



Transboundary water management adaptation in the Amudarya Basin to climate change uncertainties

Report on Position 4 "Development of the Database"

Project manager, Prof.

Responsible for position

Executor

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Introduction

Given report describes the project results on position 4 "Development of the Database". The following work was completed:

- Development of project DB, testing
- Adaptation of the project DB's interface to the database of the Planning Zone Model,
- Collection, processing and input of data into the PZ model,
- Processing and input of project results into the project DB

The above work was done by a project team (R.Toshpulatov, I.Ergashev) under coordination of A.Sorokin.

The project DB contains 2 Mb of data, including the data on:

- 3 states Tajikistan, Turkmenistan, Uzbekistan,
- 13 planning zones (provinces) of Amudarya Basin's riparian countries,
- Historical data on 2010-2015 and for the future period 2020-2055,
- 9 scenarios,
- 59 categories,
- 210 indicators

The DB Interface – 10 Mb.

1. Objective and tasks

The objective of work is to create a project DB, adapt it to the PZ model and fill its with retrospective data and project results in form of indicators.

The tasks were as follows:

- A) Develop DB and interface
- B) Collect, process and input the data into the model and DB, following the structure of the latter (i.e. data category, objects, parameters) see Annex 1
 - Retrospective data;
 - o Data over the base period (2010-2015)
 - Data on scenarios over 2016-2055 input data and calculated indicators (results of calculations by the PZ model and hydropower model
- C) Prepare (select) the data for calculations in the PZ model, including import of the data from the water requirements model (G.Solodkiy), data on cropping patterns, economic data (Sh.Muminov), data on water resources (D.Sorokin) see Annex 1

2. Work scope for development of DB and interface

An information system was developed and located on SIC's servers. The access to the system is available on <u>http://cawater-info.net/peer</u>.

Resource functionality:

- Multi-language, support of two languages: Russian and English
- ➢ User authorization
- Data input via Interface
- > Tabular and graphical data output

The web-site is designed in Google's Material Design format. Web-application is operated as SPA (single page application) through AJAX. The system consists of client-side and server-side. Server is realized on Yii as API; the data is transferred to the client-side in JSON format. The data is stored in MySQL DBMS.

2.1 Web-server's system requirements:

- ▶ Interpretator PHP 5.1 and later version
- ➢ Apache HTTP Server
- Database MySQL 4.1 and later version with support of MySQLi or pdo_mysql extension.

2.2 Web-server's technical requirements:

- \succ Hard disk space 10 Mb
- Single core processor with memory clock 2.4 GHz

➢ RAM 512 Mb

2.3 Software environment:

1) **Yii** – framework written in PHP, implements MVC. Architecture and functionality:

- Better performance compared to other PHP-based frameworks
- MVC framework
- Interfaces DAO and ActiveRecord to handle databases (PDO)
- Internationalization support
- Page and individual fragment caching
- Error trapping and processing
- Input and validation
- Authentication and authorization
- Use of AJAX and integration with jQuery
- Generation of the base PHP-code for CRUD-operations (scaffolding)
- Style support for their easy change
- Possibility to connect third-party libraries
- Database migration
- Automatic testing
- REST support

2) **AngularJS** is a JavaScript-based framework with open-source code. It is designed for development of single-page applications. It aims to extend browser applications based on MVC, as well as to simplify both the development and the testing of such applications. The framework works with HTML, which has additional custom tag attributes embedded into it. Angular interprets those attributes as directives to bind input or output parts of the page to a model that is represented by standard JavaScript variables. The values of those JavaScript variables can be manually set within the code, or retrieved from static or dynamic JSON resources. Angular implements the MVC pattern to separate presentation, data, and logic components. Using dependency injection, Angular brings traditionally serverside services, such as view-dependent controllers, to client-side web applications. Consequently, much of the burden on the server can be reduced and web-application is less heavy.

3) MySQL is an open-source relational database management system. MySQL was owned and sponsored by a single for-profit firm, the Swedish company MySQL AB, now owned by Oracle Corporation. The product is disseminated under GNU General Public License and under own commercial license. In addition, developers offer additional functionality for licensed users upon their requests. Thanks to exactly such requests, the replication mechanism was added in very earlier versions.

