ARAL SEA BASIN MANAGEMENT MODEL (ASBmm)

USER'S MANUAL

UNESCO-IHE Institute for Water Education

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Introduction

The Aral Sea basin as a single system ensuring water supply and well-being in the six countries, including Afghanistan, has been an object of water cooperation, first, within the former USSR and then among 5 independent states for many years. A wise decision to keep cooperation among the countries as declared by the Heads of five Central Asian States in relevant Agreements 1993 and 1994 was of great importance for maintenance of peaceful and joint management of water resources in transboundary Amudarya and Syrdarya Rivers. By acknowledging the Interstate Water Commission under umbrella of the International Fund for Saving the Aral Sea and its regulations that were founded on previous experience of water allocation, the States preserved the status quo of the basin's water sector.

These fundamental documents paved the way for hard work of water-management and governmental bodies in our countries in order to keep conflict-free, coordinated water management to the benefit of all the countries.

In this context, if you are a journalist, student or a novice in hydrology, hydraulic engineering or energy and you would like to get more knowledge about characteristics, issues and prospects of developments in the Aral Sea basin, ASBmm will serve you.

In addition, ASBmm is a helpful tool if you are a professional in the area of water and energy resources management and you are interested in assessment of alternative water development scenarios in riparian countries of the Aral Sea basin, taking into account socio-economic, environmental, energy and climatic factors, optimization and trade-off solutions.

What is ASBmm?

The ASBmm Version 2011, which is available on-line on http://www.asbmm.uz/, was developed jointly by IHE-UNESCO and SIC ICWC. The main objective is to develop an Internet-based platform in support for regional dialogues and desk-top studies in Central Asia, ensure free access to integrated analysis of the Aral Sea basin development scenarios.

It is expected that the analytical Internet-based platform on water-energy sectors in the CA countries would enhance web-functions of the CAREWIB Project[1] by involving user's initiative and creative work in analysis (forecasting) of the water-related situation. The users need to have an opportunity to build their own alternatives regarding flow regulation, water allocation, and, at the same time, need assistance in scientific analysis in order to have a comprehensive view on those processes and events that are typical for some structures and sites of the water-management network (river basin).

1 «Central Asian Water Information Base (CAREWIB)» aims at improving information support of water and environmental sectors in the Central Asian countries. The Project was implemented by SIC ICWC, UNECE, and Zoi environment network with active participation of EC IFAS and ICSD. The Project was financed by the Swiss Agency for Development and Cooperation (SDC) until 2012. Currently, this information system is supported by the Uzbekistan's Ministry of Agriculture and Water Resources.

The analytical Internet-platform is to be used by a wide audience. The ASBmm user web-interface allows the user to interact with PC and offers a number of capabilities, such as model and data customization, user scenario building, iteration model runs, and result interpretation. The simulation results can be viewed through Internet in tabular and graphic forms, as well as visualized in a mapping block.

Integrated ASBmm model is a software product consisting of a number of information modules and computer programs:

- Socio-economic model (computation of indicators per economic sector),
- Model for water allocation and flow regulation by reservoir hydrosystems (water and energy balances, etc.),
- Planning zone model (computation of agricultural production, water supply and water balance of irrigated land),
- Models of the Aral Sea and aquatic ecosystems – lakes in Prearalie, Arnasay lake (computation of water demand, water balance; assessments of ecosystem productivity, production losses),
- Database,
- Control routine,
- User WEB-interface.

The set of models is designed for those working in the water sector, agriculture, environmental and governmental institutions and dealing with prospective planning and development strategy building. By using this set of models, the user can: get assessments of the proposed solution and project options depending on availability of water, land and other natural resources; see consequences from these proposed options for social, ecological, and economic conditions of particular zones and countries; and compare the proposed solutions and projects with sustainable development indicators. For transboundary water projects the models make it possible to assess an impact of actions undertaken in one country on water availability and environment in neighboring countries and further may serve as a tool for coordination of mutually acceptable decisions.

The models are oriented to solve practical tasks and demonstrate advantages of an integrated approach since they consider in their structure the main characteristics of integrated management. The primary objective of integrated management is to coordinate elements, levels, and sectors of water use in a certain order, while assigning common aims and criteria (social, ecological, economical). As a result, a consensus should be reached for meeting both national and regional interests. An important element of such consensus is maintaining balance between water supply and water demand of economic sectors and ecosystems at various hierarchical levels and for different periods of time.

The set of models was designed to answer the "what if" questions. How much water the countries would demand in the future if they develop exclusively on the basis of their own potentials and capacities? And what if the countries are integrated into a single economic space, assuming specialization (in food production, energy generation, etc.) and coordination of water management in order to achieve regional well-being and security?

So that the models "could answer" such questions, they have the feature of economic analysis. Moreover, there is an assumed relationship between territorial and basin management levels. It is not effective to simulate only a river channel without a link to irrigated lands (planning zones). And vise versa, the solutions that are made at territorial level should be surely checked at basin level, with account of regional restrictions and requirements, mainly environmental ones.

