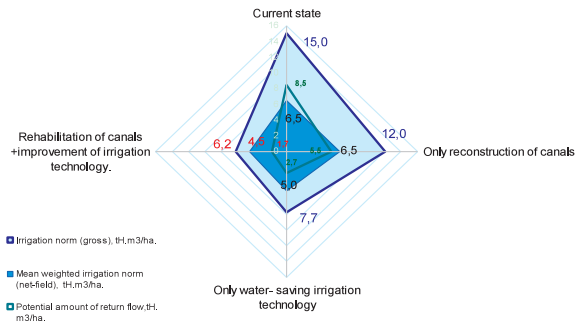
Ways of decrease of water looses



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Directed state actions

- The Government of the Republic pays great attention to the problems of streamlining of water distribution, rehabilitation of irrigation and drainage systems in irrigated lands.
- There are a number of laws and presidential decrees and orders of Cabinet of Ministers successfully implemented by the MAWR. These are a law “On water and water use”, regulation “On limited water use”, a number of decisions on restructuring of agricultural sector such as e.g. establishment of farms, organization of water management based on basin principle, establishment of water user associations.
- A special role is played by the Government in the reclamation work by creating the special Reclamation Fund for an improvement of reclamation condition of irrigated lands through reconstruction and repair of large and small drainage systems. Already this year about 77 million US Dollar were spent on land reclamation of more than 1, 2 thousand hectares of cropland.

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•Partnership for international cooperation allows to bring new ideas and experiences from other countries, to raise qualitatively level of scientific research through exchange

•An example of successful project implementation and fruitful cooperation with scientific institutions in Uzbekistan is a project on **“Measures against farmland damage from salinization in Uzbekistan”** implemented by the Japan International Research Center for Agricultural Sciences (JIRCAS)

• The results of the project implemented in the Syrdarya region aimed at adaptation of farmers to more efficient use of water in their fields by known (simple) methods of land reclamation by high-precision land leveling, small repairs of drainage on the field and others. Due to project activities farmers’ awareness was raised on major resource-saving agricultural techniques. Exactly this is the first step towards sustainable management of natural resources

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Chairman Dr. Ryoichi Matsunaga: Let me move to the last presentation. The last presentation is by Dr. Yulia Shirokova. She is the Head of Laboratory "Soil Research and Ameliorative Processes" of the Scientific Research Institute of Irrigation and Water Problems in Uzbekistan. She has experience as deputy director of scientific research institute. She received her doctorate from the Central Asian Scientific Research Institute of Irrigation (SANIIRI) in Uzbekistan. Her thesis is "Using Drainage Water to Leach Saline Soils." Her scientific interest is currently improvement monitoring and desalinization of Saline irrigated soils.

Dr. Shirokova, please start.

Dr. Yulia Shirokova: Thank you very much for the good introduction. Excuse me please; my English may not be so excellent. I will try to explain to you the situation in Uzbekistan. Maybe it will be interesting for you for future research. The name of my report is "Drought and Salt Damage in Uzbekistan."

Uzbekistan is a country located in the middle of Central Asia. The territory of the Uzbekistan is 447,400 km^2. The area of the country is different; one third is mountains and foothills and other parts are planes. It is a historical irrigation zone, because we have a sharply continental climate and we have an arid climate. In this picture you can see the difference between precipitation and evaporation. In these conditions agricultural production is impossible without irrigation. In this situation, we have a lot of problems with using our lands and new technology such as conservation agriculture. I pose the question: can we use conservation agriculture in irrigation conditions? It is a very big question in condition of irrigation and soil's salinization. In Soviet times we developed new lands at a large scale, and finally we finished our water resources. We have 4.3 million hectares of irrigated land, and we do not have enough water to irrigate them. Now we 36% of our land is used to produce cotton and 44.8% for grain crops, mostly winter wheat. About 20% of our area we are using for vegetables, melons, etc., and in our country the quality of the vegetables is very nice. But now we increase this part of production in our country. In the past period we produced so much cotton, now we have 66,000 farmers, with an average farm area of 82 hectares. But we have a big population increase. Half of our population is living in rural territory and in the past it was more, 60%. But we have a young generation; half of our population is young. But we are an increasing population and we have limited water for development of agriculture. Over the past 25 years, the area of irrigated land per capita decreased from 0.22 hectares to 0.12 hectares approximately.