3. Structure of links between tables in MySQL DBMS



Category table

Column	Туре	Null	By default	Comments
id	int(11)	no		code
ruName	varchar(250)	no		Category
enName	varchar(250)	no		Category
group	enum('planning_zone', 'transboundary_network', 'climate', 'energetics')	no		module
schema	enum('retrospective', 'perspective')	no	retrospective	scheme
sort	int(10)	yes	0	sorting

Indices

Index	Туре	Unique	Packed	Column	Unique elements	Comparison	Null	Comment
PRIMARY	BTREE	yes	no	id	59	А	no	

Data_monthly table

Column	Туре	Null	By default	Comments
id	int(11)	no		code
idIndicator	int(11)	no		indicator
idZone	int(11)	no		Planning zone
scenario	varchar(20)	no	default	scenario

year	int(4)	no		year
m1	float	yes	NULL	January
m2	float	yes	NULL	February
m3	float	yes	NULL	March
m4	float	yes	NULL	April
m5	float	yes	NULL	May
m6	float	yes	NULL	June
m7	float	yes	NULL	July
m8	float	yes	NULL	August
m9	float	yes	NULL	September
m10	float	yes	NULL	October
m11	float	yes	NULL	November
m12	float	yes	NULL	December

Indices

Index	Туре	Unique	Packed	Column	Unique elements	Comparison	Null	Comments
PRIMARY	BTREE	yes	no	id	12532	А	no	
idIndicator	BTREE	no	no	idIndicator	348	А	no	
idZone	BTREE	no	no	idZone	26	А	no	

Data_vegetation table

Column	Туре	Null	By default	Comments
id	int(11)	no		Code
idIndicator	int(11)	no		Indicator
idZone	int(11)	no		Planning zone
scenario	varchar(20)	no		Scenario
year	int(4)	no		Year
vegetation	float	no		Vegetation period
nonVegetation	float	no		Non-vegetation period
yearly	float	no		Annual

Indices

Index	Index Type Unique Packed Column		Column	Unique elements	Comparison	Null	Comments	
PRIMARY	BTREE	yes	no	id	1104	А	no	
idIndicator	BTREE	no	no	idIndicator	29	А	no	
idZone	BTREE	no	no	idZone	1	А	no	

Data_yearly table

Column	Туре	Null	By default	Comments
id	int(11)	no		Code
idIndicator	int(11)	no		Indicator
idZone	int(11)	no		Planning zone
scenario	varchar(20)	no	default	Scenario
year	int(4)	no		Year
val	float	no		Value

Indices

Index	Туре	Unique	Packed	Column	Unique elements	Comparison	Null	Comments
PRIMARY	BTREE	yes	no	id	14668	А	no	
idIndicator	BTREE	no	no	idIndicator	232	А	no	
idZone	BTREE	no	no	idZone	54	А	no	

Indicator table

Column	Туре	Null	By default	Comments
id	int(11)	no		Code
type	enum('monthly', 'yearly', 'vegetation')	no	monthly	Type of indicator (monthly /yearly)
idCategory	int(11)	no		Category
ruName	varchar(250)	no		Indicator
enName	varchar(250)	no		Indicator
ruMeasure	varchar(100)	yes	NULL	Unit
enMeasure	varchar(100)	yes	NULL	Measure
sort	int(10)	yes	0	Sorting

Indices

Index	Туре	Unique	Packed	Column	Unique elements	Comparison	Null	Comments
PRIMARY	BTREE	yes	no	id	225	А	no	
idCategory	BTREE	no	no	idCategory	225	А	no	

Scenario indicator

Column	Туре	Null	By default	Comments
id	varchar(20)	no		Code
ruName	varchar(255)	no		Name in Russian

enName	varchar(255)	no		Name in English
ruDescription	varchar(255)	yes	NULL	Description in Russian
enDescription	varchar(255)	yes	NULL	Description in Engilsh
sort	int(10)	no		Sorting

Indices

Index	Туре	Unique	Packed	Column	Unique elements	Comparison	Null	Comments
PRIMARY	BTREE	yes	no	id	9	А	no	

Table scenario_indicator

Column	Туре	Null	By default	Comments
id	int(11)	no		Code
scenario	varchar(20)	no		Scenario
indicator	int(11)	no		Indicator

Indices

Index	Туре	Unique	Packed	Column	Unique elements	Comparison	Null	Comments
PRIMARY	BTREE	yes	no	id	228	А	no	
scenario	BTREE	no	no	scenario	16	А	no	
indicator	BTREE	no	no	indicator	228	А	no	

