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On Grant

Study Peculiarities of Formation and Evaluation Quality of Collector-Drainage Water with the View of Reusing It for Irrigation

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Conducted by

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INTRODUCTION

The level of water resources availability is one of the key factors of social-economical and ecological prosperity for the countries in Central Asia. Nowadays one of the most vulnerable among them is Uzbekistan. It can be explained by its geopolitical location (situated in the center of Central Asia, in middle and low reaches of Amu Dariya and Sir Dariya rivers of the Aral basin), sector-oriented economy (agriculture plays a main role in the economy of the republic), an increasing population (the most densely populated country in Central Asia). Due to the changes that are typical for the developing countries - anthropogenic (an inadequate rehabilitation of irrigation and drainage infrastructure), political (reorientation of many damps of the work regimes from irrigation-energy to energy) and institutional (the transition from administrative to hydrographical management of water resources) as well as appearance of nature uncertainty (climate change, fluctuation of annual water availability). Currently Uzbekistan experiences an increasing deficit of water resources. The total deficit of water resources for the basin of Sir Dariya river is 2.5 km^3/year, the deficit for the basin of Amu Dariya river ranges from 1.5 to 3 km^3/year depending on the water availability of the specific year.

No doubts that the decrease of water deficit can be achieved by omnipresent water-saving, complete regulation of rivers' flow, improvement of operation and maintenance of irrigation systems, installation an advanced measurement devices and equipments along irrigation systems, implementation of an improved irrigated techniques, cultivation or introduction of drought-resistant crops. However, it is also necessary to find non-traditional methods and sources of increasing water resources availability.

As it is know that one of the solutions of this problem is a reuse of marginal water resources such as underground, collector-drainage and sewage water. At the same time their use should not have a negative impact on the melioration condition of soil and the environment.

Studying the interrelationship and impact of qualitative water composition on the soil conditions, physicochemical processes and transformation of main contaminants (within the soil-water and plant system) that occur at the process of irrigation using collector-drainage water, will allow to select the optimal ratio of irrigation water and collector drainage water conjunction in order to obtain not only the higher crop yield but also to improve soil conditions and the quality of crops produced.

Therefore, the main ***objective*** of this research is to justify the ways of collector-drainage water reuse for irrigation taking into consideration the chemical composition, formation peculiarities as well as melioration condition of soil of the territory.

LITERATURE REVIEW

Irrigation and drainage play a critical role in meeting the food requirements of the world's population on a sustainable basis. More than one third of the total global food harvest comes from an estimated 260 million ha of irrigated lands which is about one sixth of the total cultivated land. The World Food Summit convened by FAO in Rome in 1996, the United Nations Conference on the Environment and Development (UNCED) held in Rio de Janeiro in 1992, and the International Conference on Water and Environment, Dublin 1992, have all emphasized the importance of protecting the world's land and water resources in order to produce the necessary food and preserve the environment. [Edited by Chandra A. Madramootoo William R. Johnston and Lyman S. Willardson, 1997]

One of the alternatives to reduce a water resource deficit is a reuse of collector-drainage water (CDW) for irrigation. Reusing CDW also allow to prevent a number of ecological unfavorable effects such as the formation of shores (at places of CDW discharge at closed salty lakes), change of chemical composition change of river where CDW are discharged (Rubanov I.B., 1977).

Drainage water for irrigation have been used since the ancient times at the different places of Central Asia – "At Central Asia the mineralized water of Shirbad river, Tedjen during the vegetation period reach up to 3-4 g/l of solid debris and have been used for irrigation of agricultural crops" (Legostaev, 1961). At the Fergana Valley people initially used drainage water to irrigate grapes, fig, and pomegranate and mulberry trees and then they irrigated rice and cotton. As a result, they harvest high yield (Ibragimov G.A., 1973). People in Egypt has a lot experience of reusing a drainage water: before the construction of dams it occurred naturally, as drainage water was forced again into the Nile where it mixed with flowing fresh water which periodically flooded land (Giuseppe Colombo, 1990). Scientists from Japan together with researchers from Egypt conducted a series of experiments in order to study the possibilities of using poor quality water for the rice growing in salt accumulated field were examined in two experimental field of the Agriculture Research station, El-Sirw, Egypt in years 2003 and 2004 seasons (B.A.Zayed, W.H.El Hassan, 2005).

An interesting experiment of reducing the level of ground water is known in Pakistan – The surrounding area was planted to cotton, rice, and sugarcane. The average water table depth under the eucalypts ranged from 1.4 to 2.7 meters, and in the irrigated crop area surrounding the plantation was 1.1 to 2.1 meters. Soil salinity remained below critical limits in the plantation. Water table drawdown resulted in the groundwater moving as a front toward the eucalyptus plantation area and improved environmental conditions in the surrounding area. (Source – FAO 2002).

Jim Oster, the scientist from California, describes the experiment of growing eucalyptus trees on the salty soil. Growing eucalyptus trees could be part of a water reuse scheme for farmers who, to maintain agricultural production well into the future, must consider adopting measures beyond the currently standard evaporation ponds to dispose of drainage water, said Jim Oster, UC Riverside soil scientist (Jeannette Warnert, 1998).

A lot of experiences of using CDW for irrigation are known in the world practice as well as in Central Asia. During the last several decades, many experiments of using CDW for irrigation were conducted in Uzbekistan (Rachinskiy A.A., 1963, Ramazanov A., Matmuratov D., 1984, Mamatov S., 2007). Mainly these studies focused on studying the possibilities of reusing CDW for irrigation in order to harvest a significant level of yield. In this case the limiting factor of using mineralized water is yield loss. As a rule, the permissible level of CDW concentration was selected that would allowed to harvest the required level of crop yield. However, the literature review shows that for an efficient and economic use of such water, a differentiated plan is needed for the various areas, taking into account some characteristics and constrains such as: hydrologic conditions, soil type, soil and groundwater salinity, crop rotation, quality and quantity of water resources and the conditions of water works (Giuseppe Colombo, 1990).

A scientifically unjustified use of drainage water could lead to various problems including: impairment of soil physical and chemical properties, water related health problems, and possible contamination of food products and etc (Giuseppe Colombo, 1990). Drainage water quality is the major concern in reuse possibilities as it defines which crops can be irrigated and whether long-term degradation of soil productivity is a major issue. On the other hand, the soil type, drainage conditions of the land and the crop salt tolerance define what quality drainage water can be used for irrigation in combination with the availability of other freshwater resources. Previous reuse studies have shown that numerous species ranging from those classified as salt-tolerant (e.g. cotton, certain forages, etc.) to moderately salt sensitive (e.g. tomato and melon) can be grown successfully using saline drainage water (ECi of 7 and 8 mg/L B or higher) applied for the majority of the season (Technical Reuse Report, Steve Grattan1999).

A series of researches were dedicated not only to study the possibility of using CDW for irrigation in order to obtain the required yield but also to save the satisfied meliorative condition of soil. The scientists from California provided a long-term experience of using CDW for growing grass (*Bermundagrass*) for livestock. The drainage water was tested whether saline-sodic drainage and other wastewater can be used for forage and livestock production at 30 ha site in Kings County. Bermuda grass (*Cyanodon dactylon*) was planted in 1999 and grazed rotationally. Livestock trials were carried out for three years (2001-2003) [**S. Kaffka[1], J. Maas[1], M. Alonso[1], J.D. Oster[2], D. Corwin[3], 2007**]. The results of this experiment prove the possibility of using CDW for growing fodder crops (*Cyanodon dactylon, Mellilotus officianalis* and *Koschia scoparia*). The results of using using CDW with the middle level of mineralization for irrigating pastures also indicate that the biomass of crops and nutritional values are the same as well as the reduction in salinity of irrigated lands and decrease of the quantity of discharging drainage water at salty lakes due to its reuse. Also there were not any indications of a negative influence on the final part of food chain – animals.

However, the salinity resistance level of crops also depends on the dynamic character of water-soluble salts in soil and their spread in soil profile, humidification and combination of other factors such as soil type and condition (Ibragimov G., 1973). Different types of soil at the various degrees can have a negative impact on the plant development. Moreover, some salts with identical cations and different anions show their individualities – a series of sulfate Na_2SO_4, $NaHCO_3$, Na_2SO_4, whose harmfulness decreases from first one to the last type. (Rozov, 1936).

In addition to the selection of various types of salt-tolerant plants that capable not only grow using mineralized water for irrigation but also improve the melioration condition of soil, it is offered to implement different techniques. Therefore, the scientists from Australia suggest to use FILTER (Filtration and Irrigated cropping for Land Treatment and Effluent Reuse) technique or system (*N.S. Jayawardane; T.K. Biswas, 2001*). Using this technique was develop to provide a sustainable system for treatment of saline sewage effluent on naturally occurring saline and/or sodic soils. Potentially, it can also be used to ameliorate soils that are salinised by inappropriate application of saline effluent on soils with impeded drainage. The FILTER technique involves using the nutrient-rich effluent for irrigated cropping combined with removal of excess water from the root-zone through a subsurface drainage system, during wet weather and winter periods when evapotranspiration demand is low.

