REPORT

Monitoring of the Amudarya River Delta and the Dried Bed of the Aral Sea under the "CAWA" Project – «Dynamics of Surface and Ground Water Change in the Amudarya Delta and the Dried Bed of the Aral Sea» June 2009 – December 2010

The project is implemented jointly by SIC ICWC, the German Geoscience Research Centre (GFZ) and the Institute «GIDROINGEO» of the State Geological Committee of the Republic of Uzbekistan in order to study dynamics of surface (river and collector-drainage) water and deep and shallow groundwater changes in the Amudarya Delta and Prearalie.

The objective of work in 2009-2010 was to implement monitoring in the Amudarya river delta (discharge and quality of surface and ground waters) and in the Aral Sea of water (changes in sea level and salinity), soil (salt content), as well as groundwater monitoring. This work is a follow-up of 3-year research completed within the framework of the GTZ Project "Stabilization and Use of the Dried Bed of the Aral Sea in Central Asia". The project results indicated to substantial dynamics of landscapes as the sea desiccated and formation of new landmass.

Over the last three decades, as a consequence of the Aral Sea drying, desertification, and environmental pollution processes, a very complex environmental situation is observed in Prearalie. This is, primarily, caused by a change in watering conditions. The main reason of abrupt environmental and economic deterioration in Prearalie region, especially in the Republic of Karakalpakstan, is the severe reduction of inflow from the Amudarya river. As early as in 1963-1965, the annual inflow to Prearalie boundary, from Tuyamuyun gauging station was 60 - 65 km^3 and fed the Aral Sea, deltaic lakes and irrigated land, while in 2001 this value decreased to 6 - 7 km^3 and accounted for only 10%.

Given work consists in studying both external and underground processes and their interaction on the ground, in the sea, on the exposed seabed and in Prearalie, in identifying dynamics of deep and shallow groundwater.

According to the plan of monitoring over surface and ground water quantity and quality in the Amudarya Delta and on the dried bed of the Aral Sea, data for analysis of processes from October to December 2010 were collected. (In 2009-2010, data were collected for analysis).

1. Research target

The Amudarya delta has developed under the influence of long-term natural fluctuations of the river runoff, various marine and riverine processes and erosion dynamics. Eventually, this formed the landscape of the delta and its hydrological and hydro-geological profiles, with numerous water bodies. These water bodies, when the Aral Sea level was 53 m +BSL (lakes Sudoche, Karateren, Kokchiel, Akchakul, Zapadnoe), were the lakes of the coastal deltaic plain occasionally flooded by river and sea waters and linked with the Adjibay and Djiltirbas bays. During wet years, lakes were completely desalinated with plentiful river waters and have got features of water bodies with good flow-through. When inflow of freshwater decreased during dry years, these lakes were partly flooded with sea water, with resulting abrupt change in physical and

chemical properties of water and subsequent modification of their flora and fauna and their biological productivity. Preservation of biodiversity and improvement of natural productivity of bio-resources are primary environmental-social challenges in Prearalie. Lakes and wetlands that have high potential bio-productivity and serve as natural habitats for local and global fauna are critical for meeting these challenges. Establishing the buffer protection zones in the form of a series of local water bodies with the purpose of forming artificial wetland ecosystems has been started in the South Priaralie prior to 1995 according to the temporary plans. That time, unregulated water bodies such as Ribache, Muynak, Djiltirbas, Dumalak and others, with the total water surface of about 1600 sq km, has been constructed in the Amudarya delta and on the dried Aral Sea bed. Despite of a limited scale of implemented measures, an ecological effect was quite significant and resulted in 1.5-2 times reduction of salt and dust transfer to adjacent cultivated lands, partial flora and fauna restoration in the delta, as well as in improvements of fishery and livelihoods of the local population. However, design and construction work was not implemented for a long time due to the lack of funds until the GEF Agency has begun to finance the WEMP Project (Component E) and the Small Water Bodies Project through IFAS' funds. This imparted new impetus to those activities. In particular, using these funds, the Sudoche lakes system was constructed, and the Mezdureche Reservoir was partially reconstructed.

The Aral Sea shrinkage and loss of a natural linkage with its bays resulted in ceasing of replenishment with sea water, and the delta has become completely dependent on the regime of river water inflow. As a result of permanent reduction of river inflow that started in the 1960s, the lakes began functioning as natural evaporators, with following drastic reduction of water volumes and increase in salinity. At present, all water bodies within the Amudarya delta may be divided into two groups, according to their water regime: first one - the lakes fed by collector-drainage water (Sudoche, Western Karateren, Akushpa, Eastern Karateren, a part of Djiltirbas lake and others); and, second one - the lakes fed by the Amudarya river water (lakes Mezdureche, Dautkul, Ribache, Muynak, Dumalak and others). According to the pattern of water supply and quality of water, the territory of the Amudarya delta may be divided into three zones:

1. The Left Bank Zone is the command area of the Suenli canal and Collectors GLK, Sudoche lake and Adjibay lake. The main water bodies are lakes of the Sudoche wetland – Akushpa, Taily, Karateren, Big Sudoche, and Begdulla-Aidyn and lakes of the Karadjar system – the Mashankol, Hojakol, and Ilmenkol.

2. The Preamudaryinskaya zone includes coastal and deltaic lakes fed from the Amudarya river and the large irrigation canals. The main water bodies are the Mezdureche Reservoir, Ribache and Muynak Bays, and Makpakpol Lake.

3. The Right Bank Zone is located along the Kyzketken canal, within the command areas of Collectors KC-1, KC-3, and KC-4. The main water bodies are the Djiltyrbas Bay and collector Akchadarya (collector), water of which flows through Zhanadarya to Eastern part of the Large Aral Sea.