Zone table

Column	Туре	Null	By default	Comments
id	int(11)	no		Code
ruName	varchar(250)	no		Name in Russian
enName	varchar(250)	no		Name in English
group	enum('planning_zone', 'transboundary_network', 'climate', 'energetics')	no		Group
isLeaf	int(1)	no		Last nested element
schema	enum('retrospective', 'perspective')	no	retrospective	Scheme

Indices

Index	Туре	Unique	Packed	Column	Unique elements	Comparison	Null	Comments
PRIMARY	BTREE	yes	no	id	42	А	no	

4. File system structure of Project DB

The DB is located in the following directories:

assets/ (cached files of server-side application)
css/ (all css-styles used in the system)
fonts/ (all fonts, including icon fonts used in the system)
images/ (images)
ng-modules/ (parent directory of user application)
protected/ (protected directory containing components of server-side application)
themes/ (interface customization)
ng-modules – basic directory of user interface, here realized as AngularJS-based SPA
application; the code is written in Javascript within the framework of MVC, SOLID. The
directory is divided into two sections (app, dependencies).

App directory contains models, controllers and configuration files of the user application. Dependencies directory contains relationships of the user application. The components are adjustable and stored in configuration file ng-modules/app/config.js.



Configuration file, section of settings for inquiries to API



ApiController is in the middle between models and inquiries from the side of user

5. Interface

The main page contains the header with the menu, where the user can select a planning zone, modules, language, as well as log in. The logged in user can have access to the button to add new planning zone.



The menu on the left contains the list of indicators, as well as edit, add, and delete buttons for categories and indicators activated for authorized uses.

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9	2218	34.46	17.84	527.9	465.61	465.75	00434	825.64	528,34	212.4	256.17	229,97	174.31	4585.59
1	2011	80.54	124.96	161.33	194.37	315.47	995.47	148.25	\$26.79	270.85	143.75	79.29	37.06	2905.81
	però	65.54	98.87	1010.01	234.08	410.15	1077.02	725.48	749.58	417,79	173.65	7.92	10.0	00.11
	221.0	19.97	812.48	475.35	1991	295.18	400.00	918.45	785.01	415.5	200.04	11.01	88.17	4435.37
•	1014	24.75	148.72	343.34	301.84	225.65	425.57	876.01	411.17	315.01	245.87	132.41	101.04	2532.57
•	2018	1.			182					1		- E.		0.00
۶.	2018					1							0	0.010

Below the web-site heading, there is a table with the output data on the selected indicator and PZ by year and month, as well as a graph, with the possibility to change the format of information output.



Planning zones and other modules are selected through the main top dropdown menu:

C		Зоны планирования +			Транст	раничная сет	
Тра	ансгран	Хореам Южный Каракалпакстан		не форми	ировани	e p.Baxu	U -
	БЕЗ УЧЕТА	Северный Каракалпакстан Сурхандарыя		изменения	климата		
#	Год	Карши		Апрель	Май	Июнь	
1	2016	Бухара Навои	17	1505.95	2158,79	3525.12	
2	2017	Гарм	\$3	819.07	1896.31	3265.92	
3	2018	Baxu	15	878.69	1957.91	2579.04	
4	2019	Пяндж Горно-Бадахшан	16	1003,1	1542.76	2467.58	
5	2020	Верхний Кафирниган	53	1161.22	1829.35	3343.68	
6	2021	Нижний Кафирниган Каратаг-Ширкент	38	1324.51	2188.25	3525.12	
7	2022	Webser -	25	855 36	1936 48	2695.68	

Selection of "Retrospective/Perspective" data, language options, and exit are also in the main top menu on the right:

РЕТРОСПЕКТИВА	ПЕРСПЕКТИВА	выйти	ENGLISH	

The panel to select scenarios is located above the main table, below the heading:

		E	ез учет/	ИЗМЕНЕНИ	И КЛИМАТА	C YHETON	изменения	КЛИМАТА	
иток к	8	#	Год	Январь	Февраль	Март	Апрель	Май	
MIVA A		1	2016	492.83	420.91	648.17	1505,95	2158.79	

6. Scope of work on data collection and input

The data was collected from different sources. The data is divided into two blocks: retrospective data for the base period (2010-2015) and perspective data based on scenarios (2016-2055).