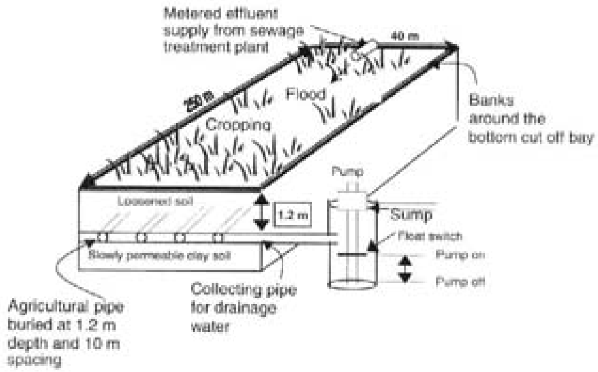


Fig. 1. Schematic diagram of a typical FILTER bay. The three drainpipes used to measure the water table height at the mid-point between the 10-m spaced drains are not shown in this diagram.

A closed hydroponic system was established in the cultivation of single-truss tomato, where drainage was utilized for improving the fruit quality (K. Okano, Y. Sakamoto, S. Watanabe, 2004).

The recommendations for the optimal regime of leaching were developed, the determination of soil solution concentration in the root zone (FAO, 1985). At most of the cases these recommendations were drown without the consideration of chemical processes that occur in soil and water system for the specific type of soil. The most important matter is to adopt these parameters for local conditions.

The above-mentioned information from the literature review proves one more time that using CDW is a real potential possibility for decreasing the deficit of water resources. Nowadays on the territory of the Republic of Karakalpakstan and Djizzak province use CDW for irrigation mixing with water from the channel and during water-short years they use water directly from the collectors without mixing with river water. As a rule, it leads to the deterioration of meliorative soil condition and reduction in the yield of growing crops (Ibragimov, 1973, Mamatov S, 2007). Therefore, it is necessary to consider a series of factors such as: qualitative composition of CDW used for irrigation, meliorative soil conditions, crop type and the technology of irrigation.

The main part of the preservation of satisfied soil condition, harvest of qualitative yield, development of the optimal irrigation technique and procedures is to study physicochemical processes that occur in soil and plants by irrigating this type of water. Therefore, the quantity and quality assessment of CDW at some regions of the Republic of Uzbekistan and study the conditions of their formation is the main objective of this grant research.

Research Methodology and Objects

Planned objectives were achieved by the means of the following methodology:

- Expert evaluation of the suitability level of CDW for reusing for irrigation of agricultural crops (on the example of the northern zone of the republic of Karakalpakstan)
- Creation of an experiment plot for detailed study of changes and trend of soil and plants physiological processes by reusing CDW for irrigation with traditional irrigation technique that is typical for arid area
- Collection and analysis of existing materials from design and operation organizations according the volume of CDW on the large irrigated areas (on the example of Djizzak Steppe)

EXPERIMENTAL PART

1. Brief description of Karakalpakstan

The territory of the Republic of Karakalpakstan is located at the lower delta of Amu Darya river, Ustyurt plateau and northeastern part of Kizilkum desert. The main sector of the republic's economy is agriculture, growing mainly cotton and rice. Livestock is developed at the Prearal area.

At the downstream of Amu Darya River, especially at the delta, the mineralization continuously rise in connection with the increase of water withdraw for irrigation and the discharge of CDW to the river. The source of irrigation water for the Republic of Karakalpakstan is Amu Darya River. During the water-short years, collector water is used for irrigation that is mixed with irrigation water from the channels.

In order to achieve objective of this grant, the followings were conducted:

1. Collection, compilation and analyses of data on flow, withdraw, chemical composition of Main collectors collector-drainage water for 2002-2007 by months average annual indexes for evaluating the suitability level of CDW for reusing it for irrigation
2. Conduct the chemical water analysis of studying collectors and soil samples from experimental plot at the laboratories of Central Asian Scientific-Research Irrigation Institute (CANIRI) and Tashkent Institute of Irrigation and Melioration (TIIM). The methods of plasma photometry (for determining Na), dry residue was determined by the weighing method, chlorine ion – by argentometric method, other elements – by titration method, were used for conducting the analysis of water. The analysis of soil was conducted with the help of using filtration, titration, atomic absorption and chromatographic methods.
3. The quality of CDW was evaluated by four criteria:

a) The SAR criteria was calculated by the following way:

SAR = [Na]/[square root of [Ca]+[Mg]] *100; mg/eqv

(According to existing classification, SAR is satisfactory when its value is up to 18)

b) Contents of Sodium:

PS=Na/([Ca]+[Mg]+[K]+[Na])*100; mg/eqv

(According to existing classification, PS is satisfactory when its value is up to 60)

c) Magnesium alkalinization risk (Sobolch, Daraba classification):

$$Mg=[Mg]/([Ca]+[Mg])*100 \text{ mg/eqv.}$$

(According to Sobolch, Daraba classification, Mg is satisfactory when its value is up to 50)

d) Cl/SO_4 – considering total mineralization and ion content and their proportion: Classification by U.Usmanov:

1. Good
2. Satisfactory
3. Satisfactory with care measures
4. Unsatisfactory

The assessment of collector drainage water (CDW) quality in Karakalpakstan

The quality of CDW was evaluated according to the data received from the Hydromeliorative Expedition of the Republic of Karakalpakstan for 2003-2007. Four collectors of Karakalpakstan were studied - KKS, KS-1, KS-3, KS-4 (figure.1). Every collector is a main canal and has the following characteristics:

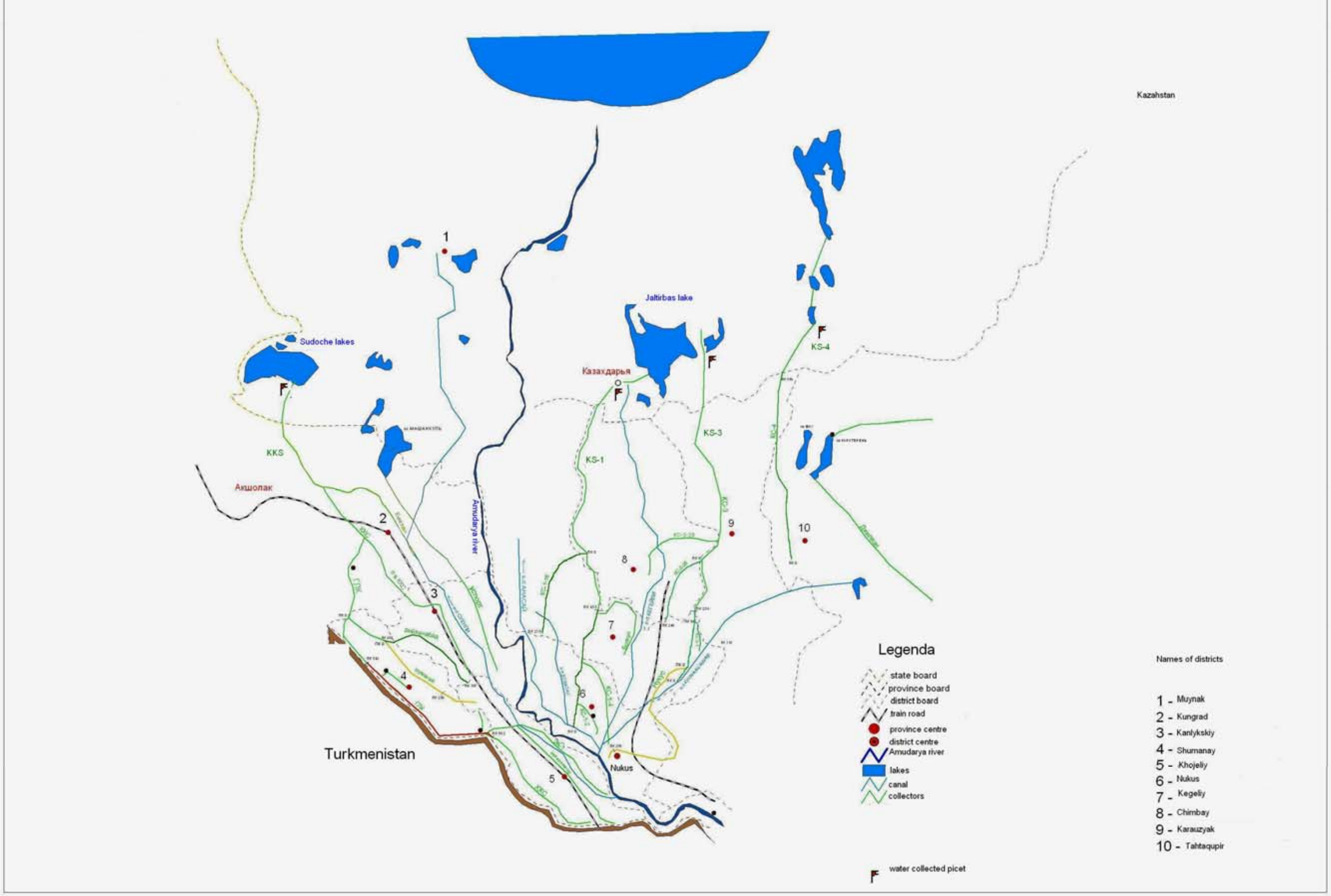
KS-1 – serves to Nukus, Kegeyliy, Chimbay and Muynak regions, total length is 63.34 km, servant area – 1143 ha.

KS-3 and 4 serve to Kegeyli, Chimbay, Karauzyak and Tahtakupir regions. The length of the collector is 430.44 km and servant area is 6653.1 ha.

