4. REPUBLIC OF UZBEKISTAN

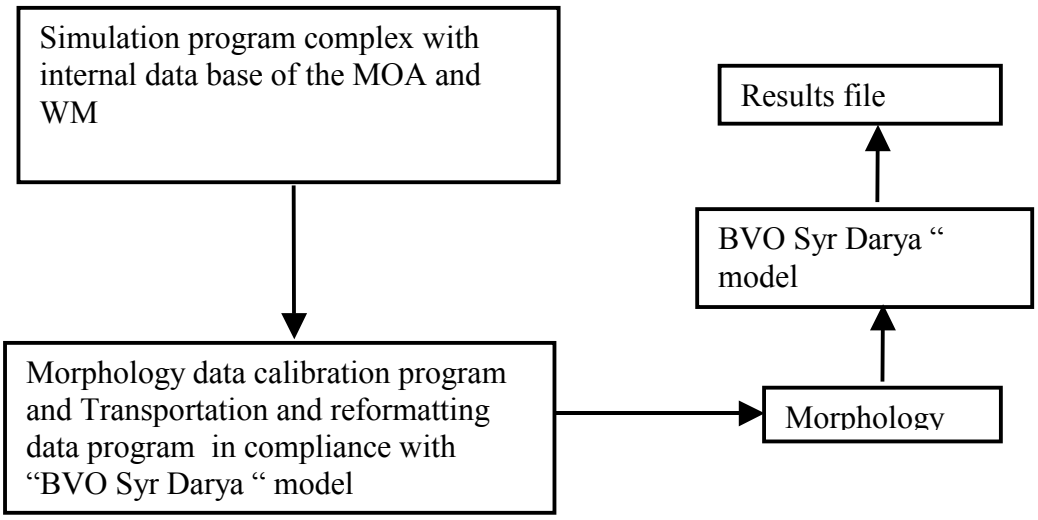
4.1. Results of BVO Syr Darya Model Application in the Uzbek Ministry of Agriculture and Water Management, Sh. Kuchkarov, H. Gaparov

Sh. Kuchkarov, Chief Specialist
Water Budget Department, and
Kh. Gapparov, Head
Department of Water Resources Balance
Ministry of Agriculture and Water Management

In order to solve urgent tasks in the Ministry of Agriculture and Water Management of the Republic of Uzbekistan (MOA & WM RU) mathematical models and the program created in the BVO Syr Darya were used. The GAMS language served as the basis for creating software programs. The MOA & WM RU (Maintenance Division) solves the tasks connected with elaboration of operation regimes of separate water reservoirs and irrigation systems. To speed up the solution of these tasks there was approved a decision to use a mathematical model and programs developed in the BVO Syr Darya.

Elaboration of a Separately Taken Water Reservoir Operation Regime

Previously, in the MOA & WM RU a complex for estimation imitation of operation regimes of separate water reservoirs was developed. This complex includes an internal data base on morphology of 44 reservoirs located on the territory of the RU and those which are important for Uzbekistan but located outside of the Republic. Programs that transport information from this complex to water resources management programs created in the BVO Syr Darya have been added to this complex. The operating scheme of these additional programs is presented below.



The procedure for estimating performance consists of a simulation program complex that allows the selection for estimation any of the reservoirs included into data base. Although after performance of this selection the operation of this program may be interrupted. Since the selection has already been made, the data connected with the morphology of a definite water reservoir is withdrawn from the internal data base. These data are written to a separate file in the format comprehensible for the program performing the estimations.

But:

1) morphology of the selected reservoir presented in the form of a table often does not fit format (twenty lines) required by the BVO Syr Darya program;
2) data on the "Volume" – "Level" relationship of the reservoir are not sorted in increasing order; and
3) the file that contains morphological data is not located in the working directory of the BVO Syr Darya program.

Data program calibration and transportation and data re-formatting programs to meet the requirements of the "BVO Syr Darya" model have been created to improve these mismatch/ discrepancies.

In cases when there are less than twenty lines, the data calibration program uniformly adds lines and estimates intermediate data by linear interpolation. In cases when more than twenty are present, then the program deletes some lines from the table and uniformly extracts them from the original table.

In cases when data are not located in an increasing order, the data calibration program, reformats them in increasing order.