Each block consists of 4 sections:

- ➢ Planning zone (PZ)
- > Transboundary network
- ➢ Climate
- ➤ Energy

"Retrospective" Block

Section "PZ" in the Retrospective block consists of the following categories:

• Total irrigated area, including under crops;

- Calculated crop water requirements;
- Crop yield;
- Sale price of crops;
- Water withdrawal by sector
- Water disposal by sector
- Population

For this section, the data source was http://www.cawater-info.net

Section "Transboundary network" consists of the following categories:

- River flow by formation zone, including Vakhsh, Panj, Kafirnigan, Surkhandarya, and Kunduz rivers;
- River flow at gauging stations on the Amudarya River, including the virtual Kerki station, Atamyrat, Birata, Tuyamuyun, and Samanbay;
- Operation mode of the Nurek and Tuyamuyun reservoirs;
- Limit and actual water withdrawal in river reaches;
- CDF discharge into the river.

For this section, the data of BWO Amudarya was used.

Section "Climate" in the Retrospective block contains the data on average temperature and precipitation for all PZs in the Amudarya basin. The data was taken from <u>http://meteocenter.net</u> and <u>www.pogodaiklimat.ru.</u>

Section "Energy" contains the data on discharge of the Nurek HEPS and on energy generation by the Vakhsh hydropower cascade and Nurek HEPS. For this section, the data of CDC Energy, BWO Amudarya, and SIC ICWC was used (data prepared by D.Sorokin).

"Perspective" Block

Section "PZ" in this block consists of the following categories on BAU, FSD, and ESA scenarios:

- Total irrigated area, including under crops (Sh.Muminov);
- Calculated crop water requirements (simulations of crop water requirements under conditions of climate change simulated by REMO 0406 scenario, derived by G.F.Solodkiy);
- Crop yield (Sh.Muminov);
- Water withdrawal by sector (calculated in the PZ model)
- Water disposal by sector calculated in the PZ model)
- Population (Sh.Muminov);

Section "Transboundary network" consists of the following categories:

- River flow by formation zone, including Vakhsh, Panj, Kafirnigan, Surkhandarya, and Kunduz rivers, by scenario, with account of and without climate change;
- Amudarya River channel balance for energy and energy-irrigation scenarios

For this section, the data was prepared by A.G.Sorokin.

Section "Climate" contains the data on average temperature and precipitation based on the REMO 0406 scenario for all PZs in the Amudarya basin. For this section, he tdata was prepared by G.F.Solodkiy.

Section "Energy" contains the following sub-sections for energy and energy-irrigation scenarios. For this section, the data was prepared by Denis Sorokin.

- Operation mode of the Nurek reservoir
- Discharge at the Nurek HEPS
- Energy generation by the Nurek HEPS and Vakhsh hydropower cascade

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	10.1	9.1	2010	1.00	0.00	2.24	#10	11.00	9.24	1011		0.00	0.00	0.04	0.24	2.05
And the second second second second	1	4		10.0	10.	8.14		4.5	8.04	0.04	10.00	0.04	1.0	1.10	10.04	4.67
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7. Example of database filling

Figure 7.1 Input of data on water withdrawal for industrial and technical needs for October 2014, Retrospective Block



Figure 7.2 The data on wheat prices in the Retrospective Block

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Нурекскому родокранилицу,	1	2016	194.4	167.4	200.1	285.3	583.9	1069.7	791.2	306.7	225.1	21.6	216.4	219.7	4414.50
Netwine D	2	2017	129.8	154.0	185	2897	535.8	909	676	283	209.2	197.8	200.1	202.1	4081.00
p Danga - Haseoul Danga, Mini MJ	э	2018	158.5	145.1	173.5	247.3	506.1	727.2	633.9	265.3	196.1	185.5	187.6	190.4	3824.55
	4	2019	180.2	155.2	185.5	264.4	541.2	901.5	677.8	283.7	209.7	70E.3	200.6	203.e	4091,70
Кафирниган -	5	2020	196.5	110.2	202.2	288.2	590.1	1001.1	729	309.4	229.7	216.3	218.7	222	4461.50
курсы, млн м2		2021	229.1	193.8	221.7	330.2	675.9	12164	846.8	354.4	262	247.7	290.5	254.3	8110.60
Сурхандарыя -	7	2922	175.8	151.4	180.9	257.9	527.9	967.1	661.1	276.7	204.6	193.5	195.7	198.6	2991.20
ресурсы, млн.м3	8	2029	191.6	165	197.2	281.1	575.2	1054.1	720.6	301.6	220	210.9	213.2	216.5	4350.20
> р.Кундуз - сброс в Анударью, млн. м3	- 9	2024	177.1	259.0	182.3	259.0	531.0	1754	666.7	278.8	206.1	104.6	107.1	200.1	4129.30
	10	2025	196.3	189.1	202.1	288	389.6	1040.2	738.4	305.1	228.5	218.1	218.5	221.8	44(7.76