KKS – main canal, serve Hodjeyli, Shumanay, Kanlikul, Kungrad regions. The length of the collector is 727.5 km and servant area is 1577 km.

The sampling method was used for evaluating the quality of CDW in Karakalpakstan. The water was sampled from the hydro-posts that are located at the tail of the collector, right before discharging into ponds. It helped to determine the most polluted drainage water.

Scheme of collector drainage systems of Karakalpakstan



The collected data contained the information of the chemical composition of CDW: the content of the ions of HCO_3, Cl, SO_4, Mg, Ca, Na and electro conductivity (EC), the annual and monthly information about flow, the level of mineralization and discharge of CDW for the studied collectors. The qualitative and quantitative composition of the content dissolved salt at analyzed water - $CaHCO_3$, $CaSO_4$, $CaCl_2$, $Mg(HCO_3)_2$, $MgSO_4$, $MgCl_2$, $NaHCO_3$, Na_2SO_4, NaCl, $KHCO_3$, K_2SO_4, KCl – were calculated in order to determine the suitability of CDW for irrigation using the above-mentioned four criteria. Moreover, these indexes were calculated for the most intensive period of irrigation – July-August. The results of the analysis are shown at the tables 1-4.

Table 1

Suitability Parameters of Collector-Drainage Water for Irrigation – Collector KS-1

Months	Average mineralization, g/l	Parameters of a degree of suitability				Monthly average flow, m^3/s	Annual, m3
		PS	SAR	Mg	Cl/SO_4		
2003							
July	2,76	57,5	17,2	37,2	5	0.1	267840
August	2,04	37,3	7,2	55,5	3	0,9	2410560
September	2,50	43,5	8,8	52,5	3	0,3	777600
							3456000
2004							
July	1,86	45,1	6,5	44,4	3	0,6	1607040
August	1,94	43,0	6,7	47,3	3	0,4	1071360
September	2,27	38,1	7,1	53,4	3	0,2	518400
							3196800
2005							
July	2,25	44,3	7,3	40,4	3	2,6	6963840
August	2,70	43,9	5,5	40,9	3	2,2	5892480
September	2,96	39,3	7,5	57,9	3	2,1	5224640
							18080960
2006							
July	1.752	33.12	4.3	30.24	3	3.8	10177920
August	1.758	43.86	6.3	52.9	3	1.9	5088960
September	1.995	37.31	5.5	38.5	3	2.8	7257600
							22524480
2007							
July	2.140	23,60	5,00	30,52	3	31	83000000
August	2.561	46,1	5,25	41,85	3	24,1	64500000
September	2.946	42,53	5,7	43,19	3	23,7	61400000

Table 2

Suitability Parameters of Collector-Drainage Water for Irrigation – Collector KS-3

Months	Average mineralization, g/l	Parameters of a degree of suitability				Monthly average flow, m^3/s	Annual, m3
		PS	SAR	Mg	Cl/SO_4		
2003							
July	1,84	45,9	9,9	49,7	3	3,6	9642240
August	2,20	56,2	14,9	57,6	3	5,2	13927680
September	2,46	52,2	9,4	53,2	3	3	7776000
							31345920
2004							

July	1,86	44,4	7,5	45,5	3	5,5	14731200
August	1,94	47,4	10,8	45,6	3	5,2	13927680
September	2,28	47,1	10,5	53,0	3	4,1	10627200
							39286080
			2005				
July	1,83	44,1	7	49,7	3	4,6	12320640
August	2,68	45,5	8,2	56,1	3	7	18748800
September	3,60	51,4	11,5	59,7	4	4,1	10627200
							41696640
			2006				
July	2,78	44,3	8,8	44,1	3	8	21427200
August	3,42	47,4	10,6	65,9	4	10,2	27319680
September	3,41	43,7	8,9	36,6	4	8,9	23068800
							71815680
			2007				
July	3.122	47,99	5,45	25,70	3	7,2	19284480
August	2.366	34,736	4,6	19,63	3	8,3	22230720
September	3.906	47,1	8	59	3	6,2	16100000
							55400000

Table 3

Suitability Parameters of Collector-Drainage Water for Irrigation – Collector KS-4

Months	Average mineralization, g/l	Parameters of a degree of suitability				Monthly average flow, m^3/s	Annual, m3
		PS	SAR	Mg	Cl/SO_4		
			2003				
July	1.464	40.38	8.4	49.71	3	4.9	27855360
August	1.409	45.82	6.2	54.51	3	1	10981440
September	1.416	37.13	6.3	43.47	3	2,2	5702400
							15802560
			2004				
July	2.509	47.67	8.5	47.98	3	1,6	4285220
August	1.476	28.35	3.3	51.98	3	1.8	4821120
September	1.44	40.98	5	57.61	3	2.9	7516800
							12337920
			2005				
July	2.535	38.52	7.3	45.55	3	0.6	1607040
August	0.881	28.5	2.4	40.5	2	2.3	6160320
September	1.209	3.5		43.8	2	4	10368000
							18135360
			2006				
July	1.752	33.12	4.3	30.24	3	3.8	10177920
August	1.758	43.86	6.3	52.9	3	1.9	5088960
September	1.995	37.31	5.5	38.5	3	2.8	7257600
							24606720
			2007				
July	2.671	37,89	3,55	51,56	3	3,8	10177920
August	2.439	40,326	4,67	19,63	3	2,9	7767360
September	2.678	42.533	5.78	36.63	3	4,2	10886400
							28831680

Table 4

Suitability Parameters of Collector-Drainage Water for Irrigation – Collector KKS

Months	Average mineralization, g/l	Parameters of a degree of suitability				Monthly average flow, m^3/s	Annual, m3
		PS	SAR	Mg	Cl/SO_4		
2003							
July	2.1	44.62	8.5	42.57	3	1.7	4553280
August	1.83	45.72	9.8	49.71	3	4.1	10981440
Sept.	1.9	51.6	10.7	40.62	3	3.5	9072000
							15534720
2004							
July	1.932	40.23	4	55.27	5	1.4	9072000
August	2.106	41.93	6.8	50.77	3	3.6	9642240
Sept.	2.677	46.83	8.7	46.14	3	2.2	5702400
							24416640
2005							
July	2.009	37.05	7.5	59.1	3	0.9	2410560
August	2.152	37.28	5.3	58.73	5	1.2	3214080
Sept.	2.236	31.84	4.5	56.85	3	3	7776000
							13400640
2006							
July	2.209	36.52	5.8	42.52	3	21.7	58121280
August	2.259	36.53	5.5	52.83	3	22.8	61067520
Sept.	2.408	42.68	6.7	51.37	3	20.9	54172800 **173361600**
2007							
July	3.245	25,95	5,69	9,90	3	18,1	48479040
August	3.334	32,522	4,66	41,78	3	21,5	57585600
Sept.	2.488	32.737	3.8	40.42	3	17,0	44064000
							150128640

The literature review shows that one of the conditions to preserve the ecological stability of soil while using CDW for irrigation is a compliance with the agro-meliorative techniques. The leaching process during a winter season also plays an important role. With this purpose the volumes of CDW that are applicable for irrigation during a winter season – December-February, were also evaluated with the help of three indexes and estimating salt content. The assessment results are shown at tables 5-8.

Table 5

Suitability Parameters of Collector-Drainage Water for Leaching – Collector KS-1

Months	Average mineralization, g/l	Parameters of a degree of suitability				Monthly average flow, m^3/s	Annual, m3
		PS	SAR	Mg	Cl/SO_4		
Dec.2003	2.173	33,614	3,47	63,11	3	6,4	5300000
Jan.2004	2.975	32,53	3,9	66,41	3	8,2	14700000
Feb.2004	4.619	45,166	7,82	60,05	4	4,8	8300000
							28300000

Dec.2004	4.692	41,782	7,77	58,3	4	1,9	10000000
Jan.2005	2.268	34,721	3,6	25,86	3	3,9	16100000
Feb.2005	3.762	40,936	7,35	37,82	4	5,7	14300000
							40400000
Dec.2005	3.294	50,803	7,52	23,79	3	18,8	23000000
Jan.2006	3.259	48,121	7,28	53,9	3	15,9	14000000
Feb.2006	5.284	53,086	10,66	49,71	5	2,8	13000000
							50000000
Dec.2006	3.645	40,291	8,18	39,72	3		11000000
Jan.2007	3,77	45,92	8,87	22,02	4		14000000
Feb.2007	5,79	43,037	9,13	56,47	4		11000000
							36000000

Table 6

Suitability Parameters of Collector-Drainage Water for Leaching – Collector KS-3

Months	**Average mineralization, g/l**	**Parameters of a degree of suitability**				**Monthly average flow, m^3/s**	**Annual, m3**
		PS	**SAR**	**Mg**	**Cl/SO_4**		
Dec.2003	2.173	33,614	3,47	63,11	3	5	5300000
Jan.2004	2.975	32,53	3,9	66,41	3	5,5	14700000
Feb.2004	4.619	45,166	7,82	60,05	4	3,3	8300000
							28300000
Dec.2004	4.692	41,782	7,77	58,3	4	3,8	10000000
Jan.2005	2.268	34,721	3,6	25,86	3	6	16100000
Feb.2005	3.762	40,936	7,35	37,82	4	5,9	14300000
							40400000
Dec.2005	3.294	50,803	7,52	23,79	3	8,6	23000000
Jan.2006	3.259	48,121	7,28	53,9	3	17,7	14000000
Feb.2006	5.284	53,086	10,66	49,71	5	8,3	13000000
							50000000
Dec.2006	3.645	40,291	8,18	39,72	3	4,1	11000000
Jan.2007	мар.77	45,92	8,87	22,02	3	5,4	14000000
Feb.2007	май.79	43,037	9,13	56,47	5	4,6	11000000
							36000000