The built-in socio-economic block and indicators showing dynamics of certain planning zones offer new features, such as assessment of country economic development options, demographic situation, and investment policies, identification of the needs of economic sectors, and analysis of the future in terms of sustainable development. The models can assess water conservation measures and optimal cropping patterns proceeding from available investments. Connection of the Prearalie model enhances the set of models in part of accounting of environmental requirements and evaluation of how stable is the environmental situation in the Aral Sea coastal area (Prearalie) [2].

Every state in the region has its own national interests and issues regarding water resources management. However, there are challenges that are key and common for most of the states. Those include avoidance of critical situations that could be caused by natural factors (drought) and ineffective management. The range of criteria applied in the models allows finding trade-offs that exclude, for example, conflicts between irrigation and hydropower. Potential effects and damages in economic sectors and relevant compensations can be estimated as well.

How to use the Manual?

This manual provides the user with the instructions on how to work with ASBmm and view the results through the user interface. The user interface for ASBmm can be accessed through Internet. The interface is located on a special web-site (http://www.asbmm.uz/).

The desktop of the ASBmm interface includes a guide in form of a diagram of interconnected blocks by "navigating" among which the user can:

- Create a user's project,
- Open the project (already created),
- Customize the model (select task, combination of scenarios),
- Run one model or a few models in cycle (depending on task selected),
- Select a method for the evaluation of the results (integrated assessment, assessment by water body, comparison of the results for one Project or for two selected Projects),
- View the results of calculations and save them,
- Go to the Main page.

Given manual explains how to carry out each of the above listed procedures.

[2] The Prearalie and Aral Sea Block is under finalization.

Before using ASBmm

What is required to work with the model?

In order to work with ASBmm, you need a PC and internet access.

How to access the user interface?

The user interface is available on http://www.asbmm.uz/.

How to enter?

The main interface window of the model looks as follows:

(1) On the ASBmm web-site the user can use the toolbar and get the following information:

- ~ "PROJECT DESCRIPTION" – information about the Project and brief description of ASBmm
- ~ "HELP" – help information about the models and iteration procedures;
- ~ "NEWS" – news related to ASBmm

- "HISTORY" – information about development of the set of models, existing versions and future plans on its improvement;
- "FAQ" – a list of questions that may arise while the user operates ASBmm and answers to them;
- "DEVELOPERS"- information about the developers of ASBmm
- "FORUM" – a space, where the users are invited to give their opinions about the Project, share their calculation results obtained using ASBmm, discuss similar models, the issues and scenarios of the Aral Sea basin development, etc.

(2) The user may shift between English and Russian languages (Рус/Eng);

(3) Brief description of the set of models in form of an information sheet;

(4) A rolling tape with pictures and short texts has two arrows (left and right). By clicking on an arrow the user can move to another picture with a short explanation on the interface or the modeling set;

(5) An interactive atlas is located in the middle of the Interface placing a cursor over which opens the map of the Aral Sea basin divided into the five Central Asian states. By clicking on any of the states the user can see the administrative map of this state;

(6) The lower right corner of the Interface contains a news feed on the project - digest;

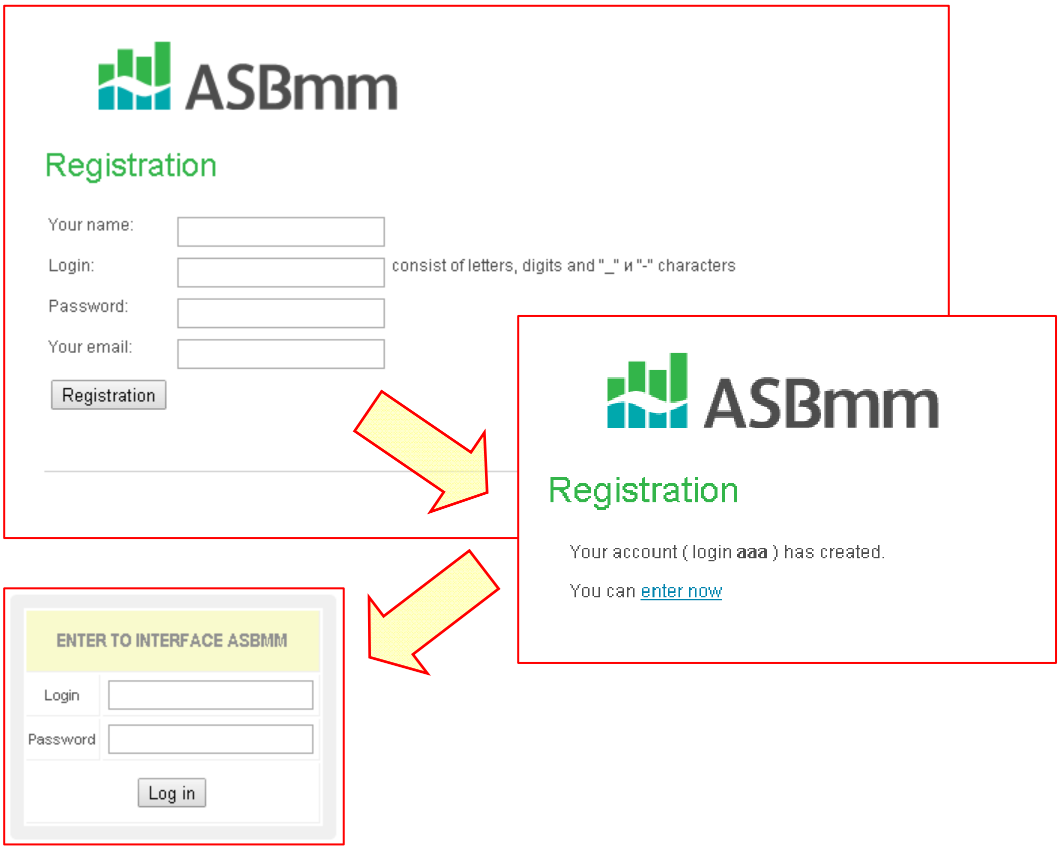
(7) There is a "Feedback" on the bottom, by clicking on which the user opens a dialogue window "Contacts", where he/she can answer any question to the project administration and receive the answer to his/her e-mail;