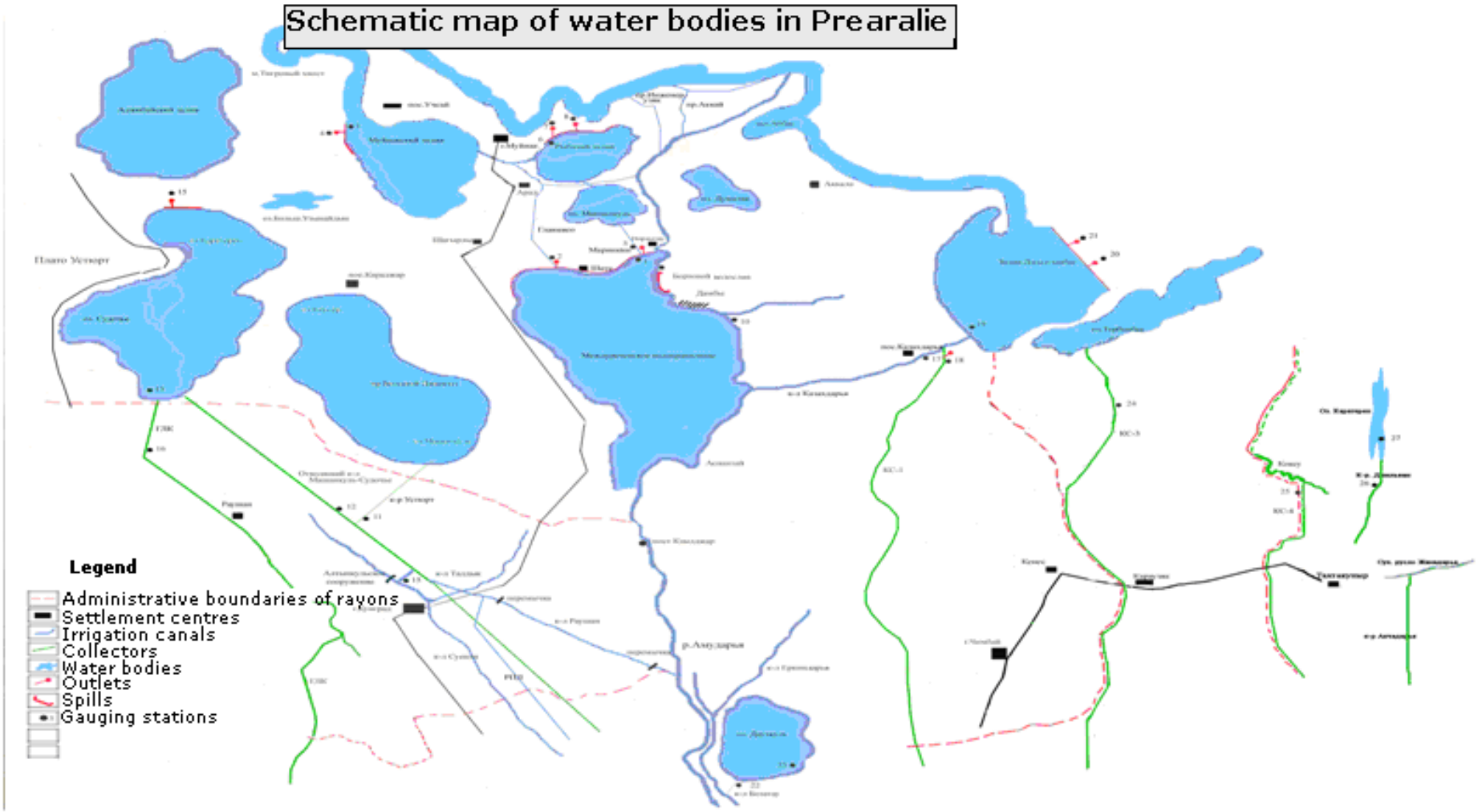

Schematic map of water bodies in Prearalie
Legend
Administrative boundaries of rayons
Settlement centres
Irrigation canals
Collectors
Water bodies
Outlets
Spills
Gauging stations

Рис. 1

According to the water exchange pattern, water bodies of the South Prearalie are divided into: flow-through water bodies – the Mezdureche Reservoir and Makpalkol Lake; water bodies with low (periodical) flow-through – lakes Karateren, Big Sudoche, Begdulla-Aidyn, Mashankol, Hojakol and Ilmenkol, bays Ribache, Muynak, Djiltyrbas; and closed drainage water sinks – lakes Akushpa and Tayli.

2. Description of monitoring sites

A monitoring plan (discharge and quality of surface and ground waters) was drawn up for the Amudarya river delta and the Aral Sea – water (water levels and salinity) and soil (salt content).

Target	Monitoring frequency	Monitoring parameters	Monitoring points
Amudarya delta (soil)	Once a year	pH and salt content	30 points
Amudarya delta Groundwater	Every decade	Level and salt content	33 points
Amudarya (Takhiatash, Samanbay, Kyzyljar)	Every decade	Расход, температура, Минерализация	Three points – water discharge
Canals – Glavmyaso, Porlytau and others flowing to the delta	Every decade	Discharge, temperature, salinity	Two points
Drainage water GLK, KC-1, KC- 3 and KC-4	Every decade	Discharge and salinity	Four points
Aral Sea (information from Karakalpak Hydromet)	4 times a year (twice in 2009)	Water level	Western and Eastern parts (if available, in western)
	Twice a year (once in 2009)	pH, hydrochemistry	Western and Eastern parts (if available, in western)

Takhiatash section (Takhiatash waterworks) is located 2 km far from Nukus city. Water is distributed between Suenly canal and Kyzketken canal in this section; the waterworks is equipped with hydrometric measurement devices; and water discharge is measured in downstream..

Samanbay section is located within the Nukus city boundaries, 6-7 km far from Takhiatasj waterworks. Besides measurements of discharge in this section, water samples are also taken once a month to measure salinity.

Kzyldjar section is located 100 km downstream of the Samanbay section. Here, water is distributed between Mezdureche reservoir and along the old channel of Kazakhdarya.

Monitoring points along such canals as Marinka, Muynak and Raushan include outlet structures at Mezdureche reservoir and Suenly canal, respectively.

Monitoring points along collectors (hereinafter, mean “main drains”) in tail parts are arranged in form of bridges for stream gauge to measure discharge and take samples for chemical analysis.

Monitoring points for groundwater level and salinity are arranged in three zones in the delta:

- **central zone** – the command area of the Amudarya main channel, Glavmyaso and Marinkinuzyak canals: in two plots – one of the shirkat farm Aral (9 wells) and another one in shirkat farm Muynak (16 wells);
- **left bank zone** – the command area of Raushan canal: plot of the shirkat farm Raushan (9 wells);
- **right bank zone** – the command area of Kyzketken canal and Kazakhdarya channel, plot of the shirkat farm Kazakhdarya (10 wells).

The analysis of data during the monitoring period of 2009-2010 indicated that the data were not enough and that water discharge measurements were not accurate in the observation sites due to outdated measurement devices. In order to improve the quality of monitoring in the Amudarya Delta and Prearalie, SIC ICWC made inventory of gauging stations in August-September 2010. Based on the inventory results, it was decided to construct 21 new gauging stations to measure discharge and levels in canals, collectors and lakes in the Amudarya Delta and Prearalie (Fig. 1). This construction is made at expense of the CAWa Project, according to cost estimates. By present, 21 new gage rods have been delivered to Nukus, constructions materials were procured for installation of the rods at the above structures as shown in Figure 1, and construction is to be completed in the first quarter 2011.

Based on the plan, the monitoring of the Amudarya river delta was completed and the following results were received:

In the three points (sections) along the Amudarya river (Takhiatash, Samanbay, Kyzyljar), water discharge and salinity were measured every quarter. The results are given in Tables 1 and 2.

The NATO SfP Project 974357 identified that in order to keep environmental sustainability in the Amudarya Delta and feed the lake systems occupying an area of 180,000 ha, 8 km^3 of water are needed in humid years, 4.6 km^3 in normal year, and, at least, 3.1 km^3 in dry years. Though the period of 2002-2007 was enough humid, in 2002 and in 2007 inflow to the Delta was half of the amount envisaged for normal years. By the end of 2008, practically all lakes in the Delta were dry. The estimations showed that in the dry period of 2007-2008, inflow to the delta was 1.59 billion m^3, and the lake systems' area decreased from 120 thousand ha to 6-7 thousand ha. Here, there is no balance as such, i.e. the negative part of water balance exceeds the positive one by 1.5 billion m^3.

Table 1 shows actual inflow into the Delta through Takhiatash, Samanbay, and Kyzyldjar sections during May-December 2009 and January-December 2010. The analysis of data on inflow into the delta from the Amudarya river shows that, in 2009, the inflow, including drainage water, was about 3.7 billion m^3. Data over 2010 show, especially for the growing season, that flow discharge in the river amounted to 4.0 km^3 just in one month. Thus, the quantity of water flown downstream of Samanbay point in 2010 is enough to maintain the ecosystem stability in the Delta and Prearalie.