Table 7

Suitability Parameters of Collector-Drainage Water for Leaching – Collector KS-4

Months	**Average mineralization, g/l**	**Parameters of a degree of suitability**				**Monthly average flow, m^3/s**	**Annual, m3**
		PS	**SAR**	**Mg**	**Cl/SO_4**		
Dec.2003	1.683	18,172	1,35	56,61	3	1,95	5200000
Jan.2004	2.199	32,121	3,24	56,05	3	1,5	4000000
Feb.2004	2.054	32,915	3,22	53,56	4	2,1	5300000
							14500000
Dec.2004	2.792	42,423	5,44	50,42	4	0,7	1900000
Jan.2005	2.835	47,178	6,22	47,53	3	1,4	3700000
Feb.2005	3.265	34,176	5,48	49,71	4	2	4800000

							1040000
Dec.2005	1.038	37,924	2,73	19,82	3	1,1	2900000
Jan.2006	0.936	4,331	0,24	39,72	3	2,6	7000000
Feb.2006	1.279	26,175	1,94	69,75	5	3,2	7700000
							1760000
Dec.2006	2.069	13,408	1,19	69,75	3	1,7	4600000
Jan.2007	2.194	33,135	3,46	47,33	4	1	2700000
Feb.2007	4.104	42,334	8,87	44,16	4	0,7	1700000
							9000000

Table 8

Suitability Parameters of Collector-Drainage Water for Leaching – Collector KKS

Months	Average mineralization, g/l	Parameters of a degree of suitability				Monthly average flow, m^3/s	Annual, m3
		PS	SAR	Mg	Cl/SO_4		
Dec.2003	2,601	17,034	3,47	63,11	3	6,4	5300000
Jan.2004	2,941	32,53	3,9	66,41	3	8,2	14700000
Feb.2004	3,934	45,166	7,82	60,05	4	4,8	8300000
							28300000
Dec.2004	2,479	41,782	7,77	58,3	3	1,9	10000000
Jan.2005	2,863	34,721	3,6	25,86	3	3,9	16100000
Feb.2005	3,053	40,936	7,35	37,82	3	5,7	14300000
							40400000
Dec.2005	2,488	50,803	7,52	23,79	3	18,8	23000000
Jan.2006	2,348	48,121	7,28	53,9	3	15,9	14000000
Feb.2006	5,39	53,086	10,66	49,71	5	2,8	13000000
							50000000
Dec.2006	6,183	40,291	8,18	39,72	5	17,1	11000000
Jan.2007	2,354	45,92	8,87	22,02	3	8,3	14000000
Feb.2007	3,577	43,037	9,13	56,47	3	10	11000000
							36000000

The analysis of the heavy metals' content indicated that at the composition at irrigated water samples of main collector (KS-1 and KS-3) the heavy metals were not found. However, the other two collectors (KKS and KS-4) contain Cr that exceeds the permissible level of Cr at 5 times.(Table 9-10)

Table 9

Consisting of heavy metal into the irrigated water samples

Collector	Ni	Cr
KS-1	**H/O**	**H/O**
KS-3	**H/O**	**H/O**
KKS	**H/O**	**5**
KS-4	**H/O**	**5**

Table10

Pesticide, mg/kg

	α	γ	DDE	DDT
KS-1	H/O	H/O	H/O	H/O
KS-3	H/O	H/O	H/O	H/O
KKS	H/O	H/O	0,0009	H/O
KS-4	H/O	H/O	H/O	H/O

The content of prohibited types of pesticides was not determined, except for the collector KKS where a small amount of DDE was found.

Djizzak Region

The second object of the research was Djizzak province as a province that contains significant reserves of CDW, whose main part discharges at Arnasay depression that deteriorates the ecological environment of the region. Figure 2 displays the region map with the collector-drainage network. The data were collected from the secondary sources for years of 2002-2006 (indexes of flow, mineralization, discharge, the content of chlorine ions at water).

On the base of data from Hydromeliorative expedition of Djizzak region, the primary assessment of CDW was made, choosing the main collectors at this region (CK-9, CK-11, Pogranichniy, ARC-11, CK-12, KLI). The assessment was based on the content of chlorine-ion and mineralization level of CDW. In 2001-2004 the heightened content of chlorine and mineralization level were observed (3,5-4,5 gr/l in 2002, 2,3-2,9 gr/l in 2005-2006, that is referred to the «weakly saltish» type according to the international classification) (Appendix 1-4). It indicates about the possibility of CDW reusing for irrigation in this region. However, due to the absence of the broader (elemental) analysis of CDW quality, the assessment using four above mentioned criteria was impossible to conduct.

The experimental plot with the size of 1 ha was created on the territory of "Yorlakab" farm, Zamin region, Djizzak province in order to study the changes of soil, chemical and physiological processes. The area was divided into 3 plots. Growing crops on these plots were irrigated by three types of water: water from irrigation channel, water from collector and mixed canal and drainage water (Figure 3).

As it is described in the literature review about the CDW, it is necessary to take into consideration the hydrological characteristics, physicochemical indexes of soil and irrigated water. As a result, soil cut(profile)s (by 2x1m size that reach the ground water table) were made on the whole area of three plots before seeding winter wheat. It provide the full description of soil horizons, soil samples for each soil horizon from three cuts were taken, the physicochemical analysis of these samples was conducted as well as the analysis of groundwater samples from each cut. The complete chemical analysis of three types of irrigation water was conducted. Winter wheat of "Moskvich" variety was seeded at the first decade of November 2007.

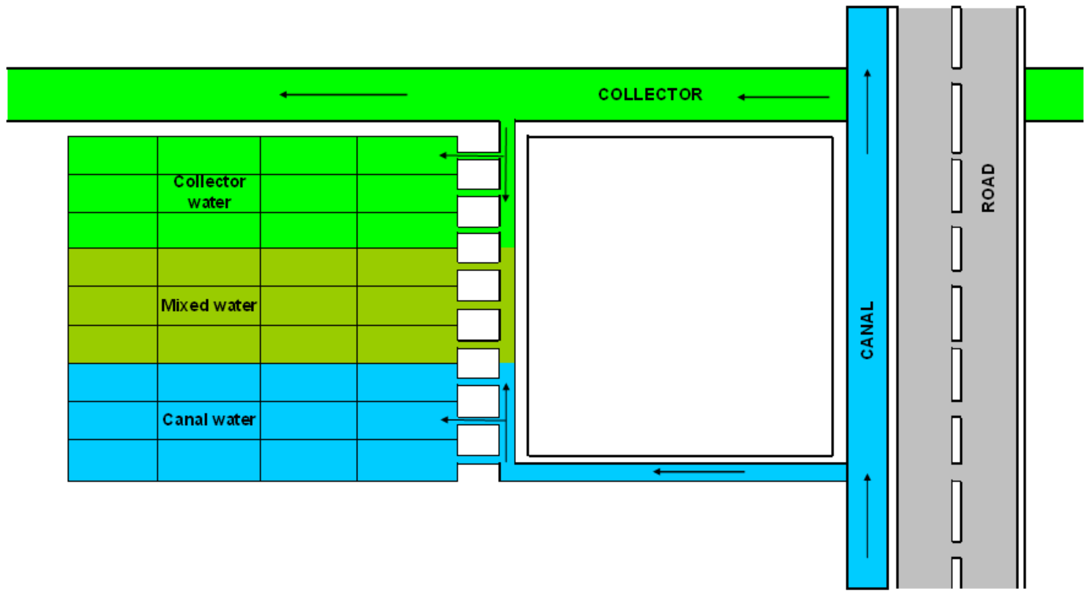


Figure.3 Scheme of the experimental plot

The results of the analysis are shown in the tables 11-19.

The chemical analysis of groundwater sampled from each cut showed the predominance of sulfate salts – magnesium, calcium and sodium. Their total content at the first cut was 70%, 80% at the second one and 75% at the third one from the total content of salts in soil profile. SAR, PH and magnesium content were calculated (table 11). Also the chemical analysis of irrigation water samples was conducted. The water samples were collected from collector, canal and from the point of mixing water (table 12). At these types of water the predominance of sulfates at each type of water was observed at the level of about 80%. According to the two criteria from the table – SAR and PH – the type of water is suitable for irrigation. However, there is some excess of magnesium.