(8) The upper right corner contains active hyperlinks, such as login to the user interface (Login to the Interface) and registration for new users (Registration).

How to register?

Interface is one of the main working elements of the system, throught which the user interacts with the system. It is designed in form user-friendly blocks between which the user can switch quickly. Before accessing the interface, the user should register by clicking on "Register" in the upper right corner of the web-page.

Then, the registration window opens, where the user should fill in contact details, create login and password and then click on the "Registration" button:

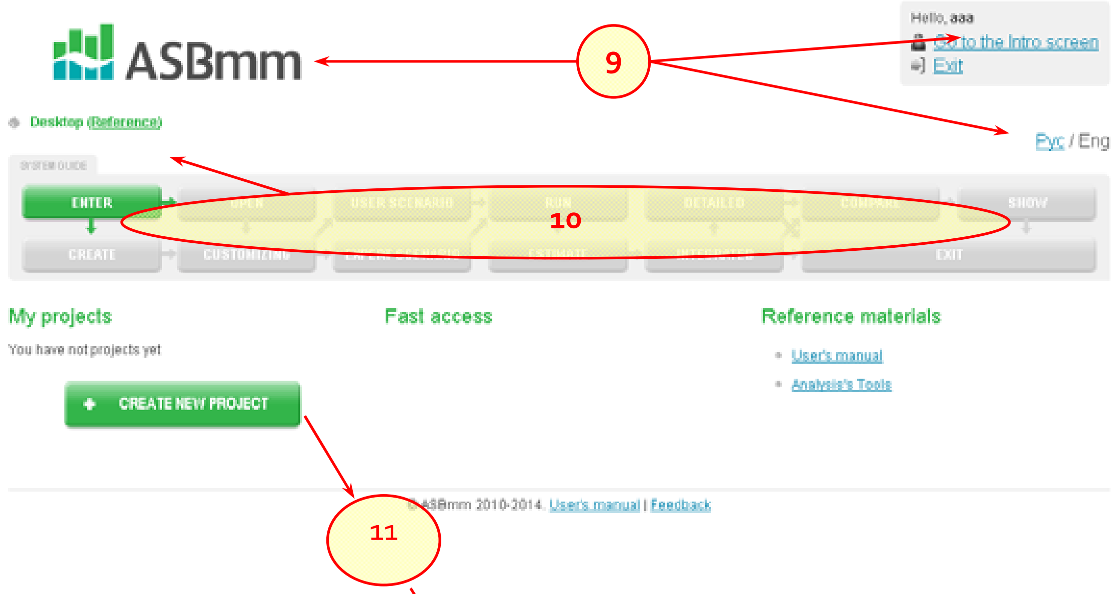


If registration is successful, a window appears "ENTER TO INTERFACE ASBMM", in which the user is prompted to enter the login and password. Clicking on "Log in" opens ASBmm interface.

Desktop

The desktop is divided into several blocks. In the upper part the user can see logo, language selector, status line and authorization block, using which the user may enter the system and finish work at any time by clicking on "Exit" (9).

The working area (10) located in the central part, occupying most of the page, is designed for the direct work with the program. It is made in a form of a block diagram under one title "System Guide".
Each block represents a stage (status) of the system: setting up the user matrix; editing the user's scenario; viewing the expert's scenario; running calculations; viewing the results; comparing projects. The current stage, which is activated by the user at the moment, is highlighted in green. The completed stages are colored in turquoise. The arrows between the blocks show links between the stages, i.e. where the user can move and which way the user followed from the start. The user can come back to any completed stage by clicking on respective block.