Chimqurgan

	Initial file			**=> intermediate file**			**=>**	**final file**	
N	level	volume	area	level	volume	area	volume	level	area
01	462	0.011	0.034	462	0.01	0.03	0.01	462.00	0.03
02	464	0.672	0.772	463	0.34	0.40	0.34	463.00	0.40
03	466	3.789	2.511	464	0.67	0.77	2.23	465.00	1.64
04	468	11.286	5.142	465	2.23	1.64	7.54	467.00	3.83
05	470	24.108	7.770	466	3.79	2.51	17.70	469.00	6.46
06	472	42.004	10.180	467	7.54	3.83	24.11	470.00	7.77
07	474	64.484	12.334	468	11.29	5.14	53.24	473.00	11.26
08	476	91.961	15.193	469	17.70	6.46	64.48	474.00	12.33
09	478	125.391	18.285	470	24.11	7.77	108.68	477.00	16.74
10	480	165.064	21.429	471	33.05	8.98	125.39	478.00	18.28
11	482	212.225	25.790	472	42.00	10.18	145.23	479.00	19.86
12	484	268.515	30.577	473	53.24	11.26	165.06	480.00	21.43
13	486	335.975	36.585	474	64.48	12.33	212.23	482.00	25.79
14	488	417.304	44.459	475	78.22	13.76	240.38	483.00	28.19
15	490	511.779	50.071	476	91.96	15.19	268.52	484.00	30.58
16				477	108.68	16.74	302.25	485.00	33.59
17				478	125.39	18.28	376.64	487.00	40.53

18			479	145.23	19.86	417.30	488.00	44.46
19			480	165.06	21.43	464.54	489.00	47.27
20			481	188.64	23.61	511.78	490.00	50.07
	21		482	212.23	25.79			
	22		483	240.38	28.19			
	23		484	268.52	30.58			
	24		485	302.25	33.59			
	25		486	335.97	36.59			
	26		487	376.64	40.53			
	27		488	417.30	44.46			
	28		489	464.54	47.27			
	29		490	511.78	50.07			

The above table shows how the initial information from the internal data base of the complex of simulation estimations is transformed into the information input format acceptable for the BVO Syr Darya model.

The transport program re-writes the file into a special directory in the BVO Syr Darya directory that has been written in the file **PATH.GMS.**

A universal scheme applicable for estimation of the optimal management regime for any of the 44 water reservoirs included in the data base of the MOA & WM RU has been created with the help of the interface attached to the BVO Syr Darya model.

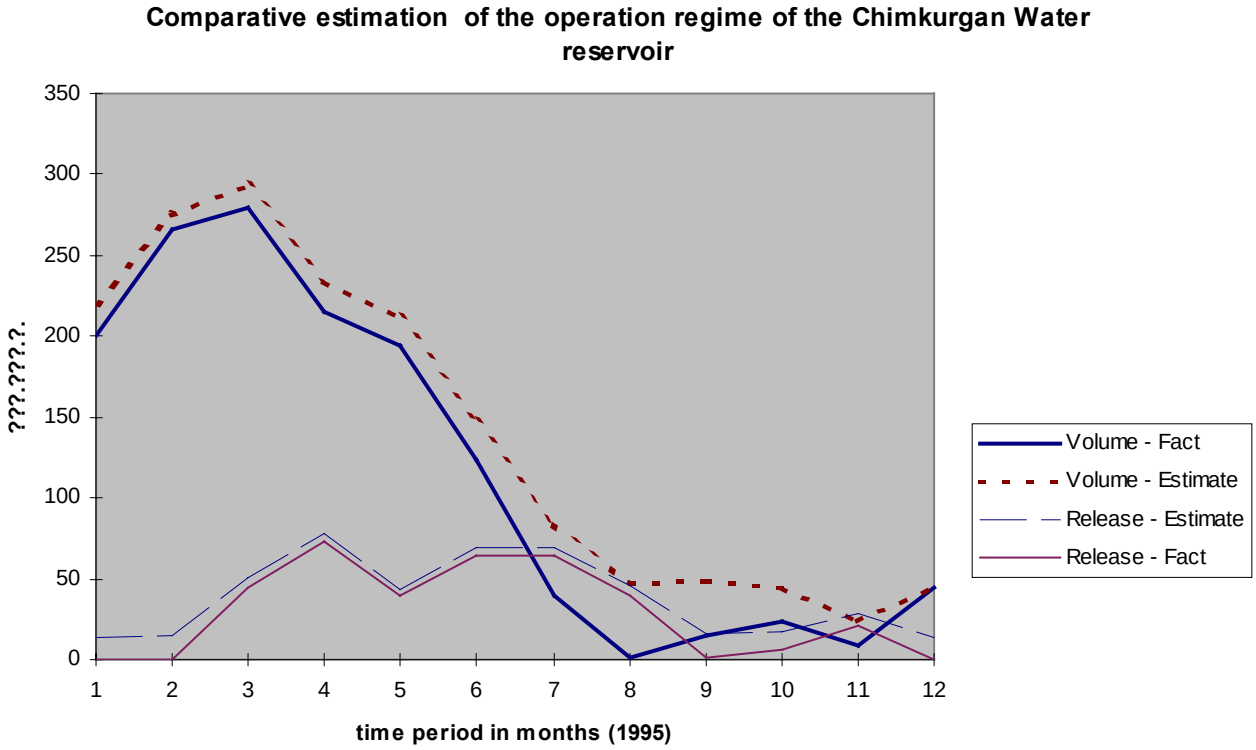
The scheme consists of a source node, a reservoir node, a consumer node and an extra water release node (in case there are any) which is called a mouth. Also there are two additional control nodes in the scheme that provide flexibility of information output into the results file. Figure 1 presents this universal estimation scheme.