Table 11

Salt content in canal, mixed and drainage water

Collector	Data	Total mineralization	Salt content										Sum of ions	PN	SAR	Mg	Cl/SO_4	Sulfates content
			Ca(HCO)	$CaSO_4$	CaCl	$Mg(HCO)_3$	$MgSO_4$	K2SO_4	$MgCl_2$	Na_2SO_4	KCl	NaCl						
Water from canal	Oct, 2007		0,275	0,516			0,475	0,01		0,312		0,3	1,87	33,20	3,07	41,82	1	70,2139
Mixed water	Oct, 2008		0,324	0,679			1,069	0,02		0,834		0,32	3,24	34,91	4,30	55,96	3	80,30864
Water from collector	Oct, 2009		0,34	0,801			1,187	0,017		0,794		0,53	3,7	36,09	4,80	55,27	3	75,64865

Table 12

Salt content in the ground water from cuts

Collector	Data	Total mineralization	Salt content										Sum of ions	ПН	SAR	Mg	Cl/SO_4	Sulfates content
			$Ca(HCO)_3$	$CaSO_4$	CaCl	$Mg(HCO)_3$	$MgSO_4$	K_2SO_4	$MgCl_2$	Na_2SO_4	KCl	NaCl						
Ground water from soil profile #1	Oct, 2007		0,552	1,03			1,781	0,06		2,065		0,62	6,11	43,21	7,83	57,41		80,7856
Ground water from soil profile#2	Oct, 2008		0,502	1,004			1,899	0,057		1,949		0,62	6,03	41,69	7,42	60,10		81,42312
Ground water from soil profile#3	Oct, 2009		0,486	0,95			2,225	0,059		1,381		0,59	5,69	33,89	5,56	65,25		81,10721

The table shows that the water from the canal contains a less amount of magnesium. However it increases as more volume of collector water added. One of the main reasons for containing magnesium salts at irrigation water can be also an inflow of magnesium from the fields that are located at upper stream. The groundwater, sampled from different cuts, also contains varies amounts of magnesium that is higher compared to the irrigation and collector water. Though at the first cut, the closest one to the collector has a less amount of magnesium (57.41), the index at the following cut was 60.10 and the most remote cut from the collector had a maximum content and even exceeded the permissible limit. Therefore, it can be made an assumption that the main factor of forming collector water is groundwater because the fertilizers containing magnesium were not applied on the experimental plot for a long time, the irrigation water does not contain magnesium and it leads to the conclusion that the main source of magnesium at collector water is groundwater. It can be proved by the geological fact about this region where the main rock forming mineral is epsolit ($MgSO_4 \bullet 7H_2O$) and bloedite that are easily soluble salts and because of the intensive rise of groundwater during the last decades it increase the risk of magnesium salinization of this region. The difference of this index by the size can be explained by the different degree of draining sub-plots. Thus, the closes sub-plot to the collector has a better degree of draining and larger salt ejection from soil, respectively. The sub-plot located at the most remote distance from the collector has the smallest degree of draining and salt ejection, respectively.

The studied soil cuts had 6 genetic horizons. The ground water table was located on the depth of 180, 160 and 167 cm (according to the number of the cut). The analysis of mechanical composition of horizons of soil samples (according to the methodology of Kachinskiy N.A.) showed that at the cuts the upper layers (0-30, 30-43, 43-58 cm) refers to the heavy loamy soil, the layers located below (below 90 sm) – medium and light clay. Only at the third cut at the depth of 40-68 sm is light clay (table 13-14). The content of physical clay range 35,8 - 76,9%. Therefore, the soil of experimental plot can be referred to the category of heavy soil. At these conditions the CDW reuse for irrigation requires specific approaches and technologies considering all existing factors that have influences in order to prevent long-term negative consequences.

The morphological description of soil cuts were conducted that showed the following results:

Cut №1:

- at the depth of 0-30 sm the soil is lightly grey, the upper part is dry, has heady mechanical content, averagely compacted, water-soluble white crystals dots are in soil profile, the composition is nuciform. It also has many plant roots and solo reed roots can be found below. At the top of the horizon the passages of earth worms can be seen.

- at the depth of 30-43 sm the soil is lightly grey, freshly moistened, heavy loamy soil, compacted, gypsum nails are clustered at this horizon. It has an average amount of plant roots. The passage to next horizon by color.

- at the depth of 43-58 sm the soil is dark grey, moistened, has a cloddy structure, has some plant roots. It has a passage to the next horizon by the mechanical composition and color.

- at the depth of 58-91 sm the soil is light grey, moistened, medium-loamy, slightly compacted, has a layer structure, has a small amount of reed roots. It has a passage to the next horizon by the density.

- at the depth of 91-127 sm the soil is light grey, moistened, clayey mechanical composition, has a lot of small and some number of large roots. It has a passage to the next horizon by the density.

- at the depth of 127-150 sm the soil is light grey, with dark spots, the upper part of horizon is moistened, medium compacted. The lower part of horizon has groundwater.

Cut № 2. Irrigated serous- pratal soil, heavily loamy soil, low level of salinity.

- at the depth of 0-25 sm the upper level is dry, heavily loamy, medium compacted, lumpy-powdered, has a big amount of root with different diameters, also has passages of earthworms. It has a passage to the next horizon by the color.

- at the depth of 25-42 sm the soil is dark grey, quite moistened, loamy, heavily compacted, has large roots. It has a passage to the next horizon by the color.

- at the depth of 42-61 sm the soil is light grey, moistened, medium loamy, medium compacted, has a lumpy structure, sometimes rusty spots can be found, has some partially decomposed roots. It has a passage to the next horizon by the color.

- at the depth of 61-86 sm the soil is light grey, moistened, medium loamy, medium compacted, cane roots can be met more frequently. It has a passage to the next horizon by the mechanical structure and moisture.

- at the depth of 86-120 sm the soil is light grey, moistened, medium loamy, medium compacted, cane roots can be met very often. It has a passage to the next horizon by the mechanical structure.

- at the depth of 120-160 sm the soil is light grey, heavily moistened, clayey, slightly compacted, rusty spots can be met. There is water at the depth of 160 sm.

Cut №3 – It completely match with the horizons from the cut №2.

The analysis of nutrients content at studied soils showed that soil has a lower content of movable potassium and phosphor, only at the upper level (0-30 and 27-40 sm) of the first and second cuts the content of movable potassium is has an average level (more 200 mk/kg) (table 15). The humus content at the upper level ranges 1.13-1.23%, gross content of nitrogen ranges 0.73-0.137%, the phosphorus content – 0.043-0.096% and gross content of potassium – 1.16-1.63%. Therefore, the soil of experiment plot can be characterized as poor availability of organic matters.

According to the results of water infusion, the conclusions were made about the type of soil salinity that is characterized as chloride- sulfate and known as strong and medium salinization. The content of SO_4^{2-} ions range from 0,078 to 0,494 mg.eqv (table 16). Only the content of the second horizon of the second cut has 0,078 mg.eqv of SO_4^{2-} ions that corresponds to the nonsaline type of soil (according to the classification of the salt by Egorov V. and Minashin N., 1976).

The table 17 displays the analysis of absorbed matters and absorbing capacity. Using this table some recommendations can be made (according to the methodology of Kimberg N.V. and Kochubey. M.I., 1960) about the soil salinity level of the studied area.

The gypsum and carbonates' content by cuts (table 18) varies the following way:

- gypsum content of the first cut decreases with the depth up to 91 sm – from 0.95 to 0.259%. At the next two horizons (91-180 sm) the increase of gypsum content is observed – from 0.769 to 1.356%. The carbonate distribution among horizons is similar – ranges within the limits of 7.09 and 7.44%, only at the horizon 91-127 sm is 8.14%.

- It is observed a fluctuation of gypsum quantity at the second cut that ranges from 0.399 to 0.985%. The carbonate distribution varies within wider limits – from 7 to 9.2%.

- the third cut displays a fluctuation of gypsum quantity from 3.62 to 1.727%. The carbonate content ranges from 6.16 to 8.23%.

Moreover, the cut 1 and 3 contained the larger amount of gypsum concentration at the deepest horizons while the second one – at the depth of 42-61 sm.

Based on the received results of micro-aggregate and mechanical composition of cuts the data were calculated by the aggregation level of root and sub-root horizons of studies area. Therefore, the soil aggregation of the first plot was 32% at both horizons, at the second one – 25.7-24.9% respectively and 25% at the third one (table 22 and 23).

Table 13

Micro aggregate composition

Cut #	Deep, sm	Fraction's weight, %								
		>0,25	0,25-0,1	0,1-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	Physical clay	Physical sand
1	0-30	2,5	1	12,1	54,7	20,3	7,9	1,5	29,7	70,3
	30-43	3,5	1	12,7	53,4	21,8	6,6	1	29,4	70,6
2	0-25	4	1	15,6	49,7	16,5	11	2,2	20,7	79,3
	25-42	4,5	1,5	19,9	39,8	16,2	12	6,1	34,3	65,7
3	0-27	4,5	2	15,5	41,2	17,8	13	6	36,8	63,2
	27-40	1,5	0,5	18,7	41,9	9,3	14,8	7,3	31,4	68,6

Table 14

Mechanical composition (by Kachinskiy method)