Creating a project

To start working with ASBmm, the user has to create a new project. By clicking on the "Create new project" button, the user should enter the name of new project in the opened window (11) and choose the task to be solved from the list.

For the solution of the 1st task "Asses flow regulation by reservoirs hydrosystems with HEPS and water balance of river basins", the water allocation model (WAM) is used which is a part of ASBmm complex; for the solution of the 2nd task "Assess water requirements per PZ" and the 3rd task "Assess water availability and agricultural output losses in PZ", the planning zone model (PZM) is used; and, for the solution of the 4th task "Socio-economic assessment of regional development", the socio-economic model (SEM) is used.

The user may also select the offered combination of tasks, for which the ASBmm control program forms cycles: cycle 1 - sequential solution of the 1st and 4th tasks (involve WAm and SEm); cycle 2 - sequential solution of the 2nd, 1st, 3rd and 4th tasks (involve PZm, WAm, then again PZm and SEm). During formation of the cycles, a part of outputs from some models (intermediate results) are used as inputs for other models.

Customizing and working with the models

Project matrix

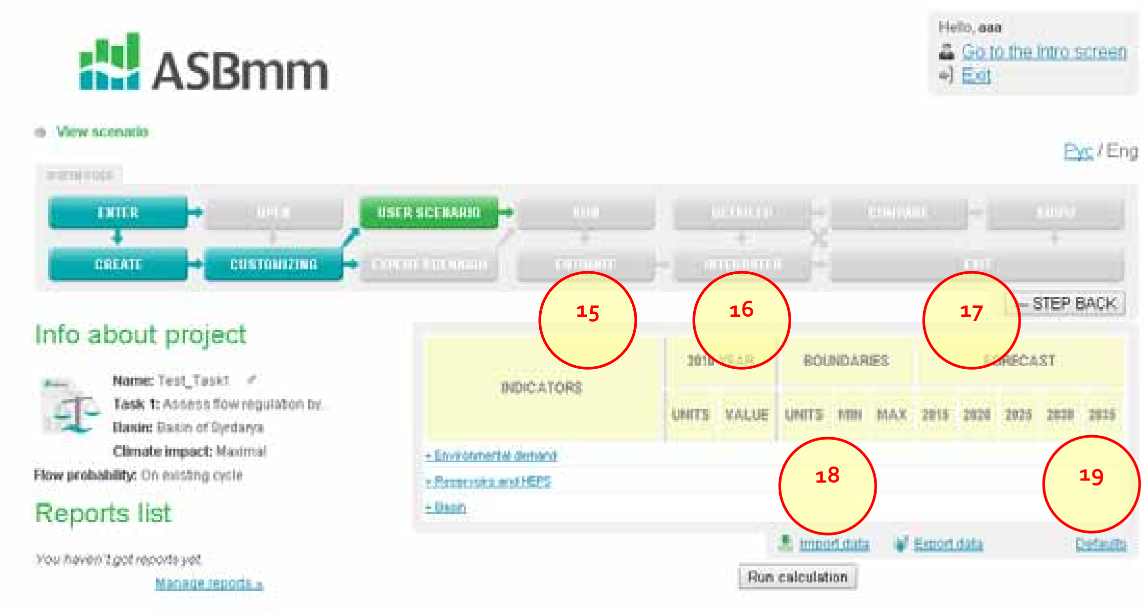
After creation of the project, the user gets to the page "Select User's Strategy". On this page the user can select (define) the development strategy of the region (basin, planning zone), i.e. customize the model's (s) operation mode, which is a part of the selected project tasks. All information intended for the development strategy selection, grouped in the so-called "Project matrix" (12) presented in the form of a table. Specifying through selection the values of the corresponding parameters/scenarios - basin/planning zone, climate impact, water content of the rivers and scenario of socio-economic development - the user customizes the operation mode of the model.

By clicking on respective scenario, the user gets summary information about it. There is the "DB" icon (13) near the name of each scenario, by clicking on which the user can view all parameters of the selected scenario.

It is important to note that the user has to choose one of pre-determined scenarios for climate impact and flow probability. "Socio-economic development" has several expert scenarios (business as usual, national vision, regional) and a user's scenario, which is created on the basis of "Business as Usual" scenario. If the user's scenario option is chosen, then the "Setup user scenario" button (14) appears on the screen. Clicking on this button brings the user to the form, where the user's values can be entered for each of listed indicators.

Setting up a user's scenario

The user's scenario setup form is an important element of project settings. There the user can set projected conditions (for each indicator) to run calculations.



The table of indicators consists of the three following columns:

(15) Indicators;

(16) Values of indicators as at 2010 (unit, value);

(17) Projected values (unit, boundaries [min, max], forecast).