The output scheme elaborated by A.I. Leshanskiy of the BVO Syr Darya is applicable for the use in the MOA & WM RU.

The Chimkurgan reservoir, in the Amu Darya river basin, has been selected to demonstrate the working capacity of the scheme. The base year for estimation was the 1995 calendar year.

Initial volume of the Chimkurgan reservoir = 169.10 million m^3

	volume (fact) million m^3	volume (estimation) million m^3	release (estimation) million m^3	release (fact) million m^3
1	200.00	219.86	13.26	0.00
2	265.90	275.05	14.80	0.00
3	280.00	292.58	50.90	44.42
4	215.00	234.15	77.86	73.27
5	194.70	211.92	43.49	39.14
6	123.10	147.13	68.67	64.67
7	40.00	84.06	68.77	64.28
8	1.80	47.50	45.90	39.58
9	15.20	47.65	16.17	1.81
10	23.00	44.01	17.13	5.70
11	9.00	23.17	28.87	21.08
12	44.00	44.00	14.17	0.52



Comparative estimation for Chimkurgan reservoir showed that the optimal solution differs somewhat from the actually operation: water reservoir release in an optimal regime is not so deep as was realized in practice. Still, the program provided the required amount of water to consumers.

The next important task that has been realized in the Ministry of Agriculture and Water Management was the task on optimal flow management of the Kara Darya River basin.

The Kara Darya River scheme was created, including its main water intakes and irrigation management systems that are used in the MOA & WM RU, using interface programs developed in the BVO Syr Darya. The Figure below presents the Kara Darya River scheme.

The following estimations have been conducted:
1999 perspective calculations to assess the model's ability to estimate reality.
Data was taken from the operative base of the MOA & WM RU.

5 Information about sources and their mineralization

1 4 (flow – 1) (runoff 1) mineralization; 1-hour, 2 –day, 3 –decade, 4 month

inflow to Andijan reservoir

48.30	0.00
52.90	0.00
51.50	0.00
111.30	0.00
409.50	0.00
342.80	0.00
337.60	0.00
156.70	0.00
71.70	0.00
76.50	0.00
68.00	0.00
50.00	0.00

intermediate inflow before Kunganer

4.83	0
5.29	0
5.15	0
11.13	0
40.95	0
34.28	0
33.76	0
15.67	0
7.17	0
7.65	0
6.80	0
5.00	0

intermediate inflow before Teshiktash

4.83	0.00
5.29	0.00
5.15	0.00
11.13	0.00
40.95	0.00
34.28	0.00
33.76	0.00
15.67	0.00
7.17	0.00
7.65	0.00
6.80	0.00
5.00	0.00

old head of Big Fergana Canal (BFK)

33.4	0
50.0	0
47.1	0
43.9	0
62.1	0
68.8	0
78.8	0
77.9	0
36.8	0
45.4	0
41.7	0
60.0	0

KDP ???