Water supply to the Left Bank system is made through the Suenly canal (feeds Tallyk canal, Ustyurt collector), while the Right Bank receives water through the Kyzketken canal (feeds Kegeily and Kuanysh-jarma canals) from Takhiatash waterworks. Table 2 gives the total water diversion and spills from Suenly and Kyzketken canals by delta system for hydrological years.

At the head of Glavmyaso canal and Porlitau canal, water discharge and salinity were measured monthly. The monitoring results – water delivery along canals from July to

December 2009 and from January to December 2010 – are given in Table 3. Water is supplied to Muynak lake from Tallyk and Glavmyaso canal, Ribache lake – from Tally and Porlitau canals, and Sudoche lake – from Raushan canal, Ustyurt collector and KKC.

Water into the delta flows from both the river and the collectors, such as KC-1, KC-3, KC-4, Akchadarya (right-bank), KKC and Ustyurt, as well as from Ustyurt into Mashankul lake (one should note that the Raushan canal carries water to Sudoche lake through the Ustyurt collector).

The system of right-bank collector originates in Beruny collector, followed by Main South Karakalkapstan collector (GUKK) and Akchadarya collector, and, through Janadarya, collector water flows into the Eastern part of the Large Aral Sea.

Table 4 gives data on inflow from all the collectors into the Delta in July-December 2009 and January-December 2010. The total amount of collector water is 2324.2 Mm^3 only for 2010.

Table 5 shows actual inflow of surface water into the right-bank zone of the Eastern part of Large Aral Sea for 2010.

The analysis of data on Akchadarya collector (right-bank collector, Fig.2) shows that the share of the right-bank collector varies from 20% to 40% in the total amount of surface water inflow (2644.13 Mm^3) into the Eastern part of Large Aral Sea. The share of the right-bank collector accounts for up to 40% in the total amount in some months. Figure 2 shows that dynamics of changes in the total amount of surface water flow to the right-bank zone is linked directly to discharge in the right-bank collector. Over 2010, the right-bank collector delivered 0.7 km^3 of water to the Aral Sea. The actual amount of inflow into the Delta from all collectors over 2002-2010 is shown in Table 6. The data show that the inflow in 2010 was twofold of that in humid years 2005 and 2007.

Wells were drilled throughout the Delta in 44 points, where groundwater level and salinity were measured quarterly. The monitoring results are given in Table 9, 9a.

The monitoring over groundwater level in the Amudarya Delta and Prearalie in June-December 2009 and January-December 2010 indicates to upward trends of groundwater level with the increase in inflow from the Amudarya river (Fig.3). The Figure shows that dynamics of surface river flow in Amudarya agrees with dynamics of groundwater. There was large inflow into groundwater, and, as a result, groundwater salinity decreased (Fig.4), especially during the growing season 2010. When flow rate decreased abruptly in the Amudarya river by the end of year, accordingly groundwater salinity increased.

Two expeditions were undertaken to the selected objects. The first expedition was organized in May-June 2009, while the second one – in April-May 2010. The expedition in the end of May – beginning of June found that such lakes as Sudoche, Ribache, Muynak, and Mezdureche did not almost have a water surface, although water availability had increased dramatically in the Amudarya river.

Changes in water horizon in the lake systems in the Amudarya delta (Table 7) over 2010 show that with the increase of inflow from the Amudarya river into the Delta (except for Muynak Bay), water horizons in all lakes were above design levels.

Given the minimum design water surface of Delta's lakes of about 120 thousand ha, from the RS images, the actual water surface was 8280 ha in June, 16230 ha in July, and 22794 ha at the beginning of August – as low as at the end of the dry period 2000-2001 in the Delta. However, data received later (end of 2009 and beginning of 2010) show that water levels in some of lakes reached the design level. Those are Zhiltyrbas, Ribache, and Mezdureche. In April-May 2010, water levels in some lakes even were higher than their design levels (Sudoche: design level – 52.20, current level – 52.49; Zhiltyrbas: 52.00 –

52.13; Ribache: 52.00 – 52.09, and, accordingly, others) (Tables 7.1, 7.2, 7.3, 7.4, 7.5, 7.6).

Actual inflow into the Aral Sea during the growing season 2010 (Table 11) is 17150 Mm^3 as compared to planned one of 2100 Mm^3 (816.7 %). If we sum up all amounts of water flown to the Delta and the Aral Sea, i.e. inflow during the non-growing season, Table 12 (from such canals as Marinkin, Muynak, Raushan, and Kazakhdarya in an amount of 618.76 Mm^3), inflow during the growing season (in an amount of 17150 Mm^3), and water from collectors (2324.2 Mm^3), the total surface water volume is 20092.96 M^3 or 20.0 km^3.

This is evident from transformation of the Aral Sea (satellite images) in April, June, September, and October 2010 (Figures 5, 6, 7, 8). According to satellite images, the area of the Eastern part of the Aral Sea was 116990.80 ha in August 2009 and 625833.17 ha by the end of 2010 when the sea was filled with water, i.e. the area of the Eastern part increased more than 5 times.

Table 10 shows the results of NOAA image processing for wetland (lake systems) areas in hectares over October 2010. Thus, in November 2009, an area of wetlands was about 105 thousand ha, whereas in April 2010, it already reached 226 thousand ha, i.e. increased as much as more than twofold. The GIS experts from SIC ICWC have prepared new information on wetland areas in the Amudarya delta on the basis of satellite images over September-November 2009 and April-October 2010. In October 2010, the area of wetlands increased to 356 thousand ha, i.e. large quantities of water are discharged from the river into the delta.

№	Year	Month	Area of Eastern part of the Aral Sea (ha)
1	2007	August	530118.10
2	2008	August	350169.80
3	2009	August	116990.80
4	2010	July	478071.30
5	2010	August	600122.20
6	2010	September	616705.90
7	2010	October	625833.17
8	2010	November	521066.90

Estimation of water balance in the Amudarya River Delta and the Large Aral Sea. Using the available data on water resources and wetland areas in the Amudarya Delta, we have made calculations of water balance for 2010.

The components of water balance of the Amudarya Delta and the Large Aral Sea:

- River water inflow - 17768.76 Mm^3;
- Collector-drainage water inflow - 2324.20 Mm^3;
- Rainfall - 252.45 Mm^3;
- Groundwater inflow (Report of GIDROINGEO for 2010) - 147.0 Mm^3;

Total inflow: (+) **20492.41 Mm^3**;

- Evaporation: The total water area is 115183.56 (water surface of Delta's lakes, Table 14) + 484891.81 (water surface of Eastern part of the Large Aral Sea, Table 14) + 399437.95 (water surface of Western part of the Large Aral Sea, Table 14) = 999513.32 ha × 10000 m^3/ha = 9995.13 Mm^3

Areas overgrown with reed (data of SIC' GIS experts) 191345.98 × 12000 m^3/ha = 2296.15 Mm^3

Total losses: (**-**) **12291.28 Mm^3**;

The exceeding of inflow over evaporation (balance) is + 8201.13 Mm^3.

The comparison of data of water balance in the Amudarya River Delta and the Large Aral Sea with the results of image processing (by SIC's GIS experts) shows that this exceeding was used for a change in volume of Eastern and Western parts.

In November 2009, the water level was 26.3 m, the volume was 0.655 km^3, and the water surface was 79699 ha in Eastern part of the Aral Sea.