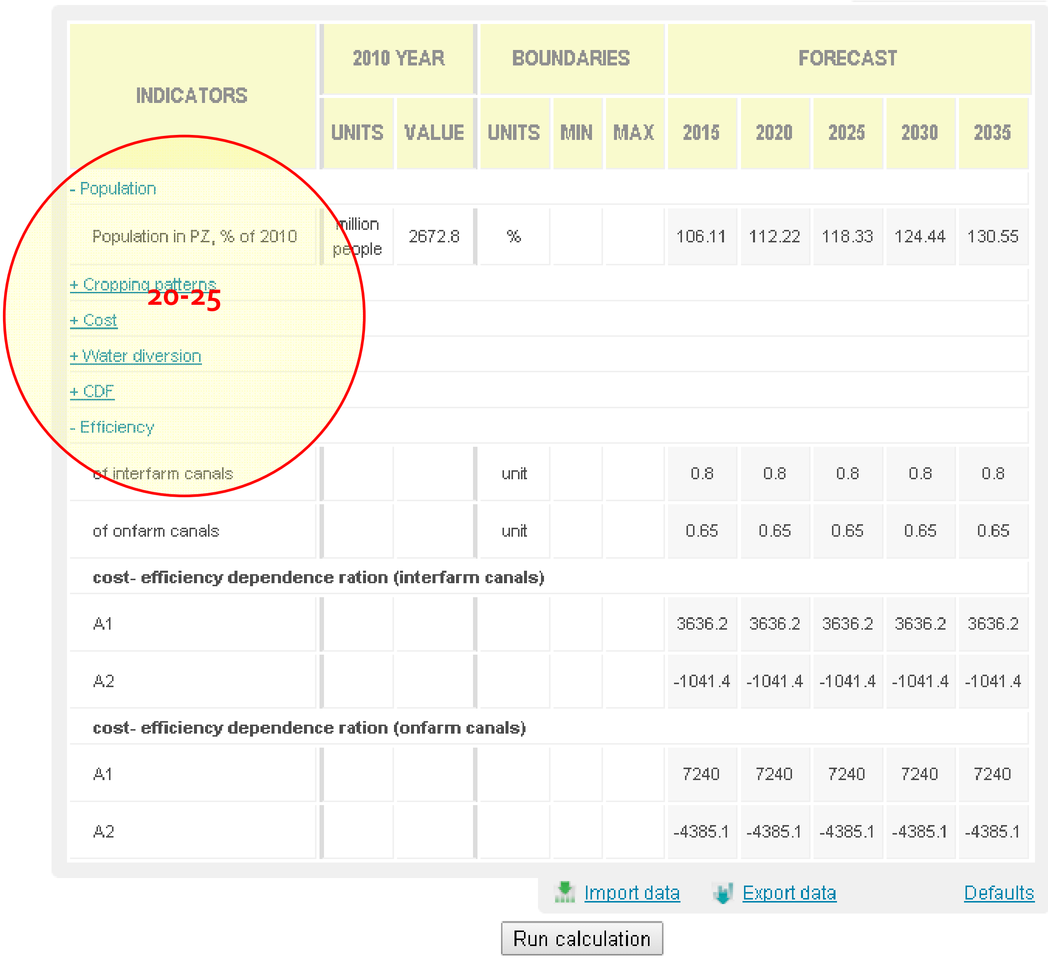
Thus, on the basis of 2010 indicator values the user makes forecast between minimum and maximum boundaries indicated in the table. Double clicking on respective cell allows the user to change the projected value. It is possible to export the entire list of indicators (whole table) to Excel (18), fill it and then import it back. This simplifies filling of data for the user's scenario.

The user can at any time change back the initial values by clicking on "Defaults" (19) at the bottom of the table.

Working with the Planning Zone model (PZm)

PZ model is a flexible tool of the ASBmm set of models. This model performs calculations for assessment of water use and irrigated agriculture productivity in given planning zone, as well as for economic evaluation of some actions (improvement of irrigation network efficiency, development of new lands).

The interface allows the user to work with the selected planning zone independently (water use assessment regime) or in combination with the river model (water availability and agricultural production losses assessment regime). Besides, the user can integrate several zones into a water-management district and operate them in combination with the river model and the socio-economic model.



INDICATORS	2010 YEAR		BOUNDARIES			FORECAST				
	UNITS	VALUE	UNITS	MIN	MAX	2015	2020	2025	2030	2035
- Population										
Population in PZ, % of 2010	million people	2672.8	%			106.11	112.22	118.33	124.44	130.55
+ Cropping patterns										
+ Cost										
+ Water diversion										
+ CDF										
- Efficiency										
of interfarm canals			unit			0.8	0.8	0.8	0.8	0.8
of onfarm canals			unit			0.65	0.65	0.65	0.65	0.65
cost- efficiency dependence ration (interfarm canals)										
A1						3636.2	3636.2	3636.2	3636.2	3636.2
A2						-1041.4	-1041.4	-1041.4	-1041.4	-1041.4
cost- efficiency dependence ration (onfarm canals)										
A1						7240	7240	7240	7240	7240
A2						-4385.1	-4385.1	-4385.1	-4385.1	-4385.1