Cut #	Deep, sm	Fraction's weight, %									
		>0,25	0,25-0,1	0,1-0,05	0,05-0,01	0,01-0,005	0,005-0,001	<0,001	Physical clay	Physical sand	Note
1	0-30	2,3	0,7	11,4	33,3	10,4	21,8	20,1	52,3	47,7	loamy heavy
	30-43	2,7	0,8	15,9	29,9	14,1	19,9	16,7	50,7	49,3	loamy heavy
	43-58	2	0,5	13,9	30,5	13,2	18,7	21,2	53,1	46,9	loamy heavy
	58-91	0,7	0,3	51	12,2	10	11,7	14,1	35,8	64,2	loamy middle
	91-127	0,3	0,2	2	21,3	16,5	27,9	31,8	76,2	23,8	Clay middle
	127-180	1,5	0,8	5,2	23	14	28,4	27,1	69,5	30,5	Clay light
2	0-25	3	1	10,5	33,2	13,1	18,3	20,6	52,3	47,7	loamy heavy
	25-42	3	1,2	21,7	20,5	12,4	18,6	22,6	53,6	46,4	loamy heavy
	42-61	0,7	0,3	5,7	35	15,7	19,9	22,7	58,3	41,7	loamy heavy
	61-86	1,5	0,5	5,6	55,6	9,7	12,8	14,3	36,8	63,2	loamy middle
	86-120	0,7	0,3	5	36,9	17	15,2	24,9	57,1	42,9	loamy heavy
	120-160	1	0,5	9,1	23,4	12	26,1	27,9	66	34	Clay light
3	0-27	3	1	11,6	26,7	13,5	21,9	22,3	57,7	42,3	loamy heavy
	27-40	2	0,5	9	32	11,7	21,6	23,2	56,5	43,5	loamy heavy
	40-68	0,7	0,3	3,5	33,4	17,7	24,2	20,2	62,1	37,9	Clay light

	68-93	3	1	10,2	29,9	11,9	22,5	21,5	55,9	44,1	loamy heavy
	93-135	2,3	0,7	8,6	18,9	14,1	31,7	23,7	69,5	30,5	Clay light
	135-167	1,5	0,5	6,8	14,3	15,4	36,7	24,8	76,9	23,1	Clay middle

Table 15

Content of nutrient

Cut #	Deep, sm	Humus, %	Gross, %			Movable, мк/кг		Comment	
			N	P_2O_5	K_2O	P_2O_5	K_2O	P_2O_5	K_2O
1	0-30	1,13	0,137	0,084	1,25	16,93	275	Low	Middle
	30-43	0,97	0,102	0,096	1,62	8,67	140	Very low	Low
	43-58	0,86	0,084	0,056	1,5	7,33	123	Very low	Low
	58-91	0,64	0,07	0,037	1,25	5,33	83	Very low	Very low
	91-127	0,53	0,056	0,064	1,37	10	131	Very low	Low
	127-180	0,32	0,025	0,02	1,1	11,47	100	Very low	Low
2	0-25	1,15	0,106	0,045	1,43	15,32	145	Low	Low
	25-42	0,75	0,078	0,074	1,63	8	80	Very low	Very low
	42-61	0,69	0,073	0,064	1,1	9,47	75	Very low	Very low
	61-86	0,51	0,053	0,047	1,5	8	60	Very low	Very low
	86-120	0,5	0,05	0,017	1,8	8	75	Very low	Very low
	120-160	0,38	0,026	0,023	1,62	13,46	70	Very low	Very low
3	0-27	1,23	0,106	0,057	1,63	23,06	160	Low	Low
	27-40	0,97	0,093	0,043	1,16	9,73	233	Very low	Middle
	40-68	0,6	0,052	0,017	1,1	6,67	80	Very low	Very low
	68-93	0,45	0,04	0,071	1,1	12,8	103	Very low	Low
	93-135	0,44	0,034	0,065	1,25	9,47	118	Very low	Low
	135-167	0,31	0,027	0,53	1,2	13,46	75	Very low	Very low

Table 16

Water extract composition, in %% to air-dry soil

Cut #	Deep sm	Solid residue	Alkalinity		Cl	SO4	Ca	Mg	Anions, cations	Na on difference		Component's sum%	Comment
			в CO_3	Total in HCO_3						Mg.eqv	%%		
1	0-30	0,865		0,03	0,045	0,494	0,075	0,043	12,03	4,76	0,109	0,781	nonsaline
				0,49	1,27	10,27	3,74	3,53	7,27	1,27			
	30-43	0,68		0,033	0,017	0,374	0,085	0,04	8,8		0,029	0,562	lowsaline
				0,54	0,48	7,78	4,24	3,29	7,53				
	43-58	0,225		0,037	0,014	0,103	0,015	0,021	3,14	0,66	0,015	0,187	lowsaline
				0,61	0,39	2,14	0,75	1,73	2,48				
	58-91	0,21		0,033	0,01	0,101	0,02	0,012	2,92	0,93	0,021	0,181	nonsaline
				0,54	0,28	2,1	1	0,99	1,99				
	91-127	0,505		0,027	0,017	0,269	0,055	0,03	6,51	1,3	0,029	0,414	lowsaline
				0,44	0,48	5,59	2,74	2,47	5,21				
	127-180	0,76		0,027	0,021	0,422	0,11	0,037	9,81	1,28	0,029	0,633	lowsaline
				0,44	0,59	8,78	5,49	3,04	8,58				
2	0-25	0,52		0,03	0,028	0,267	0,055	0,037	6,79	1,01	0,023	0,425	lowsaline
				0,54	0,2	1,62	1,25	0,49	1,74				
	25-42	0,165		0,033	0,007	0,078	0,025	0,006	2,36	0,62	0,014	0,147	nonsaline
				0,54	0,2	1,62	1,25	0,49	1,74				
	42-61	0,54		0,3	0,01	0,321	0,08	0,033	7,45	0,74	0,017	0,446	nonsaline
				0,49	0,28	6,68	4	2,71	6,71				
	61-86	0,56		0,024	0,01	0,308	0,095	0,018	7,08	0,86	0,019	0,462	nonsaline
				0,39	0,28	6,41	4,74	1,48	6,22				

	86-120	0,385		0,027	0,014	0,216	0,045	0,027	5,32	0,85	0,019	0,335	lowsaline
				0,44	0,39	4,49	2,25	2,22	4,47				
	120-160	0,79		0,027	0,014	0,42	0,11	0,027	9,57	1,86	0,042	0,627	lowsaline
				0,44	0,39	8,74	5,49	2,22	7,71				
3	0-27	0,23		0,03	0,021	0,099	0,03	0,012	3,14	0,65	0,014	0,191	lowsaline
				0,49	0,59	2,06	1,5	0,99	2,49				
	27-40	0,21		0,037	0,007	0,105	0,02	0,021	2,99	0,26	0,006	0,178	nonsaline
				0,61	0,2	2,18	1	1,73	2,73				
	40-68	0,55		0,024	0,014	0,304	0,07	0,027	7,1	1,39	0,031	0,458	lowsaline
				0,39	0,39	6,32	3,49	2,22	5,71				
	68-93	0,61		0,027	0,01	0,343	0,1	0,027	7,85	0,64	0,014	0,508	nonsaline
				0,44	0,28	7,13	4,99	2,22	7,21				
	93-135	0,735		0,021	0,014	0,411	0,1	0,04	9,28	1	0,023	0,599	lowsaline
				0,34	0,39	8,55	4,99	3,29	8,28				
	135-167	0,79		0,021	0,014	0,44	0,07	0,061	9,96	1,46	0,033	0,633	lowsaline
				0,34	0,39	9,23	3,49	5,01	8,5				

Table 17

Absorbed bases and absorbing capacity of soil; %

Cut #	Depth, sm	мг-экв на 100г почвы				Sum	Calculated in %			
		Ca	Mg	K	Na		Ca	Mg	K	Na
	0-30	3,4	4,4	0,45	1,06	9,31	36,52	47,36	4,83	11,38
	30-43	3,6	3,8	0,45	0,49	8,34	43,16	39,33	5,4	5,57
	43-58	4,4	3,8	0,38	0,49	9,07	48,51	41,4	4,19	5,4
	58-91	4	3,8	0,27	0,93	9	50	41	3,38	11,62
	91-127	3,6	3,2	0,35	0,86	8,01	40,4	36,81	3,93	9,65
P-1	127-150	4,4	3,6	0,31	1,26	10,07	43,69	35,75	3,08	12,51
	0-25	4,4	3	0,45	4,05	8,9	49,44	33,71	5,06	11,8
	25-42	4,8	2,8	0,38	0,65	8,63	55,61	32,44	4,4	7,53
	42-61	6	4,4	0,38	0,93	11,71	51,24	37,57	3,25	7,94
	61-86	5,6	2,8	0,31	0,65	9,36	58,33	29,16	3,31	6,94
	86-120	4,8	3,6	0,31	1,21	9,92	48,38	36,29	3,31	12,7
P-2	120-160	5,2	4	0,31	1,49	11	47,27	36,36	2,82	13,36
	0-27	4,8	4,4	0,51	1,21	10,92	43,96	40,29	4,67	11,08
	27-40	4,4	4,8	0,51	0,65	10,36	41,51	45,28	4,81	6,27
	40-68	5,6	4,4	0,35	0,65	11,03	50,77	39,39	3,45	5,9
	68-99	5,4	3,8	0,35	0,65	10,23	52,78	37,14	3,71	6,35
	99-135	4,4	4,8	0,31	0,93	10,44	42,15	45,97	2,97	8,91
P-3	135-167	5,6	4	0,35	1,49	11,59	48,32	34,51	3,02	12,85

Table 18

Carbonate composition

Cut #	Deep, sm	Gipsum	CO_2
1	0-30	0,95	7,13
	30-43	0,82	7,09
	43-58	0,345	7,3
	58-91	0,259	7,11
	91-127	0,769	8,14
	127-180	1,356	7,44
2	0-25	0,613	7,32
	25-42	0,445	7
	42-61	0,985	8,54
	61-86	0,899	9,2
	86-120	0,484	8,4
	120-160	0,399	7,26
3	0-27	0,362	7,3
	27-40	0,53	7,6
	40-68	1,031	8,23
	68-93	0,993	8,23
	93-135	1,373	7,35
	135-167	1,727	6,16

The physicochemical content of experimental plot soil was composed; the results are shown in the table 19.