We need to think about the future. We have two trans-boundary rivers, Syrdarya and Amudarya. We have developed so much land, our water passing along the Amu Darya River often do not reach the Aral Sea and this sea has disappeared. This is an environmental tragedy. There is not enough water for the end of the Amudarya River. It is a trans-boundary river used by four republics of Central Asia, Tajikistan, Uzbekistan, Kazakhstan and Turkmenistan.

Agriculture uses approximately 85% of the water resources. Here we can see the forming and using copper water resources. Upstream countries like Tajikistan have a lot of water and produce energy. These are not so much of agriculture. Turkmenistan and Uzbekistan use a lot of water, which is why we depend on these countries. In addition, we depend upon natural processes like hydrological cycles and sometimes we do not have enough water. The volume of water resources in Uzbekistan decreased over 20 to 25 years from 64 km^3 to 53 km^3, but in the last year we used 46 km^3. This includes maximum 90% surface water. We use only 1% underground water, and sometimes we are reusing water after drainage collection.

In Soviet times we developed a lot of excellent irrigation and drainage infrastructure. Our water infrastructure was very famous throughout the world because it was very complex. We have 180,000 km of canal networks, 140,000 km of drainage, and more than 160,000 constructions including pump stations. Some parts of the irrigated lands are irrigated by pumping stations. This is expensive water for agriculture. The government pays for exploitation of these pumping stations.

Here I introduce only length of irrigation systems. Upstream of the river we do have not so much engineering systems and length of canals is very big. In the middle stream of Syrdarya (on new developed lands, with engineering irrigation systems), the length of irrigation network is not so big. Downstream of Amudarya we have a long irrigation network, which means we lose a lot of water, when we distribute water in the irrigated area. In this picture I introduce to the insufficiency of water downstream of Amudarya. In 2001, 2006 and 2008 we do not have enough water in nature due to climate conditions, the hydrological cycle. Also maybe some upstream users of water may do some not-excellent things. Here we can do comparing requirement and real water supply in down stream of Amudarya. In this case we lose yield of crops and economical efficiency of agriculture and social consequences of them. For example, in 2001 in Karakalpakstan there was migration of population because conditions were very difficult; some lost their entire yield. But they could not change place; they greatly depend on this water.

The soil in Uzbekistan is also very different depending on geological (genetical) conditions. Here we have mountainous soils that have enough humus but maybe not so much for an arid climate; it is 2% to maximum 3%. Here we have desert land and desert soil, and here is irrigated oasis and alluvial soil. Here we do not have enough humus; humus is a maximum of approximately 1%.

According to the data of the Land Use Committee Area the bonitet rate of soils average is 50 (50% from maximum) and irrigated land with low productivity is 24%.

Here I try to describe the situation of fertility of our soil. We have a lot of plough pan problems. If we plough for a lot of time we can find compacted layer below the plowed (plough pan). The density very strongly decreases our yield. Also, we do not have organic matter after bringing our crops after yield, and we could not increase our humus due to the arid, very hot climate. Also after harvesting are sometimes does not of organic residues of plants.

A big problem in our land is soil salinization. Soil salinization has two factors. Historically, geologically we have some soil salinity in the natural soil material. But during irrigation we create the conditions to move up salts, “sleeping” in lower layers of soil-forming rocks by increasing groundwater. Groundwater is the reason for salinization. In some places we can see the moving of these salts during the season.

We also have different slopes of irrigated lands. It is distribution territory about slope. We have pre-mountain big slope and 20% we have approximately zero sloping. It is important for irrigation; it is a factor to help us choose irrigation technology. I can say the same about infiltration, because infiltration is a very important factor for losing water and for using water properly by irrigation.

Here also I repeat this groundwater table. Upstream of the river levels of ground water is deeper, but deeper groundwater is sometimes a factor creating losses of irrigation water (especially in technology furrow irrigation). If the lower layers of have big filtration like gravel, we can lose a lot of water.

Here I introduce the loss of crop yield by salinity. On the photo we can compare: upstream of Syrdarya River (where soil is non-saline) we can see the normal cotton plant density, but in downstream of Amudarya River (where soil is saline) situation in the fields is bad. We are losing yield due to soil’s salinity. Here we have local graph to decrease yield of cotton, it is salinity of the soil. According to the FAO we could start to lose yield of cotton to approximately 8 dS/m. In local technology, local kinds of soil, local groundwater we find that the criteria of cotton yield losses (critical point) is approximately 4 dS/m.