The water surface decreased to 67551.4 ha in April 2010. Since then large quantities of surface water has began to flow to the Eastern part, and the surface area amounted to 625833.17 ha in October 2010. Water level reached 29.0 m in the Eastern part. From April to October, the area increased almost 10 times and the volume was 8.38 км^3 (GIS experts' data) in the Eastern part, i.e. the accumulated volume in the sea was **7.73 km^3**.

As to the Western part of the Large Aral Sea, water level was 27.5 m in November 2009 and 27.8 m in the end of 2010. During 2010, water level rose by 0.30 m in the Western part and its surface area was 393187.0 ha. In April 2010, the surface area was 378992 ha. Thus, the accumulated volume in the Western part is about **1.10 km^3**.

The total accumulate volume is 8.83 km^3 for both parts of the Large Aral Sea.

Based on above estimations and satellite data, one may conclude that about **9.0 km^3** of water were accumulated in the Large Aral Sea in 2010.

If we compare these data with water inflow, then it seems that the difference in the balance is the groundwater inflow in amount of about 700-800 Mm^3.

Table 14

Month	Wetland area in the Amudarya Delta			Area of Eastern part (ha)	Area of Western part (ha)
	Water surface, ha	Overgrown with reed, ha	Total area, ha		
I					
II					
III					
IV			226396.55	67551.40	405688.90
V					
VI			298477.19		
VII			284446.69	478071.30	
VIII			326099.13	600122.20	

IX			347694.11	616705.90	
X	115183.56		356063.56	625833.17	
XI				521066.90	393187.0
XII					
Average	115183.56	191345.98	306529.54	484891.81	399437.95

Actual inflow into the Amudarya River Delta (Mm^3)

Table 1

Section line	Months and years												
	2009												
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total for 9 months
Takhiatash	-	-	-	-	31.47	123.7	286.6	1037	438.05	362.88	243.65	251.6	
Samanbay	-	-	-	-	28.12	105.5	280.4	1005	430.79	354.07	236.4	247.5	
Kyzyljar	-	-	-	-	19.21	77.67	237.7	890	418.88	338.26	212.54	229.7	
	2010												
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	Total annual
Takhiatash	479.8	63.67	192.54	558.6	2799.4	2233.4	3704.8	3961.4	2285.5	870.1	308.45	349.06	17806.72
Samanbay	387.9	60.48	190.51	548.4	2925.5	1994.1	3794.7	3977.0	1481.1	1001.3	286.67	387.03	17034.69
Kyzyljar	334.5	56.16	109.04	405.54	2844.3	1542.2	3500.3	3596.0	1402.4	860.4	201.4	343.96	15196.2

Total water diversion and spill from Suenly and Kyzketken canals by delta systems for hydrological years

Table 2

Structure	Hydrological year							
Suenly and **Kyzketken**	**2002-2003**	**2003-2004**	**2004-2005**	**2005-2006**	**2006-2007**	**2007-2008**	**2008-2009**	**2009-2010**
Water volume, Mm^3 (diversion)	3628	3255	3552	3186	1440	3196	3206	5312.21
Water volume, Mm^3 (spill)	1403	1873	719	1414	1511	369	284	1790.3

Water delivery by canal, July-December 2009 and January-September 2010

Table 3

Canal	Months											
	2009											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Marinkin, Mm^3	-	-	-	-	-	-	12.7	85	97.5	-	-	-
Muynak, Mm^3	-	-	-	-	-	-	-	38.2	77.0	39.8	13.0	8.3
Raushan, Mm^3	-	-	-	-	-	-	36.4	89.5	153.6	77.4	15.1	23.7
	2010											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
Marinkin, Mm^3	-	-	-	46.66	-	-	-	120.53	40.18	-	-	-
Muynak, Mm^3	22.29	7.78	10.37	12.96	4.9	7.8	34.13	42.77	-	13.39	12.1	10.72
Raushan, Mm^3	64.02	19.81	43.54	24.9	10.7	10.8	10.52	11.49	3.46	54.22	4.49	-

Actual inflow into the Delta from collectors

Table 4

Collector	Months											
	2009											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
KC-1 Mm^3							16.5	37.8	29.5	26.8	35.5	195.6
KC-3 Mm^3							10.5	13.7	26.2	9.9	2.3	76.45
KC-4 Mm^3							4.6	11.5	8.8	3.5	1.1	37.6
Raushan Mm^3 (Ustyurt and KKC)							26.7	52.8	52.7	35.0	14.8	23. 7
Ustyurt to Mashankul lake							-	7.36	9.6	1.3	-	5.51
Akchadarya (Right-bank)							41.58	74.99	69.73	41.65	41.48	36.38
Total:							99.88	198.15	196.53	118.15	95.18	375.24
	2010											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
KC-1 Mm^3	42.60	31.88	36.45	36.3	45.5	48.2	66.17	69.16	49.8	34.48	27.73	16.42
KC-3 Mm^3	20.47	7.335	16.33	22.3	21.4	22.8	26.64	35.02	22.01	6.64	15.56	17.28
KC-4 Mm^3	13.22	9.073	8.812	9.07	12.7	14.0	13.11	17.43	16.64	8.57	11.92	8.29
Raushan Mm^3 (Ustyurt and KKC)	63.96	19.2	43.57	24.9	33.7	88.0	97.67	100.99	72.12	24.07	26.17	52.02
Ustyurt to Mashankul lake	7.38	-	4.82	3.37	2.01	22.29	21.82	22.65	11.67	1.18	-	5.43
Akchadarya (Right-bank)	78.57	56.71	43.03	81.13	48.38	45.36	83.45	77.18	60.99	47.91	44.06	27.13
Total:	226.2	124.2	153.01	177.07	163.69	240.65	308.86	322.43	233.23	122.85	125.44	126.57
	Total annual: 2324.2 Mm^3											

Actual inflow of surface water into the right-bank zone (Zhyltirbas system) of Eastern part of the Large Aral Sea (2010)

Table 5

Collectors and other structures	**2010**											
	I	**II**	**III**	**IV**	**V**	**VI**	**VII**	**VIII**	**IX**	**X**	**XI**	**XII**
KC-1 Mm^3	42.60	31.88	36.45	36.3	45.5	48.2	66.17	69.16	49.8	34.48	27.73	16.42
KC-3 Mm^3	20.47	7.335	16.33	22.3	21.4	22.8	26.64	35.02	22.01	6.64	15.56	17.28
KC-4 Mm^3	13.22	9.073	8.812	9.07	12.7	14.0	13.11	17.43	16.64	8.57	11.92	8.29
Kazakhdarya Mm^3	68.77	42.42	47.49	69.13	124.5	113.19	146.62	148.87	110.59	80.27	56.16	60.91
Akchadarya Mm^3 (Right-bank collector)	**78.57**	**56.71**	**43.03**	**81.13**	**48.38**	**45.36**	**83.45**	**77.18**	**60.99**	**47.91**	**44.06**	**27.13**
Total:	**223.63**	**147.42**	**152.11**	**217.93**	**252.48**	**243.55**	**335.99**	**347.66**	**260.03**	**177.87**	**155.43**	**130.03**
Akchadarya, % of total CDF	35.1	38.5	28.3	37.2	20.0	19.0	24.8	22.2	23.5	26.9	28.3	20.9
	Total annual for 2010 = 2644.13 Mm^3, of which Akchadarya collector is 693.9 Mm^3 or 26.2 % of total CDF											