Table 19

Chemical content of the experimental plot soil

Cut №	Salinity Index (content, %)			Content , %		Agrochemical indicators , %			
	Sum of toxic soils	Cl - ions	Na	Gypsum	Carbonates	Humus	Total Content		
							N	P	K
1	0,5-0,8	0,01-0,045	0,021-0,109	0,259-0,769	7,09-7,44	0,32-1,13	0,025-0,137	0,02-0,96	1,25-1,62
2	0,37-1,2	0,024-0,033	0,017-0,042	0,316-1,399	7,00-9,20	0,38-1,15	0,026-0,106	0,017-0,074	1,1-1,8
3	0,147-0,707	0,007-0,021	0,006-0,033	0,362-1,727	6,16-8,23	0,31-1,23	0,027-0,106	0,017-0,065	1,2-1,63

DISCUSSION

The analysis of CDW quality assessment of main collector in Karakalpakstan using four criteria showed the availability of the potential additional water reserves that can be used for irrigation during the intensive irrigation seasons (July-September) as well as for leaching of salty soil (December-February). As the tables 1-4 display information for four collectors, the suitable water volume for irrigation at the most intensive irrigation period (July-August) is about 85-90% for from the total annual flow for collector KKS, 80-90% for KS-1, 35-40% for KS-3 and 75-81% for KS-4 respectively. Moreover, during the last studied years (2006-2007) it was observed the higher (satisfied to all four categories of years) indexes of CDW quality. The biggest increase was observed at the magnesium salinization (Mg>60). According to the data of hydro-chemical bulletins of river water quality (Glavhydromed of the Republic of Uzbkekistan) it was observed an excess of Mg content at river water at the conditions of downstream of Amu Darya during the water-short years. The research results showed that the regime of formation of ground water for irrigated land depends of the plot location and usually occurs under the influence of the level of Amu Darya river and irrigation canals as well as the quantity of irrigation water used for irrigation. The occurrence depth and mineralization of ground water of irrigated land change depending on the water availability of the year. During high-water year the area with the level of ground water is close to the surface is increased and decreases during the years of water shortage.

The ground water studied at this region is a main source of CDW that plays an important role at the formation of their quality and quantity. The runoff of drainage water, formed on the irrigated land of the Aral region, is increase during the high-water year ranging from 0.7 to 2.4 km^3/year, and mineralization of water changes ranging from 1.5 to 6 g/dm^3.

On other side, the drainage water, formed from ground water of irrigated land, is a main impacting factor on the CDW quality and water of Amu Darya river. The degree of this effect changes depending on the water availability and the season. At the high-water year the impact of ground water on the CDW quality decreases and at the water-shortage year increases. Also during the period of decrease of the natural runoff at the river (winter, spring, a loamy utumn), the impact of the ground water on the CDW quality increases. During the summer period, when the water flow at the river increases, the impact of the ground water on the CDW quality becomes the least one.

It is also necessary to take into consideration the fact that the geology of the region plays an important role at the formation of CDW because it has a significant effect on the composition of ground water as well as the formation of collector water. Thus, collectors KS-1 and KS-3 flow through the territory of Kashkanatauskiy deposit of neogenic salts where main rock forming minerals are bloedite - $MgSO_4 \cdot Na_2SO_4 \cdot 4H_2O$ (60%), halite -NaCl (20%), mirabilite Na_2SO_4 (10%) and others. In turn, magnesium salts are easily soluble. As underground water rises from the deep deposit, salts most likely are dissolved in it and go up into the upper soil level that results into the increase of magnesium concentration at the upper level of soil profile and CDW, respectively. Partially such an assumption is proved by the analysis of the quality index excess for magnesium at the different time of the vegetation period.

One of the main factors, having an influence on the CDW quality, is the quality of irrigation water delivered to the field. Thus, the exceeding the permissible limit of magnesium was not observed in July because during the period of an intensive irrigation, river has a sufficient water volume and the contribution of ground water in formation of CDW is insignificant. During this month the excess of magnesium index is not observed because the time factor is in place – water must pass through soil before it gets into the collector. As water in the river decreases, the role of ground water increases. The ground water that contains magnesium salts at the end make a significant contribution into salinity of CDW. However, in order to prove this assumption it is necessary to have more detailed study of the role of ground water in the formation of collector water and physicochemical processes occurring within the system of ground water – CDW for irrigation in time and space with the evaluation influencing on this process.

The origin of chrome ions, found in water samples, is still unclear. Most likely they are related to the volley emission of one of the factory into Amu Darya river because the discharge of contaminations comes not only from agriculture but also from industrial runoffs.

Detected trace of pesticides in water is most probably residual products that were washed by CDW from the fields.

The quality assessment of studied water by criteria proposed by Ibragimov basically showed that through water is attributed to "weakly satisfied" category but their use should be accompanied by special activities (leaching).

The quality assessment of CDW at winter period shows that they can be considered as an additional water resource that are used for leaching fields; however, at significantly smaller volume than for irrigation. Thus, the water volume, referred to «satisfactory» category is 50-55% for KKS, 40-50% for KS-1 and about 50% for KS-3. Less suitable according to the assessment results is CDW of KS-4 (only 10-12% water of total flow). As in case with water for irrigation, the excess of magnesium was observed as well as the content of Cl and SO_4. In all cases the excess by SAR is not noted. Most likely that underground water plays an important role here. Their role increases during water-shortage years – having water deficit the participation share of underground water in formation of water flow increases that probably leads to the increase of the magnesium salts. It also can be emphasize that significant excess of Mg index (Mg>60) at all collectors of winter 2003-2004 was a consequence of water-shortage summer at 2002 that apparently conditioned by increasing the role of ground water at flow formation.

The preliminary assessment of CDW quality for main collectors in Djizzak province demonstrated a tendency toward the decrease of water mineralization level and chlorine-ion content to the suitable level for irrigation during last years (2005-2006). However, the data absence for elementary analysis, correspondingly salts' composition that are contained in CDW, did not allow us to conduct a qualitative assessment of CDW using four criteria as it was made in case of water in Karakalpakstan. We strongly believe that this research is necessary and should be objectives for the following projects.

CONCLUSIONS

1. The reuse of ground, collector-drainage and waste water is an additional source for covering the deficit of irrigation water. Along with it, the sustainable development requires a justification of reusing collector-drainage water for irrigation taking into account the chemical content, condition of their formation and changes in time and space under the influence of determinative factors as well as soil-meliorative conditions.

2. The potential volume of collector-drainage water suitable for irrigation in Karakalpakstan for four main collectors at the most intensive irrigation period (July-August) 85-90% for collector KKS, 80-90% for KS-1, 35-40% for KS-3 and 75-81% for KS-4 respectively from the total annual flow of above-mentioned collectors.

3. The main water disadvantage of studied collectors is the content of magnesium (Mg>60) at CDW. The possible source of such salinity can be ground water with high concentration of magnesium that actively takes part in formation of CDW, depending on the season water availability and draining territory. Together with it, it is necessary to mention the importance of studying the role of ground water at forming the quality of CDW in order to obtain reliable results and making realistic recommendation for their use.

4. CDW at the conditions of Karakalpakstan can be utilized for irrigating agricultural crops and leaching soil, with using special techniques and activities in order to prevent magnesium salinity, especially at the water-shortage period (autumn-spring-winter).

5. Accomplished the preliminary assessment of CDW and melioration conditions of Djizzak region (on the example of experimental plot) in order to study the technology of CDW reusing for irrigating agricultural crops and regularity of processes occurring at the aeration zone.

6. At the condition of increasing deficit and progressive deterioration of water quality, it is necessary to study process' mechanism, occurring within the system of water-soil-plant while using CDW for irrigation taking into consideration condition of forming their qualities and influencing on them factors at the future research.

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Appendix

Toxic salts into the soil in the pilot areas in the Jizzakh region

№ разреза	Глубина в см	Сухой остаток	Salt content										
			Ca(HCO)3	CaSO4	CaCl	Mg(HCO)3	MgSO4	K2SO4	MgCl	Na2SO4	KCl	NaCl	Sums
1	0-30	0,865	0,04	0,221			0,212	0,304				0,074	0,811
	30-43	0,68	0,044	0,252			0,198	0,0688				0,028	0,5468
	43-58	0,225	0,049	0,0095			0,104	0,0024				0,039	0,1549
	58-91	0,21	0,044	0,0596			0,031	0,0566				0,016	0,1632
	91-127	0,505	0,036	0,16			0,149	0,07				0,028	0,407
	127-180	0,76	0,036	0,343			0,183	0,06				0,034	0,62
2	0-25	0,52	0,04	0,11			0,18	0,07				0,01	0,37
	25-42	0,165	0,044	0,048			0,029	0,037				0,012	0,126
	42-61	0,54	0,04	0,24			0,16	0,04				0,016	0,456
	61-86	0,56	0,032	0,29			0,89	0,05				0,016	1,246
	86-120	0,385	0,036	0,123			0,134	0,023				??	0,28
	120-160	0,79											0
3	0-27	0,23	0,04	0,068			0,6	0,005				0,034	0,707
	27-40	0,21	0,049	0,027			0,104	0,005				0,012	0,148
	40-68	0,55	0,036	0,211			0,134	0,087				0,023	0,455
	68-93	0,61	0,036	0,31			0,134	0,03				0,019	0,493
	93-135	0,735	0,028	0,32			0,2	0,05				0,023	0,593
	135-167	0,79	0,028	0,214			0,301	0,09				0,023	0,628