PZ parameters are integrated into six large blocks in the interface:

(20) Population – data on population growth as compared to 2010;
(21) Cropping patterns – change in irrigated areas and cropping patterns in % of irrigated area;
(22) Cost – parameters for calculation of gross production and added value (prices, crop yields, salaries, taxes, self-cost, cost and revenues in associated sectors);
(23) Water diversion – volumes of water diversion for non-irrigation needs (domestic, industrial, rural water supply);
(24) Collector-drainage flow (CDF) – share of CDF in transboundary rivers and re-use of CDF for irrigation out of the total volume of collector-drainage flow in PZ;
(25) Efficiency – average coefficients of efficiency of inter- and on-farm canals in planning zone, system's performance efficiency–rehabilitation specific cost factor.

By using available information and inputting own data, the user can simulate various development options for PZ.

The results of calculations are also grouped in large blocks and have the following structure:

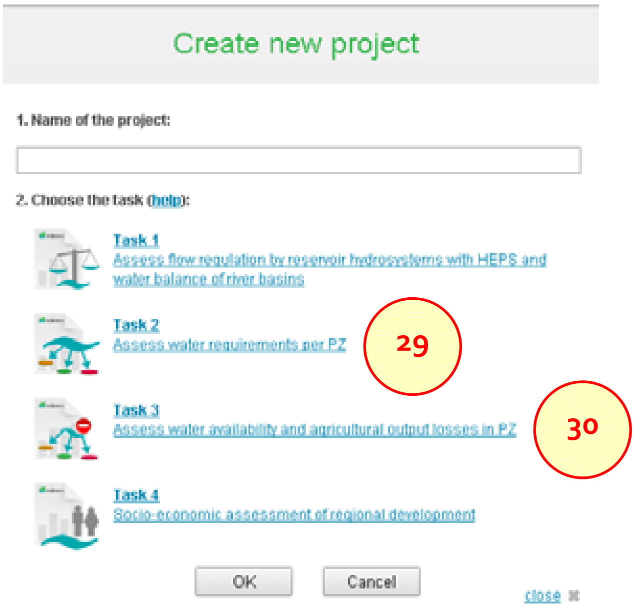
(26) Water balance;
(27) Productivity of irrigated agriculture;
(28) Estimated investments in PZ.

26-28

INDICATORS	UNITS	VALUES BY YEAR					AVERAGE FIVE YEARS
		2011	2012	2013	2014	2015	
+ PZ water balance ←click to view		Σ	Σ	Σ	Σ	Σ	
+ Productivity of Irrigated agriculture							
- Estimated investments in planing zone							
Reconstruction of irrigation network	M$	1244.1	3.5	3.5	3.5	3.5	251.6
Development of new land for agriculture ($/y)	M$	0	0	0	0	0	0.0
Investment on improved water management (IWRM)	M$	1.7	1.7	1.7	1.7	1.7	1.7
Area of new land developed for agriculture (ha)	$/ha	1	1	1	1	1	1.0

How to calculate the total water requirements of a planning zone for transboundary network?

To this end, the user has to create new project on Task 2 (29) or 3 (30) or open already existing project.



Then, the user's scenario should be adjusted and flow and climate scenarios should be selected. The list of input data for calculation of water requirements for transboundary network is shown below:

- Cropping patterns for main crops (% of irrigated area);
- Irrigated area in PZ, % of 2010;
- Water diversion by domestic sector;
- Water diversion by industry, including energy;
- Water diversion by agriculture (excluding crop production);
- Water supply from groundwater;
- Return flow to transboundary rivers;
- CDF re-use in PZ;

~ Efficiency of inter- and on-farm canals.

The result of the calculation is also dependent on water availability and climate change scenario.

How to calculate the productivity of irrigated agriculture?

The same procedure as mentioned for the calculation of water requirements for transboundary network is repeated.
The list of input data for the calculation of productivity is as follows:

~ Selling price of irrigated agriculture production, % of 2010;
~ Cost of main crop production;
~ Yields of main crops;
~ Salary costs;
~ Taxes;
~ Coefficient of added value from irrigated agriculture output processing, unit fraction.

How to calculate an amount of investments needed to improve the irrigation efficiency in planning zone?