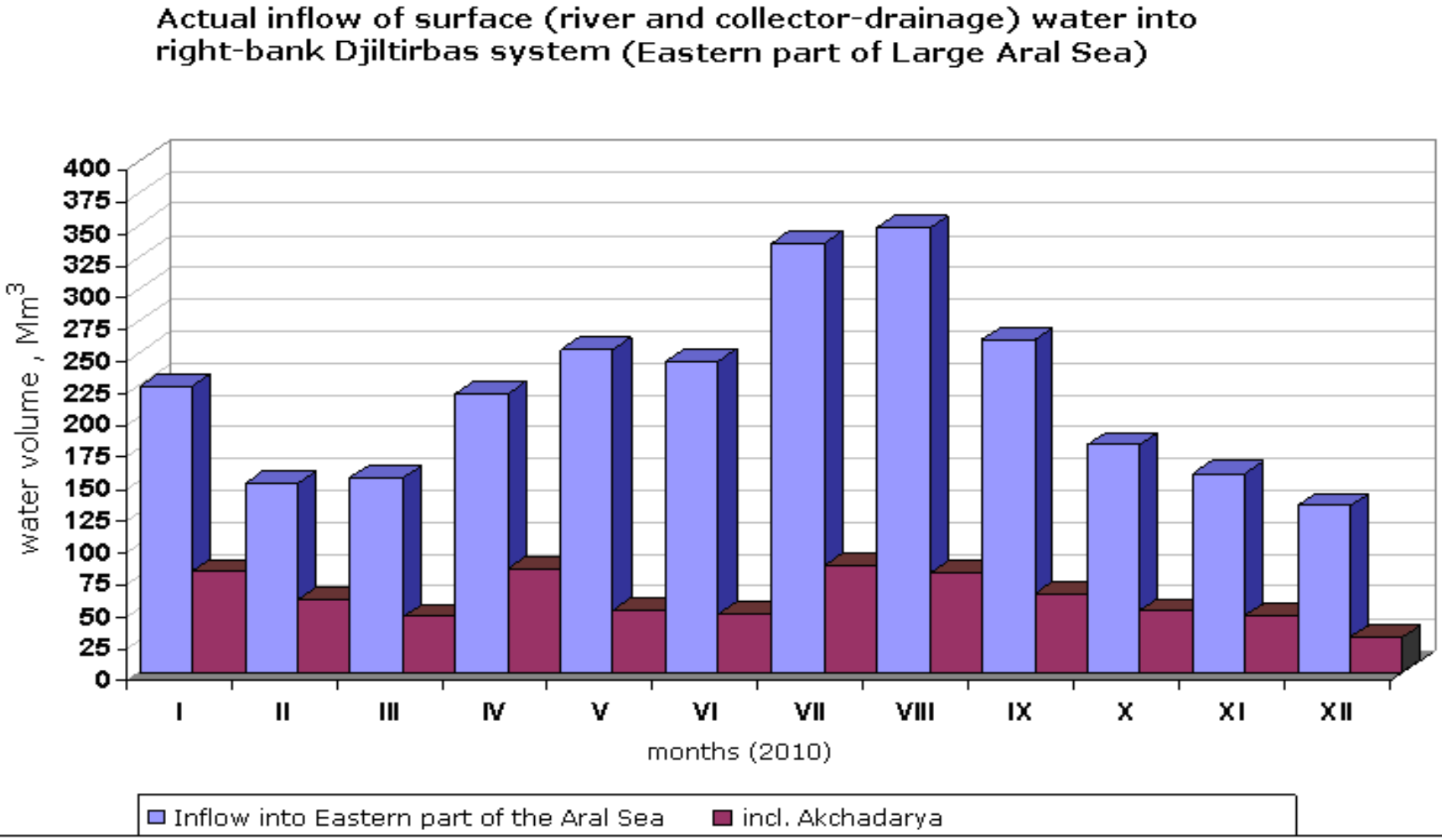

Actual inflow of surface (river and collector-drainage) water into right-bank Djiltirbas system (Eastern part of Large Aral Sea)
water volume , Mm3
400
375
350
325
300
275
250
225
200
175
150
125
100
75
50
25
0
I
II
III
IV
V
VI
VII
VIII
IX
X
XI
XII
months (2010)
Inflow into Eastern part of the Aral Sea
incl. Akchadarya

Fig. 2

Data on inflow from all collectors, 2002-2010

Table 6

Collector	**Year**								
CDF (all collectors)	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**
Water volume, Mm^3	437	1061	1083	1156	1432	1117	663.5	991.1	2324.2

Change in water horizon in the lake systems of the Amudarya Delta, January-September 2010

Table 7

Lake	**Sampling date**	**Water horizon**											
		January	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
Sudoche 52.20	1 decade	51.88	52.10	52.17	52.49	52.48	52.41	52.42	52.27	52.09	51.82	52.21	52.39
	2 decade	51.98	52.14	52.18	52.49	52.48	52.41	52.42	52.27	52.09	52.00	52.29	52.43
	3 decade	52.03	52.16	52.30	52.49	52.48	52.41	52.42	52.27	52.09	52.11	52.36	52.47
Djiltirbas 52.00	1 decade	51.95	51.94	51.90	52.11	52.10		52.14	52.35	52.37	52.35	52.27	52.27
	2 decade	51.96	51.93	51.96	52.13	52.11	52.12	52.27	52.36	52.37	52.32	52.27	52.27
	3 decade	51.96	51.92	52.06	52.13	52.12		52.3	56.87	52.35	52.27	52.27	52.27
Dautkul	1 decade	64.85	65.13	65.18	65.34	65.26		65.37	65.37	65.34	65.36	65.34	65.28
	2 decade	65.01	65.15	65.20	65.33	65.29	65.29	65.38	65.36	65.35	65.37	65.32	65.35
	3 decade	65.10	65.17	65.29	65.35	65.32		65.38	65.35	65.35	65.37	65.28	65.37
Mezdureche 56.00	1 decade	55.69	56.01	56.03	52.82	56.17		56.22	56.80	56.65	55.38	55.49	54.42
	2 decade	55.75	56.02	55.99	55.74	56.78	56.63	56.72	56.71	55.81	55.32	54.70	54.96
	3 decade	55.91	55.99	55.82	55.84	56.94		56.95	56.86	55.58	55.49	54.79	54.82
Rybache 52.00	1 decade	52.00	52.12	52.06	52.09	52.16		52.29	52.12	52.40	52.30	52.24	52.24
	2 decade	52.09	52.12	52.03	52.11	52.36	52.28	52.18	52.38	52.36	52.26	52.26	52.23
	3 decade	52.11	52.09	52.05	52.06	52.33		52.08	52.25	52.33	52.24	52.26	52.22
Muynak Bay 52.50	1 decade	50.00	50.52	50.98	51.52	51.4		51.35	51.40	51.46	51.48	51.57	51.67
	2 decade	50.09	50.70	551.10	51.49	51.42	51.41	51.33	51.44	51.45	51.50	51.60	51.71
	3 decade	50.30	50.86	51.33	51.52	51.39		51.36	51.48	51.48	51.53	51.64	51.74
Karateren	1 decade	47.41	47.56	47.72	48.9	49.00	48.7	48.53	48.61	49.08	48.99	48.82	48.88
	2 decade	47.45	47.61	48.3	49.13	48.97	48.5	48.54	48.65	49.04	48.95	48.80	48.88
	3 decade	47.52	47.68	48.65	49.10	48.78	48.56	48.58	48.78	48.99	48.95	48.80	48.90