Figure 7.3 The data on the Kunduz River flow, Perspective Block, without account of climate change

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Colora Marine Mar		1	2016	492.03	420.01	648.17	1505.95	2158.79	3525.12	4419.26	2990.02	2877.12	1226.71	713.6	5863	22565.68
lortyce, antii M3		5	2017	413.66	453.64	254,83	823.17	1901.05	3238.26	4488.54	3990.82	1761.77	405.3	n15.39	257.49	20032.55
10		з	2014	474.84	207.14	551.75	887.47	1967.7	2527.46	3746.07	3374.78	2321.02	\$83.87	589.12	495.99	18216.95
ренская ГЭС	•	4	2019	446.5	408.15	502.46	1018.15	1554.33	2293.55	3292,96	3133.73	1050-63	763.34	\$72.24	488.22	16286-07
C Benardsonn sackal	- 🖬	5	2020	427.85	404.72	\$79.53	1194.44	1847.64	2209.93	3432.64	3021.22	174E15	841.06	993.06	501.85	18090.19
			2021	412.52	364.38	811.29	1352.99	2210.14	2380.99	4216.01	3505.2	2006.32	032.95	032.53	\$12.40	20160.75
		7	2023	473-83	403.14	\$15.28	875.03	1955.85	2582.45	2239.29	2526.03	1375.77	741.40	648.01	492.35	15037.70
			2023	61.21	434.77	101.45	1045.27	2145.79	4340.95	1993.44	3872.03	1764.46	653.14	582,28	500,73	20373.74
			2024	#29.50	377.5	A70.59	1042.48	1506.54	2215.13	3255.00	3596.71	1907	842.53	013.81	546.11	17415.05
		10	2025	406.97	244.35	643.34	1179.85	1850.35	3064.5	4275.37	4101.45	100075	910.73	632.5	391.56	19787.90
			2028	454.24	407.18	1067.01	2017.05	2224.58	4715.57	5158.12	4846.12	2147.82	1259.17	827.74	700.53	28969.55

Figure 7.4 The data on inflow to the Nurek reservoir, Perspective Block, energy-irrigation scenario

Period e 2010-2015 e 2010-2015 e 2010-2015
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List of data in DB of the PEER Project

List of data in DB of the PEER Project

Block	Section	Category	Indicator	Period		
			Vakhsh River - Inflow to the			
			Nurek reservoir			
			Panj River-Lower Panj			
Retrospect	Transboundary	River flow in the	Kafirnigan River-resources			
ive	network	formation zone	Surkhandarya River-resources	2010-2015		
			Kunduz River-discharge into			
			Amudarya			
			Virtual Kerki (Upstream of			
			Garagumdarya)			
Retrospect	Transboundary	River flow in gauging	Atamyrat (Kerki)			
ive	network	stations of the	Darganata	2010-2015		
ive	network	Amudarya River	Tuyamuyun			
			Samanbay			
			Inflow			
Retrospect	Transboundary	Nurek reservoir	Volume	2010-2015		
ive	network	Nurek reservon	Releases			
			Inflow			
Retrospect	Transboundary	TMHS reservoirs	Volume	2010-2015		
ive	network	1101151636100113	Releases	2010-2013		
			Limit in reach Nurek-TMHS			
			Actual in reach Nurek-TMHS			
		Water intake in	Limit in reach Tuyamuyun-			
Retrospect	Transboundary	reaches	Samanbay			
ive	network	reactics	Actual in reach Tuyamuyun-	2010-2015		
ive	network		Samanbay			
		CDF discharge into river	In reach Nurek-TMHS			
		IIVei	Discharge, Mm3			
Retrospect		Nurek HEPS	Energy generation, mln kWh			
ive	Energy		Energy generation, min kwin	2010-2015		
ive		HEPS of Vakhsh	Energy generation, mln kWh			
		cascade				
	Climate	Karshi weather station	Precipitation	2010-2015		
			Temperature			
	Climate	Bukhara weather	Precipitation	2010-2015		
-		station	Temperature			
	Climate	Urgench weather station	Precipitation	2010-2015		
		Nukus weather	Temperature Precipitation			
	Climate	station	Temperature	2010-2015		
·		Termez weather	Precipitation			
	Climate	station	Temperature	2010-2015		
Retrospect			Precipitation			
ive	Climate	Kerki weather station	Temperature	2010-2015		
ive .		Darganata weather	Precipitation			
	Climate	station	Temperature	2010-2015		
		Gyshgy weather	Precipitation			
	Climate	station	Temperature	2010-2015		
		Uchadji weather	Precipitation			
	Climate	station	Temperature	2010-2015		
		Tedjen weather	Precipitation	2040.0015		
	Climate	station	Temperature	2010-2015		
		Ashgabat weather	Precipitation	2010 2015		
	Climate	station	Temperature	2010-2015		
· L			P			