Salt content in the water for leaching in Karakalpakistan

Collector	Data	Total mineralization	Состав солей										Sum of ions
			$Ca(HCO)_3$	$CaSO_4$	$CaCl_2$	$Mg(HCO)_3$	$MgSO_4$	K_2SO_4	MgCl	Na_2SO_4	KCl	NaCl	
KS-1	2003 Dec		0,333	0,47			0,37		0,212			0,71	1,9
KS-1	2004 Jan		0,719	0,823			1,48	2,34				2,69	8
KS-1	2004 Feb		0,51	0,635			1,33	0,02				2,03	4,53
KS-1	2004 Dec		0,33	0,47			0,087	0,84			1,8		3,757
KS-1	2005 Jan		0,3	0,92			0,335		0,179			0,714	2,448
KS-1	2005 Feb		0,316	0,821			0,53		0,097			0,859	2,623
KS-1	2005 Dec		0,3	0,631			0,23		0,149			0,551	1,861
KS-1	2006 Jan		0,503	2,193	0,039				0,235			2,887	5,857
KS-1	2006 Feb		0,381	0,916	0,044				0,047			1,247	2,635
KS-1	2006 Dec		0,235	0,21			0,292		0,098			0,206	1,041
KS-1	2007 Jan		0,527	0,169			0,653	0,634				1,06	3,043
KS-1	2007 Feb		0,462	0,563			0,059	1,773				1,795	4,652
KS-3	2003 Dec		0,343	0,3			0,624		0,21			0,692	2,169
KS-3	2004 Jan		0,434	0,38			0,946		0,285			0,917	2,962
KS-3	2004Feb		0,457	0,703			1,445	0,214			2,6		5,4
KS-3	2004 Dec		0,428	0,522			1,128	0,966				1,305	5,5
KS-3	2005 Jan		0,438	0,719			0,587		0,05			0,972	2,766
KS-3	2005 Feb		0,43	0,522			0,475	1,165				1,386	3,98

KS-3	2005 Dec		0,251	1,08			0,356	0,07				1,55	3,307
KS-3	2006 Jan		0,243	0,543			0,772	0,286				1,486	3,33
KS-3	2006 Feb		0,423	0,869			1,069	0,355				2,61	5,326
KS-3	2006 Dec		0,503	0,189			0,356	1,586			2,29	1,305	6,229
KS-3	2007 Jan		0,527	0,508			0,239	1,162				1,549	3,985
KS-3	2007 Feb		0,649	0,542			1,247	1,311				2,284	6,033
KS-4	2003 Dec		0,175	0,396			0,264		0,282			0,238	1,355
KS-4	2004 Jan		0,51	0,273			0,676		0,092			0,649	2,2
KS-4	2004 Feb		0,487	0,27			0,627		0,056			0,61	2,05
KS-4	2004 Dec		0,308	0,534			0,713	0,215			1,28		3,12
KS-4	2005 Jan		0,3	0,927			0,313	0,062			0,027	0,692	2,321
KS-4	2005 Feb		0,43	0,522			0,475	1,165				1,387	3,979
KS-4	2005 Dec		0,203	0,373			0,065		0,043			0,336	1,02
KS-4	2006 Jan		0,227	0,421	0,11				0,141			0,037	0,962
KS-4	2006 Feb		0,268	0,387			0,17		0,147			0,309	1,281
KS-4	2006 Dec		0,373	0,298			0,683		0,446			0,268	2,07
KS-4	2007 Jan		0,503	0,325			0,594	0,148				0,653	2,223
KS-4	2007 Feb		0,649	0,135			0,475	1,59				1,55	4,399
KKS	2003 Dec		0,324	0,067			1,055		0,105			0,849	2,4
KKS	2004 Jan		0,4	0,57			0,792		0,082			1,089	2,933
KKS	2004 Feb		0,446	0,622			1,276		0,053			1,54	3,937

KKS	2004 Dec		0,303	0,493			0,779		0,074		0,999		2,6
KKS	2005 Jan		0,466	0,933			0,328		0,069			1,296	3,1
KKS	2005 Feb		0,389	0,692			0,752	0,255				1,088	3,183
KKS	2005 Dec		0,276	0,719			0,273		0,208			0,588	2,063
KKS	2006 Jan		0,219	0,767			0,712	0,266				0,578	2,54
KKS	2006 Feb		0,454	0,841			1,306	0,217				2,61	5,4
KKS	2006 Dec		0,281	0,692			1,266	0,241				0,87	3,9
KKS	2007 Jan		0,36	0,604			0,369		0,1			0,857	2,29
KKS	2007 Feb		0,614	0,458			0,613	1,56				1,632	4,877

Discharge, flow and mineraliziation of collector drainage water of Jizzah region, 2003

№	Collector	Indicator	Months												Annual Water consumm
			I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1	СК-9	Расход	0,850	0,760	0,670	0,650	0,620	0,680	0,700	0,650	0,630	0,570	0,550	0,510	0,550
		Runoff	2,280	1,830	1,790	1,680	1,660	1,760	1,870	1,740	1,630	1,530	1,430	1,360	1,710
		Total	2,280	4,110	5,900	7,580	9,240	11,000	12,870	14,610	16,240	17,770	19,200	20,560	20,560
		Mineralization	5,935	6,090	6,150	6,774	4,084	4,470	4,050	3,000	7,172	7,170	4,150	4,230	5,290
		Cl	2,655	2,828	2,450	2,254	1,243	1,295	2,205	1,500	1,715	1,710	1,450	1,560	1,910
2	СК-11	Расход	0,880	1,060	1,090	1,110	1,130	1,160	1,230	0,840	0,850	0,750	0,740	0,680	0,960
		сток	2,400	2,570	2,910	2,870	3,020	3,010	3,290	2,240	2,210	2,010	1,910	1,820	2,520
		всего	2,360	4,930	7,840	10,710	13,730	16,740	20,030	22,270	24,480	26,490	28,400	30,220	30,220
		минер	4,844	6,046	3,540	2,857	4,640	5,540	3,449	4,100	4,500	4,160	4,470	4,010	4,340
		хлор	1,538	2,200	0,910	1,322	1,629	1,659	1,576	1,220	1,430	2,170	1,560	1,290	1,540
	Pogranichniy	Расход	1,320	1,110	0,820	0,890	1,950	1,397	1,156	1,750	2,980	2,890	2,314	2,470	1,750
		сток	3,540	2,690	2,190	2,300	5,360	3,492	3,096	4,700	7,710	7,738	5,997	7,609	4,700

		всего	3,540	6,230	8,420	10,720	16,080	19,572	22,668	27,369	35,079	42,817	48,814	56,423	56,423
		минер	3,650	3,000	3,500	2,020	3,045	3,200	3,130	3,400	3,620	3,250	2,750	2,650	3,160
		хлор	1,650	1,715	1,725	1,470	1,470	1,640	1,500	1,650	1,575	1,450	0,315	0,750	1,410
	ARK-1	Расход	0,180	0,120	0,220	0,230	0,220	0,240	0,260	0,220	0,240	0,210	0,190	0,160	0,210
		сток	0,480	0,290	0,590	0,600	0,590	0,620	0,700	0,590	0,620	0,560	0,490	0,430	0,550
		всего	0,480	0,770	1,360	1,960	2,550	3,170	3,870	4,460	5,080	5,640	6,130	6,560	6,560
		минер	5,250	5,582	4,519	6,340	1,776	2,525	2,460	3,160	2,580	3,590	2,690	2,570	3,580
		хлор	2,650	2,800	2,244	3,484	0,314	0,950	0,840	1,800	0,968	0,860	0,770	0,680	1,530
	СК-12	Расход	0,190	0,210	0,180	0,190	0,200	0,220	0,240	0,200	0,230	0,190	0,170	0,150	0,200
		сток	0,510	0,500	0,480	0,490	0,530	0,570	0,640	0,530	0,600	0,510	0,440	0,400	0,520
		всего	0,510	1,020	1,500	1,990	2,520	3,090	3,730	4,260	4,860	5,370	5,810	6,210	6,210
		минер	5,520	4,520	1,850	2,460	3,560	4,220	3,950	2,150	2,250	2,560	3,150	3,250	3,280
		хлор	2,800	2,240	0,580	1,500	1,250	1,350	1,450	1,350	1,250	1,150	1,240	1,350	1,460
	KLI	Расход	11,850	12,560	11,730	11,780	19,130	19,380	15,240	13,750	11,980	10,960	9,440	11,140	13,240
		сток	31,730	30,380	31,420	30,540	51,230	50,234	40,816	36,816	31,040	29,340	24,450	29,843	34,820
		всего	31,730	62,110	93,530	124,070	175,300	225,534	266,350	303,166	334,209	363,549	387,999	417,842	417,842
		минер	4,260	4,650	3,620	1,870	2,890	3,400	2,530	3,500	3,740	3,400	2,950	2,920	3,310
		хлор	1,820	1,950	1,880	0,730	0,520	0,870	0,490	1,050	1,800	0,950	0,660	0,830	1,130