Water delivery to the Amudarya Delta and the Aral Sea during growing season 2010

Table 8

Year	April	May	June	July	August	September	Delivery during grow.season		% completed
							Planned	Actual	
2010	682	3364	2833	3874	4428	1969	2100	17150	816.7

Data of monitoring over groundwater level in Prearalie, June 2009 – September 2010

Table 9

№	Entity	Monthly changes in groundwater level (June-December 2009)						
		June	July	August	September	October	November	December
1	sh/f* Aral	6.08	6.02	5.61	5.77	6.07	6.06	6.02
2	sh/f* Muynak	6.33	6.37	6.26	6.46	6.05	6.42	6.27
3	sh/f* Kazakhdarya	4.09	3.79	3.62	3.52	3.59	3.55	4.02
4	sh/f* Raushan	4.68	4.99	5.0	5.0	3.46	3.57	2.64

Note: * - sh/f stands for shirkat farm

Table 9a

№	Entity	Monthly changes in groundwater level (January-December 2010)								
		January	February	March	April	May	June	July	August	September
1	sh/f Aral	6.01	6.0	6.0	5.78	5.78	5.81	5.82	5.76	5.84
2	sh/f Muynak	6.5	6.5	6.4	5.41	5.43	5.37	5.46	5.54	5.78
3	sh/f Kazakhdarya	3.6	3.63	3.65	3.37	3.01	3.04	2.99	2.78	2.41
4	sh/f Raushan	3.15	3.07	2.47	2.26	2.34	2.11	2.00	1.85	1.80

Table 9a (continued)

№	Entity	Monthly changes in groundwater level (January-December 2010)		
		October	November	December
1	sh/f Aral	6.23	6.18	6.15
2	sh/f Muynak	5.86	5.95	6.15
3	sh/f Kazakhdarya	2.60	2.44	2.50
4	sh/f Raushan	2.02	2.38	2.38

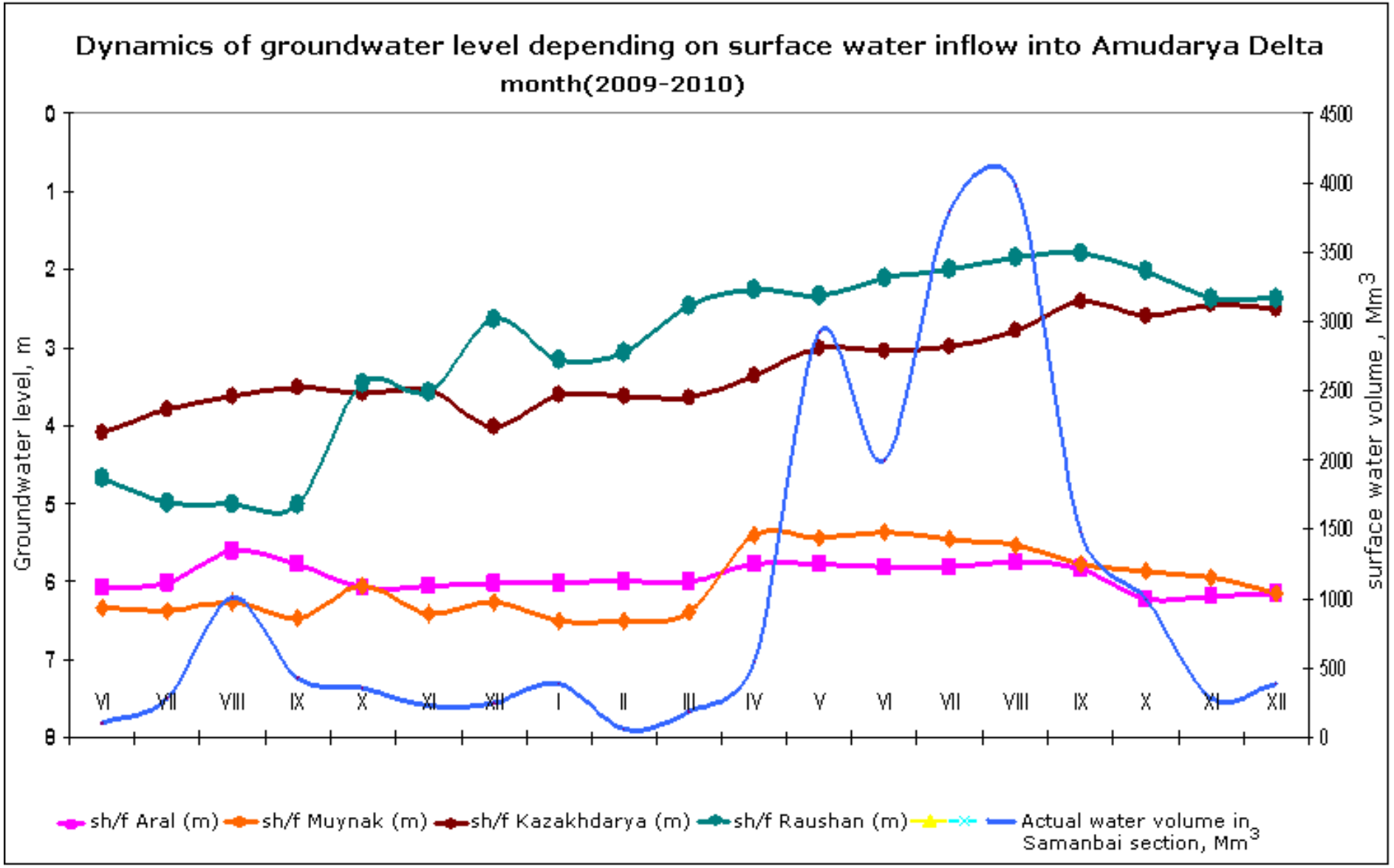

Dynamics of groundwater level depending on surface water inflow into Amudarya Delta
month(2009-2010)
Groundwater level, m
surface water volume , Mm3
0
1
2
3
4
5
6
7
8
4500
4000
3500
3000
2500
2000
1500
1000
500
0
VI
VII
VIII
IX
X
XI
XII
I
II
III
IV
V
VI
VII
VIII
IX
X
XI
XII
sh/f Aral (m)
sh/f Muynak (m)
sh/f Kazakhdarya (m)
sh/f Raushan (m)
Actual water volume in Samanbai section, Mm3