List of data in DB of the PEER Project

Block	Section	Category	Indicator	Period	
	Climate	Dashoguz weather	Precipitation	2010-2015	
	Clinate	station	Temperature	2010-2013	
	Climate	Khorog weather	Precipitation	2010-2015	
Retrospect	Climate	station	Temperature	2010-2013	
ive	Climate	Dushanbe weather	Precipitation	2010-2015	
	Climate	station	Temperature	2010-2015	
	Climate	Kurgan-Tyube	Precipitation	2010-2015	
	Climate	weather station	Temperature		

Annex 1, continued

						Annex 1, c	ontinue
Block	Section	Category	Indicator	Period		Scenario	
Perspective	Planning zone	Water withdrawal, Mm3	Total Household use Industrial use Irrigation Other	2016-2055	BAU	FSD	ESA
Perspective	Planning zone	Water disposal, Mm3	Total Household use Industrial use Irrigation Other	2016-2055	BAU	FSD	ESA
Perspective	Planning zone	Yield, ton/ha	Cotton Wheat Rice Maize for grain Vegetables Orchards and vineyards	2016-2055	BAU	FSD	ESA
Perspective	Planning zone	Irrigated area, thousand ha	Total Cotton Wheat Rice Maize for grain Vegetables Orchards and grape Forrage Other Homestead	2016-2055	BAU	FSD	ESA
Perspective	Planning zone	Calculated water requirements, mm Population	Cotton Wheat Rice Maize for grain Vegetables	2016-2055 2016-2055	BAU BAU	FSD FSD	ESA ESA
Perspective	Planning zone	Unit indicators	Irrigated area, ha/person Water productivity, \$/m3 Land productivity, \$/ha		BAU	FSD	ESA
Perspective	Transboundary network	River flow in formation zone, Mm3	Vakhsh River - inflow to the Nurek reservoir Panj River - Lower Panj Kafirnigan River - resources Surkhandarya River - resources	2016-2055	With no account of climate change	With no account of climate change	

Block	Section	Category	Indicator	Period	Scenario
			Kunduz River- discharge into Amudarya		

Block	Section	Category	Indicator	Period		Scenario	
			Inflow to the Nurek hydroscheme				
			Water releases from the Nurek hydroscheme				
			Panj(Khirmandjoy gauging station) + Kokcha River (discharge into Panj)				
			Kafirnigan River basin (recorded surface water inflow)				
			Surkhandarya River basin (recorded surface water inflow)				
	Transboundary ds network		Vakhsh River flow: mouth		With no account of climate change	With no account of climate change	
ve		River channel	Panj River flow: Lower Panj gauging station	-			
Perspecti		balance, Mm3	Kunduz River-discharge into Amudarya	2016-2055			
			Kafirnigan River flow: mouth				
			Surkhandarya River flow: mouth				
			Amudarya River flow: Inflow to the middle				
			reaches (Kelif gauging				
			station)				
			Amudarya River flow:				
			inflow to the Tuyamuyun				
			hydroscheme (Birata				
			gauging station)				
			Supply to the Aral Sea				
			from river and CDW				
			Water intake Water losses				
			Deficit				
			Limit in reach Nurek-				
			TMHS				
		Water intake	Actual in reach Nurek- TMHS				
tive	transboundary روز د Transboundary موزی network	in reaches	Limit in reach	1			
pect			Tuyamuyun-Samanbay	2016-2055	Energy	Energy-	
^o ers			Actual in reach			irrigation	
			Tuyamuyun-Samanbay	ł			
		CDF discharge into river	In reach Nurek-TMHS				
		Nurek	Inflow			Energy-	
		reservoir	Volume	2016-2055	Energy	irrigation	
ctive		_	Water releases				
E H	I	I	Discharge, Mm3	J	l	I I	