33.40	0.00
67.30	0.00
86.40	0.00
69.80	0.00
91.40	0.00
98.50	0.00
107.80	0.00
112.00	0.00
52.20	0.00
68.30	0.00
65.30	0.00
60.00	0.00

8 Information about consumers, water intake, mineralization of return waters

1 4 (flow – 1) (release 1); 1-hour, 2 –day, 3 –decade, 4 month

	PBK	Andijan	Savai	UFK	Sharikhan	Pakhtaabad	Ulugnor	BFK
1	1.7	0.001	0.80	0.00	5.501	1.001	1.001	41.101
2	1.0	0.001	1.70	0.00	9.301	1.001	1.001	76.201
3	0.7	4.501	4.80	11.50	24.501	1.001	1.001	120.201
4	1.6	5.901	6.20	19.20	45.601	2.001	2.001	99.901
5	14.9	41.601	25.10	44.10	134.301	2.001	2.001	125.201
6	17.1	36.901	23.00	45.00	132.601	2.001	2.001	109.201
7	16.0	45.701	26.70	43.70	140.601	3.001	3.001	111.901
8	15.8	46.101	27.60	42.50	136.701	3.001	3.001	109.301
9	5.7	10.701	12.90	23.70	71.201	2.001	2.001	87.301
10	4.5	12.001	13.50	19.00	62.001	1.001	2.001	91.501

11	3.0	12.001	15.00	21.00	62.001	1.001	1.001	88.001
12	1.0	1.001	10.00	0.00	30.001	1.001	1.001	80.001

A file fragment of the result formed by the BVO Syr Darya program complex is presented below

Andijan Water Reservoir _____ (WATER BAKANCE) N 1

TIME INTERVALS: :

	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	
INFLOW TO THE RESERVOIR mln.м3:													
	125.19	**137.12**	**133.49**	**288.49**	**1061.42**	**888.54**	**875.06**	**406.17**	**185.85**	**198.29**	**176.26**	**129.60**	
VOLUME: BEGINNING OF THE PERIOD :mln.м3:													
	1323.0	**1405.6**	**1489.8**	**1482.2**	**1545.3**	**1875.0**	**1875.0**	**1875.0**	**1621.9**	**1291.0**	**1164.7**	**1149.0**	
END OF THE PERIOD mln.м3::													
	1405.6	**1489.8**	**1482.2**	**1545.3**	**1875.0**	**1875.0**	**1875.0**	**1621.9**	**1291.0**	**1164.7**	**1149.0**	**1193.0**	
FILLING mln.м3:													
		82.60	**84.16**	**-7.60**	**63.17**	**329.67**	**0.00**	**0.00**	**-253.15**	**-330.88**	**-126.25**	**-15.76**	**44.04**
RELEAS FROM RESERVOIR : mln.м3:													
		42.59	**52.96**	**141.09**	**225.33**	**731.75**	**888.54**	**875.06**	**659.31**	**516.72**	**324.54**	**192.02**	**85.56**
releases_ _													
CONVERSION FACTOR : :													
	2.59	**2.59**	**2.59**	**2.59**	**2.59**	**2.59**	**2.59**	**2.59**	**2.59**	**2.59**	**2.59**	**2.59**	
INFLOW TO THE RESERVOIR : M3/C :													
	48.30	**52.90**	**51.50**	**111.30**	**409.50**	**342.80**	**337.60**	**156.70**	**71.70**	**76.50**	**68.00**	**50.00**	
FILLING : M3/C :													
	31.87	**32.47**	**-2.93**	**24.37**	**127.19**	**0.00**	**0.00**	**-97.67**	**-127.65**	**-48.71**	**-6.08**	**16.99**	
RELEASE FROM FROM RESERVOIR : M3/C :													
	16.43	**20.43**	**54.43**	**86.93**	**282.31**	**342.80**	**337.60**	**254.36**	**199.35**	**125.21**	**74.08**	**33.01**	