Fig.3

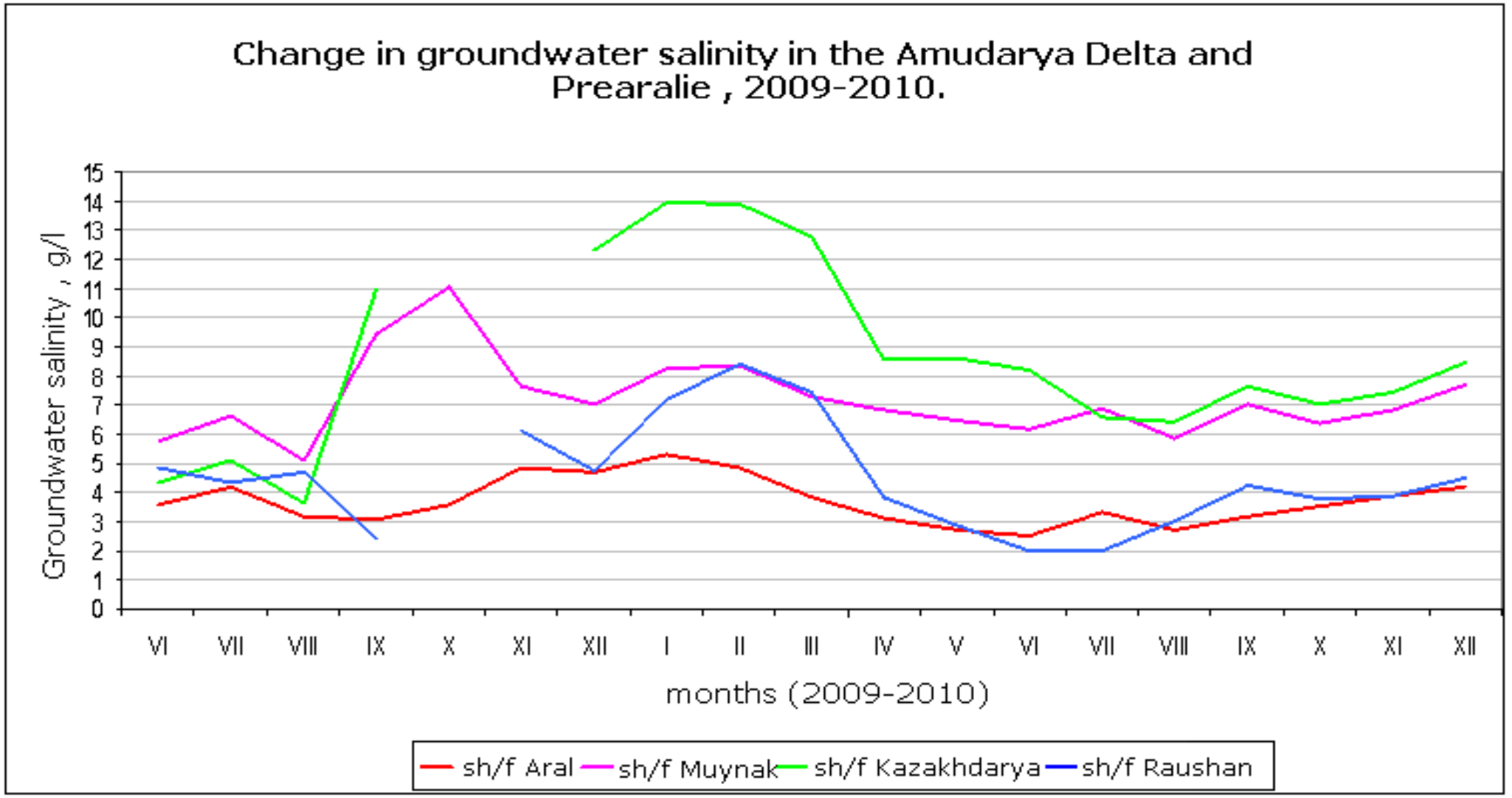

Change in groundwater salinity in the Amudarya Delta and Prearalie , 2009-2010.
Groundwater salinity , g/l
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
VI
VII
VIII
IX
X
XI
XII
I
II
III
IV
V
VI
VII
VIII
IX
X
XI
XII
months (2009-2010)
sh/f Aral
sh/f Muynak
sh/f Kazakhdarya
sh/f Raushan

Fig. 4

Area of wetlands, ha
(Results of NOAA image processing)

Table 10

№	Water body	2009			2010					
		September	**October**	**November**	**April**	**June**	**July**	**August**	**September**	**October**
1.	Sudoche	12648.24	32733.24	31365.50	63364.26	57719.78	50164.67	49372.04	50582.53	59729.32
2.	Mezdureche	19908.48	14794.54	10677.52	19548.23	29100.30	30788.79	33593.58	35541.13	27938.03
3.	Rybache	2065.75	15724.73	16841.11	9014.13	5642.84	4719.14	5585.05	5375.39	4921.98
4.	Muynak	2133.51	6606.02	5355.89	5125.59	9483.95	10782.84	12049.45	11791.77	12555.32
5.	Djiltirbas (confined by dam)	27473.0	29615.43	30180.17	41059.73	39551.59	44465.95	49180.88	49886.07	42348.89
6.	Djiltirbas (right-bank of Left flow path)	-	-	-	89653.79 – 41.060	82474.72	111294.36	129967.97	136449.90	142701.39
7	Former Adjibay Bay	-	-	-	7563.21	8475.62	9486.56	12824.64	10137.21	15429.00
8.	Dumalak	2700.66	2746.61	2882.24	5068.52	15329.55	16814.73	22809.08	24931.44	27620.26
9.	Adjibay 2*				6306.59	7723.54	12750.51	11738.26	30027.98	19370.09
10.	Makpalkol	7235.98	7710.05	4930.84	10328.17	10632.28	11257.88	12599.68	10297.01	11305.34
11.	Mashan Karadjar	1005.16	3116.32	2630.16	6434.11	7495.05	6890.01	4999.91	4835.61	8383.58
12.	Wetland southward of Muynak	-	-	-	3989.95	5765.70	7172.66	8737.13	9482.26	10180.27
13.	Wetlands north-westward of Muynak					1865.48	3524.59	4321.49	4207.12	4975.12
14.	Wetland at the head of Kazakhdarya river					2066.65	6110.75	14618.34	11176.82	8461.63
15.	Zakirkol lake					2872.87	2689.11	2882.52	2857.94	2492.24
	Total	**75170.78**	**113046.94**	**104863.43**	**226396.55**	**298477.19**	**284446.69**	**326099.13**	**347694.11**	**356063.56**

Inflow into the Aral Sea and the Amudarya Delta during growing season, million m^3

Table 11

Year	Apr	May	June	July	Aug	Sept	Plan	Actual	% %
1992	428	3620	5480	6203	4830	2620	7000	23181	331.2
1993	664	1496	4371	3940	1482	1642	7000	13595	194.2
1994	1175	527	977	4607	4100	2604	7000	13990	199.9
1995	202	133	131	250	316	380	5000	1412	28.2
1996	227	319	623	1762	1067	873	5000	4871	97.4
1997	100	172	213	144	141	152	5000	922	18.4
1998	350	3430	5770	4719	4163	1745	3000	20177	672.6
1999	206	191	312	436	625	804	3000	2574	85.8
2000	195	141	137	62	42	37	3000	614	20.5
2001	31	19	18	20	15	23	2550	126	4.9
2002	13	31	1435	1686	450	658	2550	4273	167.6
2003	754	2034	2869	2750	306	421	2000	9134	456.7
2004	359	543	1704	1216	223	256	6600	4301	65.2
2005	1173	1034	1148	5922	1774	1223	6100	12274	201.2
2006	296	217	246	238	248	283	6100	1528	25.0
2007	120	107	165	285	204	169	2400	1050	43.8
2008	132	81	61	67	29	23	1890	393.1	20.8
2009	29	44	127	361	1389	699	2100	2649.3	126.2
2010	682	3364	2833	3874	4428	1969	2100	17150	816.7