The same procedure as mentioned for the calculation of water requirements for transboundary network is repeated.
The following input parameters are used in the calculation of investments:

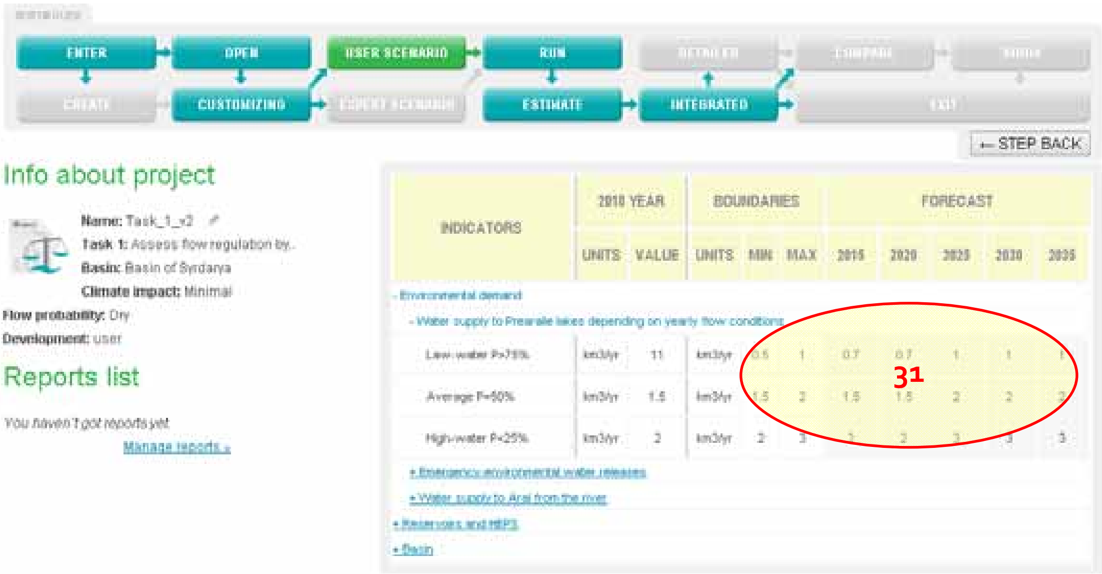
~ Efficiency of inter- and on-farm canals
~ Linear dependence ratios of investments in irrigation networks A1 and A2

The amount of investments is calculated as a difference in costs corresponding to specific levels of efficiency.

Working with the Water Allocation model (WAm)

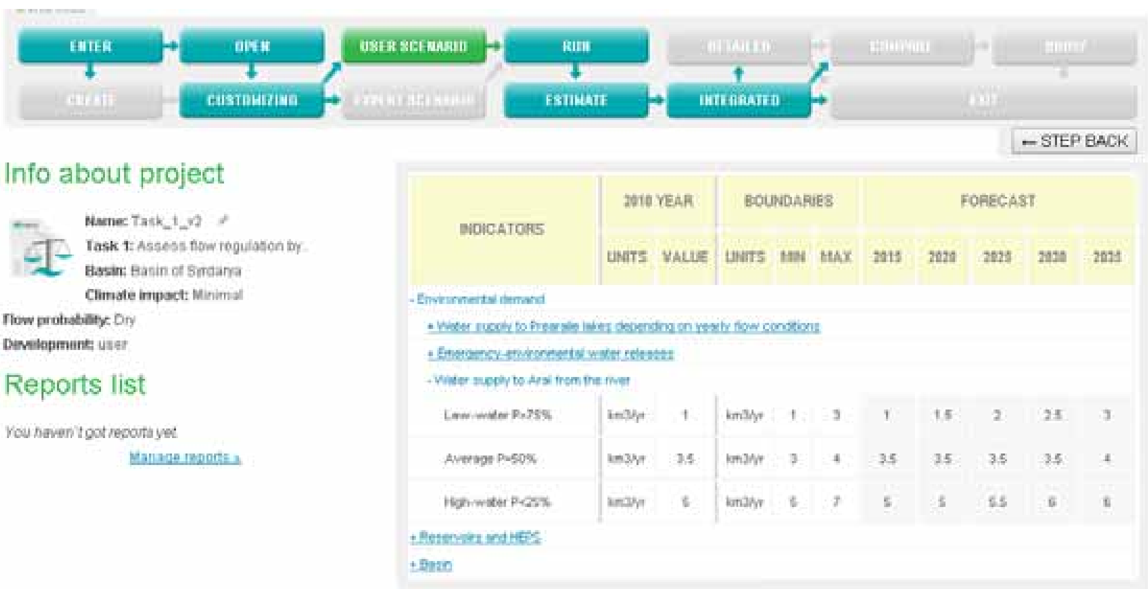
The Water Allocation model (WAm) is a specialized computer tool for modeling the processes of flow regulation for the main rivers in the Aral Sea basin, for distribution of flow between the so-called water-management districts (planning zones) and water ecosystems (wetlands in Prearalie and Aral Sea). The model does the water balance and hydropower generation calculations for the Syrdarya and Amudarya basins, based on water-management scenarios on monthly basis up to 2035.

How environmental water releases for Prearalie can be entered into the model?
To this end, the user's scenario form is opened and data is entered using the following path: Environmental demand -> Water supply to Prearalie lakes depending on yearly flow conditions (31).