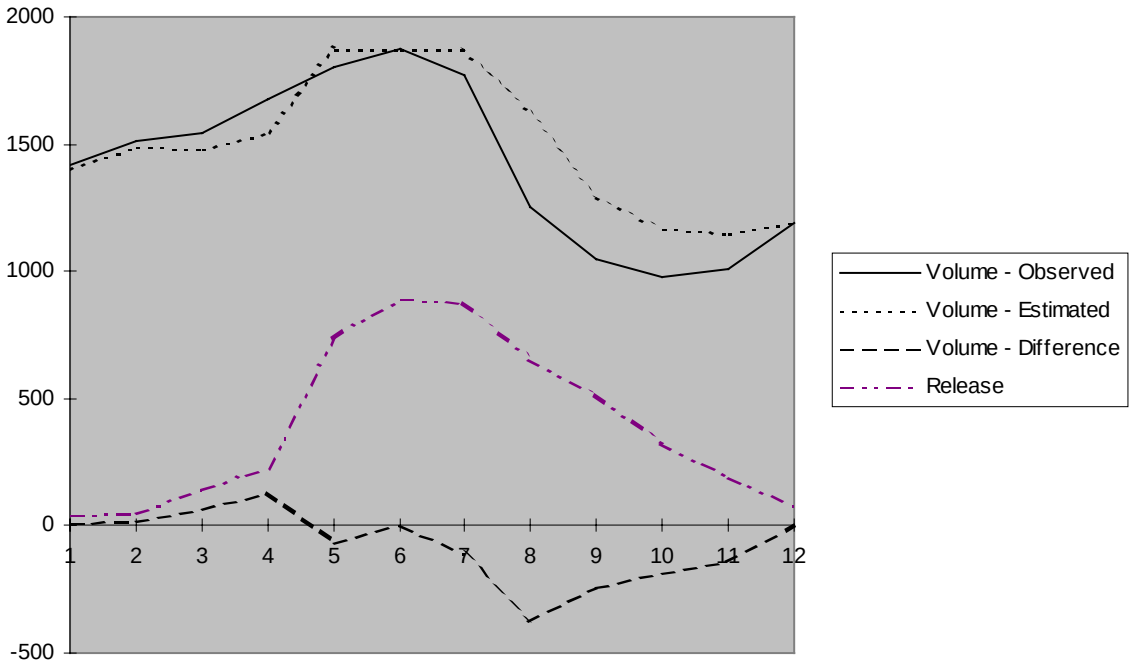
Estimation results and retrospective observations are presented in the Table below:

1	Observed	Estimated	Difference	Release
1	volume	volume		

Andijan water reservoir, all characteristics are given in mln.cubic. м.

1	1419.00	1405.60	13.40	42.59
2	1509.00	1489.80	19.20	52.96
3	1547.00	1482.20	64.80	141.09
4	1677.00	1545.30	131.70	225.33
5	1805.00	1875.00	-70.00	731.75
6	1876.00	1875.00	1.00	888.54
7	1769.00	1875.00	-106.00	875.06
8	1250.00	1621.90	-371.90	659.31
9	1047.00	1291.00	-244.00	516.72
10	976.00	1164.70	-188.70	324.54
11	1013.00	1149.00	-136.00	192.02
12	1193.00	1193.00	0.00	85.56

A graph has been obtained using the Table of retrospective estimation comparisons.



Graph comparing calculations and retrospective observations for Andijan reservoir for 1999.

The next task that has been solved using the BVO Syr Darya model was the forecast of the Andijan reservoir operation for the vegetation period of 2000 in 10 day increments.

The Hydromet service of the Republic of Uzbekistan has produced a forecast about water flow in the Kara Darya River for the vegetation period of 2000 10 day increments. A number of retrospective observations for the Kara Darya River have been studied in order to solve the intermediate inflow issue for the river. The water balance for over 5 years has been produced. Interrelations between the intermediate inflow to the Kara Darya and the total water intake in the canals were revealed. Definitely the interrelations are not very good but significant enough.
Dependence search took place between revealed water balance disparity, where intermediate inflows were missing, and water intakes into separate groups of canals and water content.
The picture below shows an illustration of the kind of interrelation that has been processed using statistical methods.