Block	Section	Category	Indicator	Period		Scenario	
Perspe	Energy	Nurek HEPS	Energy generation, mln kWh	2016-2055	Enormy	Energy-	
d		HEPS of the Vakhsh cascade	Energy generation, mln kWh	2010-2035	Energy	irrigation	
	Climate	Karshi	Precipitation	2016-2055		REMO	
	Cinnace	weather	Temperature	2010 2033		REMIO	
	Climate	Bukhara	Precipitation	2016-2055		REMO	
	Cinnace	weather	Temperature	2010 2033			
	Climate	Urgench	Precipitation	2016-2055	REMO		
	Cinnace	weather	Temperature	2010 2033			
	Climate	Nukus	Precipitation	2016-2055		REMO	
	Cinnace	weather	Temperature	2010-2033		REIVIO	
	Climate	Termez	Precipitation	2016-2055		REMO	
	Cinnace	weather	Temperature	2010-2033		REIVIO	
	Climate	Kerki weather	Precipitation	2016-2055		REMO	
	Cinnate	station	Temperature	2010 2033		REMO	
	Climate	Darganata	Precipitation	2016-2055		REMO	
e/	Cinnate	weather	Temperature	2010 2033		REMO	
Perspective	Climate	Gyshgy	Precipitation	2016-2055	REMO		
spe	Cinnate	weather	Temperature	2010 2033		REMO	
Per	Climate	Uchadji	Precipitation	2016-2055	REMO		
	Cinnate	weather	Temperature	2010 2033			
	Climate	Tedjen	Precipitation	2016-2055		REMO	
	Clinate	weather	Temperature	2010-2033		REINIO	
	Climate	Ashgabat	Precipitation	2016-2055		REMO	
	Cinnace	weather	Temperature	2010-2033		REINIO	
	Climate	Dashoguz	Precipitation	2016-2055		REMO	
	Cinnace	weather	Temperature	2010-2033		REINIO	
	Climate	Khorog	Precipitation	2016-2055		REMO	
	Cinnace	weather	Temperature	2010-2033		REINIO	
	Climate	Dushanbe	Precipitation	2016-2055		REMO	
	Cinnate	weather	Temperature	2010 2000		NEWIO .	
	Climate	Kurgan-Tyube weather	Precipitation	2016-2055		REMO	
	Cinnate	station	Temperature	2010 2000		NEWO	

List of input data for the planning zone model over 2010-2015

Water layer required for soil leaching

Efficiency of on-farm network

Efficiency of inter-farm network

Efficiency factor of irrigation technique

Leached lands /Irrigated area

Industrial water use

Household water use

Other types of water use

Limit on water withdrawal from transboundary sources Limit on water withdrawal from local

Limit on water withdrawai from local sources

Possible water withdrawal from transboundary sources

Possible water withdrawal from local sources

Possible water withdrawal from ground water sources

Water withdrawal from CDF for reuse/Water intake for irrigation, including leaching

Minimum possible water withdrawal from CDF for reuse

Maximum possible water withdrawal from CDF for reuse

Minimum water volume in the reservoirs

Maximum water volume in the reservoirs

Water volume in the reservoirs by the beginning of month

Water volume in the reservoirs by the end of month

Water losses in the reservoirs

Coefficients of functional relationship between drainage water and water intake for irrigation

Coefficients of functional relationship between waste water and water intake for non-irrigation purpose

Local water sources flowing to or formed in PZ

Total CDF from neighboring PZs

CDF into neighboring PZs/Total return flow
~ ~
CDF into lakes and depressions in PZ /Total return flow
CDF into transboundary rivers /Total return flow
Total crop area, including area under double-season crops
Water layer required for irrigation, excluding leaching
Net irrigated area
Area under double-season crops /Net irrigated area
Crop evapotranspiration
Groundwater contribution
Effective precipitation
Water withdrawal from transboundary water resources
Total actual water withdrawal
Water withdrawal for irrigation, including leaching
Total drainage and waste water
Total return flow into lakes and depressions
Return flow into rivers
Return flow into neighboring PZs
Yield, ton/ha
Crop sale price, \$/ton
Population in PZs