Note: incl. total spill from Suenly and Kyzketken canals, CDF flow

Inflow into the Aral Sea and the Amudarya Delta during non-growing season, million m^3

Table 12

Year	Oct	Nov	Dec	Jan	Feb	Mar	Plan	Actual	% %
1991-1992	1855	574	635	1456	584	827	3500	5931	169.5
1992-1993	886	1536	397	641	529	1166	3500	5155	147.3
1993-1994	1140	666	1068	1545	1101	1457	3500	6977	199,3
1994-1995	1636	988	941	1244	401	499	3500	5709	163.1
1995-1996	673	557	282	128	161	133	5000	1934	55.3
1996-1997	964	724	483	304	294	130	3500	2899	82.8
1997-1998	179	165	156	96	512	471	1500	1579	105.3
1998-1999	1092	713	850	534	365	512	2000	4066	203.3
1999-2000	952	518	956	978	456	331	2000	4191	209.6
2000-2001	76	82	73	70	79	90	2000	470	23.5
2001-2002	17	13	8	36	79	121	1500	274	18.3
2002-2003	423	728	1043	732	274	255	3000	3455	115.2
2003-2004	350	341	363	328	409	315	3000	2106	70.2
2004-2005	249	169	144	481	1250	1063	2100	3356	159.8
2005-2006	1093	581	827	459	637	921	2100	4518	215.1
2006-2007	205	155	291	216	131	169	2100	1167	55.6
2007-2008	205	155	291	216	240	123	2100	1230	58.6
2008-2009	21	20	19	19	28	37	2100	144	6.9
2009-2010	335	292	247	644	148	150	2100	1816	86.5

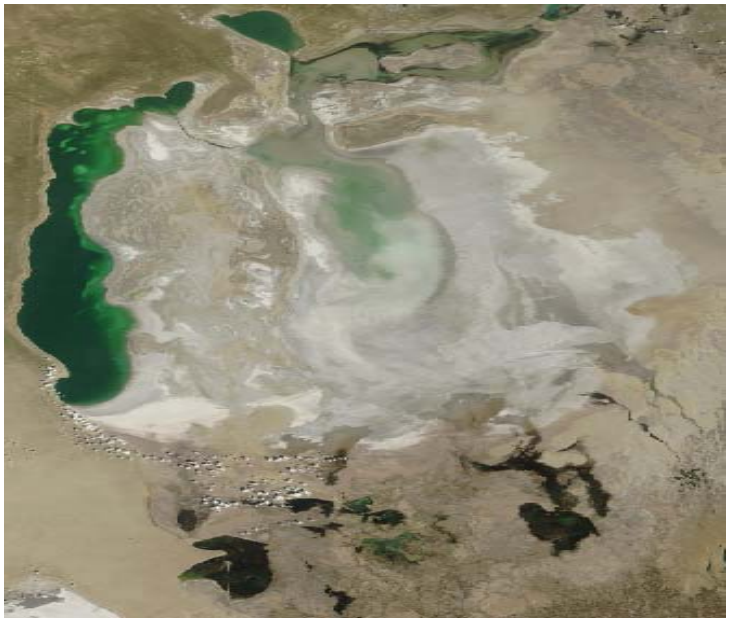
Note: incl. total spill from Suenly and Kyzketken canals, CDF flow

Table 13

Meteorological data over 2010

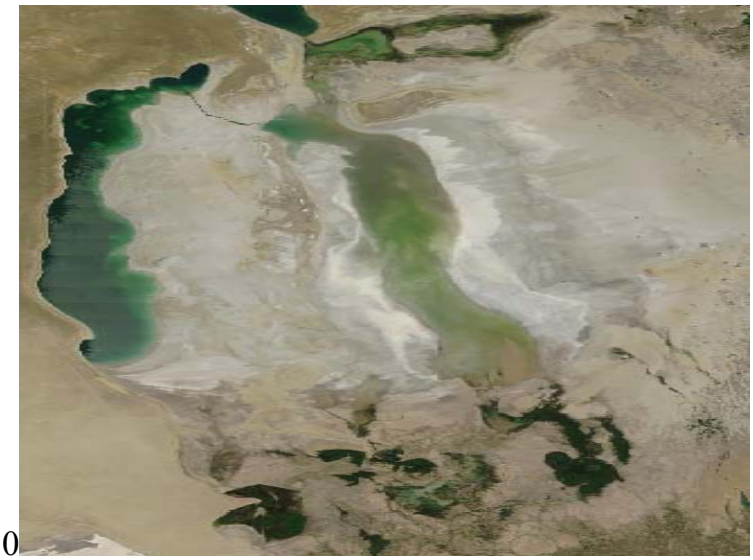
№	Weather station	Parameter	Units	MONTH												Average annual
				I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
1	Urgench	temperature	C	0.7	3.8	8.3	16.4	22.1	28.2	28.5	26.3	19.1	13.9	7.8	4.5	**15.0**
		rainfall	mm	3.7	46.8	4.5	11.1	8.8	1.8	0.7	0	0.3	0	1	1.6	**80.3**
		humidity	%	71	78	61	47	42	34	41	47	44	53	63	6.7	**49**
2	Nukus	temperature	C	-3.1	-5.6	7.3	16.6	22.8	29.6	30	27.7	19.7	13.4	7.3	0.6	**13.9**
		rainfall	mm	2.7	12.7	5.8	2.7	3.1	0	12.1	1.3	0	0.5	2.9	0	**43.8**
		humidity	%	79	84	72	60	34	25	32	35	35	49	67	65	**53**
3	Kungrad	temperature	C	-4.9	-7.1	5.5	16.2	22.3	28.7	28.6	26.5	18.7	12.1	5.5	0.3	**12.7**
		rainfall	mm	13.4	22.1	14.6	3.7	0.3	4.4	0.8	4	0	10.3	5.7	0.3	**79.6**
		humidity	%	79	72	64	50	44	36	39	44	49	57	71	67	**56**
4	Chimbai	temperature	C	-4.4	-6.6	6.4	16	22	28.3	28.6	26.6	18.8	12.3	6.5	0	**12.9**
		rainfall	mm	19.7	44.2	4.3	6.9	4.9	1	4.6	6.4	0	7.4	0.8	0	**100.2**
		humidity	%	76	75	61	47	49	40	43	47	49	57	66	61	**56**
5	Takhia-Tash	temperature	C	-2.4	-5.1	7.5	16.5	22.8	29.4	29.1	27	24	14	8.1	2	**14.4**
		rainfall	mm	2.4	12.6	0.9	7.3	2.1	0.8	1.8	1	0	18	3.7	0	**50.6**
		humidity	%	74	78	63	53	47	46	49	53	55	56	68	66	**59**
	TOTAL:	temperature	C	**-2.82**	**-4.12**	**7**	**16.34**	**22.4**	**28.84**	**28.96**	**26.82**	**20.06**	**13.14**	**7.04**	**1.48**	**13.8**
		rainfall	mm	**8.38**	**27.68**	**6.02**	**6.34**	**3.84**	**1.6**	**4.0**	**2.54**	**0.06**	**7.24**	**2.82**	**0.38**	**70.9**
		humidity	%	**76**	**77**	**64**	**51**	**43**	**36**	**41**	**45**	**46**	**54**	**67**	**53**	**55**

Fig. 5



April-2010

Fig.6



June-2010

Fig.7

September-2010

Fig.8.

October 2010

Fig. 9

November 2010