In the picture introduced how fluctuation of salts distribution to the soil’s profile during vegetation season from irrigation to irrigation in conditions of downstream of Amudarya River.

Here I introduce a diagram, of distribution of salinity in autumn, according to data from Ministry of Agriculture and Water Resources. 50% is saline-free and approximately 20% is medium or strong salinity. This is the average by Republic, but in some places (such as downstream) we can see that 90% of the territory is saline. For example In Syrdarya region, there is a slight salinity, which is not so dangerous for cotton and winter wheat, because these crops are more tolerant. But we can also see downstream (Khorezm region) that salinity is more distributed.

For cleaning the soil opposite of the salts, the local population's tradition to do leaching of the soil's. It is very hard technology because maybe it destroys humus, does the same compaction and it is costly, because it needs to use money for petrol, tractors and so on. Some farmers refuse to do it, but except for Bukhara and Khorezm. So in downstream of Amudarya River farmers traditionally do it properly, because ground water is very close from surface and they couldn't get cotton plant germination without soil leaching. But it is difficult to do it and these crops have enough tolerance but light-salinity soil is some places enough to leach by furrow.

Before we can leach we need to clean collector net, because during the long-time exploitation, the collector is not acceptable sometimes for discharging water from leached area. This type of work is now developed in the whole country due to governmental solution and support for farmers. Sometimes farmers themselves cooperate and do cleaning of some collectors.

Furrow irrigation is a traditional irrigation in our region, and is most used in the country. For cotton, which is situated in all areas, we could not use drip irrigation because it is very expensive and you need to teach people and have an economic basis for this. This type of irrigation is furrow irrigation. Furrow irrigation needs optimization for usage of water. You can see here that in the beginning of the furrow (due of infiltration) use more water than we need for soil moisturing, but for moisturing soil at the end of the furrow; we need to spend additional water.

But here is a real figure about distribution of salts along the length of the field. In beginning of the furrow the soil is leached from salts, and on the end of the furrow the salts are accumulated.

This technology (furrow irrigation) needs to be improved and optimized because in any case we lose water through this technology. That is why our way to move to progressive technology and maybe change some crops on the hills. On the hills we need to produce garden and grapes with drip irrigation. This water saving technology does not need good land leveling.

Sometimes we can lose a lot of water, when we use furrow irrigation by furrow (less in condition of good leveling and more, in condition of bad land leveling), not enough good distribution of water for plants. What we need to do in this situation?

Need acquaint of farmers with water saving technologies and to optimize parameters furrow irrigation.

This picture introduces a model, which way we need to go for strategy to reduce the losses of water in agriculture. In this model, it was calculated to what values can be reduced the specific volume of water used annually in agriculture for 1 ha (totally in the system thousands m^3/hectare), if you apply the following scenarios:

Current situation -15,000;
Only reconstruction of irrigation canals12,000;
Only water-saving irrigation technology on the field 7,720;
Rehabilitation of canals +improvement of irrigation technology on the field 6,240.

But it is a very costly approach, because (if you remember) we have very long canals. This is why it may be more important to improve water usage on the fields. For this we need to teach farmers to improve furrow irrigation or,

if possible, to use modern technology.

Our government does a lot for improvement ameliorative situation on farmers' lands, and we have laws in the country about water usage, limiting water usage (according hydrological situation).

We have good monitoring of salinity and ground water for more objective solution about rehabilitation of collector-drainage systems. In country also has a special fund control money for and organization to clean collector-drainage systems. This year for example the government used US$ 70 million for these goals.

A while ago our president has signed a decree such that farmers would be stimulated to use water-saving technology by reducing tax for the farmers.

In this complicated situation, collaboration with other countries is very useful because we can find some new ideas and some changed experiences. That is why an example of this collaboration is JIRCAS collaboration, JIRCAS work in Uzbekistan, in the project measuring against farmland damage from salinization in Uzbekistan. They work in the Syrdarya area and they also try to reduce water loss at the field level, as well as how farmers can clean collectors in their fields and do a lot of useful things, for example green manuring. It is a good example; I hope that it will be distributed and introduced to our farmers more widely.

Thank you for your attention. Thank you for the invitation. I greatly appreciate participating in this wonderful symposium.

Chairman: Thank you very much, Dr. Shirokova.