Forecast data, limits for water intakes and amounts of intermediate inflow estimated using statistical dependence were introduced into the scheme that was created for the Kara Darya River. Input data are presented in the Table below:

Information about consumers, water intakes, mineralization of return waters 1 3 (runoff -1) (release 1); 1-hour,2- day, 3- decade,4- months

	PBK	Andijansay	Savay	UFK
1	0.010	1.700	2.000	0.001
2	0.100	2.600	2.000	0.001
3	4.000	3.800	4.000	11.501
4	9.000	10.900	7.000	19.201
5	14.000	22.700	12.000	44.101

6	17.000	23.800	17.000	45.001
7	16.000	19.900	18.000	43.701
8	15.000	16.600	13.000	42.501
9	14.000	17.100	13.000	23.701
10	14.000	19.300	10.000	19.001
11	14.000	22.600	11.000	21.001
12	15.000	26.500	13.000	0.001
13	14.001	24.100	11.000	0.001
14	14.001	22.200	11.000	0.001
15	14.001	17.800	11.000	0.001
16	7.001	7.900	6.000	0.001
17	3.001	5.900	4.000	0.001
18	4.001	2.800	4.000	0.001

	Sharikhansay	**Pakhtaabad**	**Ulugnor**	**BFK**
1	29.000	3.500	1.200	25.000
2	30.000	4.700	1.200	28.000
3	39.000	7.100	2.200	31.000
4	66.000	10.000	3.100	32.000
5	77.000	10.500	5.400	45.000
6	120.000	12.900	6.300	49.000
7	119.000	12.200	5.500	48.000
8	88.000	9.800	5.400	52.000
9	89.000	9.800	6.000	55.000
10	100.000	9.800	6.800	51.000
11	95.000	9.300	8.000	53.000
12	93.000	10.600	7.400	59.000
13	93.000	9.800	6.700	51.001
14	95.000	9.700	6.600	45.001
15	84.000	9.700	4.300	42.001
16	51.001	6.800	2.200	37.001
17	41.001	6.000	0.700	22.001
18	33.001	3.600	0.700	12.001

Information about sources, inflow to Andijan reservoir. Intermediate inflow

80.00	54.00
170.00	113.00
200.00	132.00
250.00	165.00
290.00	192.00
300.00	198.00
300.00	198.00
305.00	201.00
310.00	205.00
250.00	165.00
205.00	136.00
160.00	106.00
120.00	80.00
70.00	47.00
60.00	40.00
56.00	38.00
52.00	35.00
48.00	33.00

The result of the operation of the BVO Syr Darya program complex is the following:

Andijan Water Reservoir _____ **(WATER BALANCE) N 1**

_____TIME

INTERVALS: :

1 2 3 4 5 6 7 8 9 10 11 12 14 15 16 17 18 Total

CONVERSION FACTOR : : 0.86

_____

INFLOW TO THE RESERVOIR m3/s:

80 170 200 250 290 300 300 305 310 250 205 160 120 70 60 56 52 48 2780

VOLUME: BEGINNING OF THE PERIOD: mln.м3:

1482 1500 1599 1721 1887 1947 1950 1942 1942 1933 1838 1685 1504 1304 1084 905 793 723 1482.00

END OF THE PERIOD :mln.м3:

1500 1599 1721 1887 1947 1950 1942 1942 1933 1838 1685 1504 1304 1084 905 793 723 683 683.00

FILLING :млн.м3:

18.9 98.1 122 165.5 60.6 2.28 -7.5 -0.16 -9.2 -94.1 -153 -181.4 -200.2 -219 -178 -112. -70 -40 -799.00

RELEASE FROM RESERVOIR: m3/s :

58.0 56.1 57 58.0 219 297 308 305 320 359 382 370.4 352.2 325 267 186.09 133 94.64 3579.81

A MARK AT THE END OF THE PERIOD: METER : +800

28.92 29.64 30.9 32.58 33.8 34.16 34.13 34.09 34.04 33.48 32.11 30.18 27.83 25.03 22.13 19.80 18.23 17.23

Graph of comparison of estimation results on BVO Syr Darya model

In order to assess the correctness and adequacy of the new estimation method the same task has been solved using a spreadsheet through selection and multiple re-estimation. Two results were obtained. One was obtained with the help of the BVO Syr Darya model. The second result was obtained using a spreadsheet through selection and multiple re-estimation. The results were very similar. The difference is that the BVO model guarantees the best variant and performs estimations hundreds times quicker.

The next stage in our work schedule is the basin of the Chirchik River. We are planning to make estimations not only for water way of the main river but also for the entire specter of canals that form the Chakir system.

We'd like to express out thanks to our Kyrgyz colleagues for the provided information about morphology of all the water reservoirs in the Naryn HPS cascade. This information will be included into data base of the Ministry of Agriculture and Water Management that has been described above.