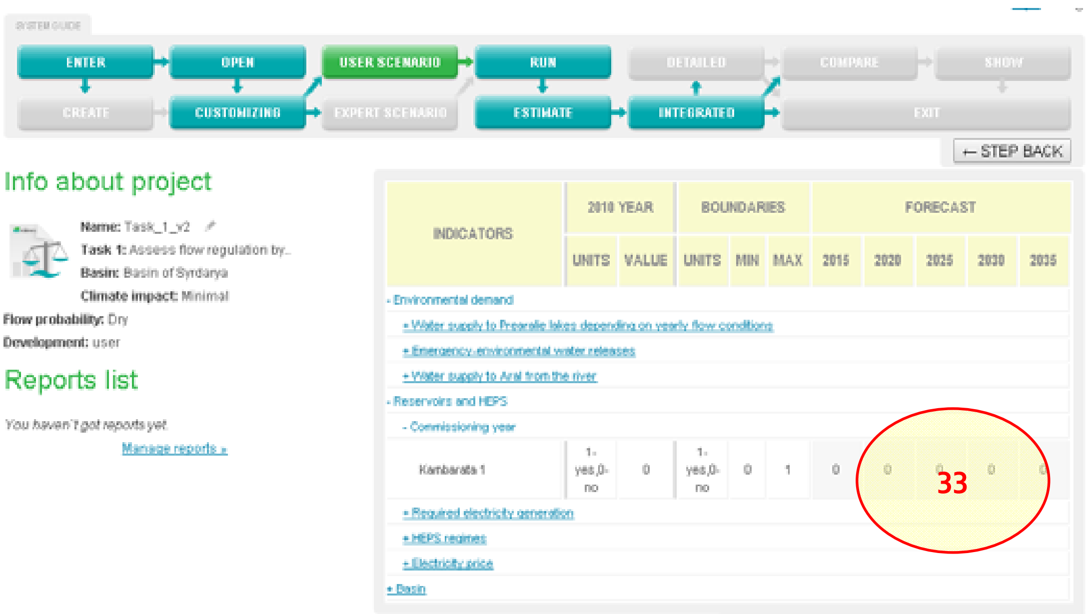
How to enter the water needs of the Aral Sea and what these needs can have an impact on?

Under this procedure, the user should open the user's scenario form and enter the data using the following path: Environmental demand -> Water supply to Aral from the river (32).



How to activate (deactivate) Kambarata 1, Roghun and any other new HEPS in the model?

Under this procedure, the user should open the user's scenario form and enter the data using the following path: Reservoirs and HEPS -> Commissioning year for new HEPS. In order to activate HEPS, enter "1", starting from the five-year period when given HEPS is put into operation, to deactivate HEPS, enter "-1" starting from the five-year period when given HEPS is stopped (33).

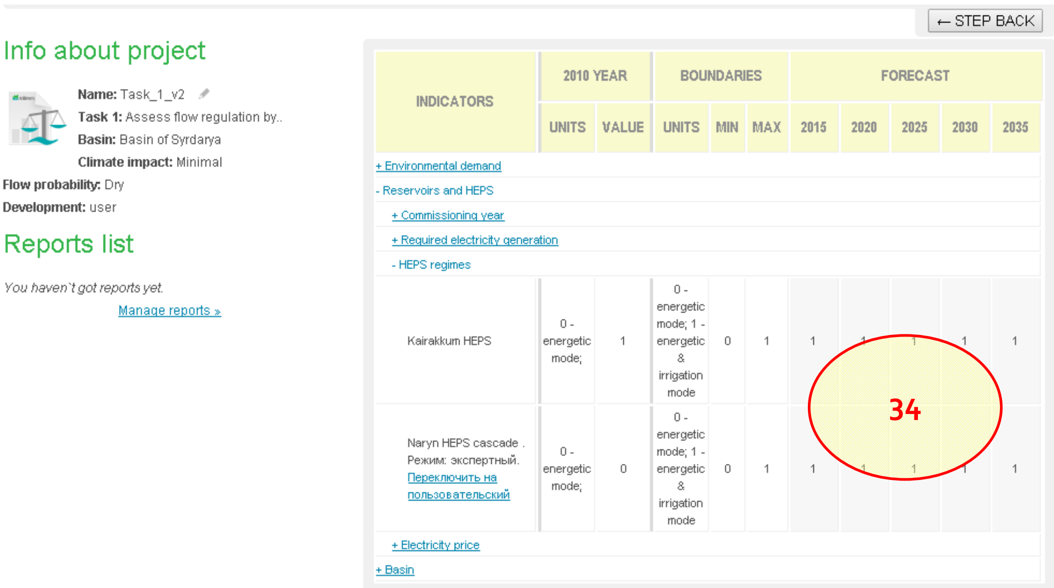


How to set up HEPS operation regime (energy generation or energy-irrigation) and what these regimes can have an impact on?

To this end, the user should open the user's scenario form and enter the data using the following path: Reservoirs and HEPS -> HEPS regimes (34):

- ~ "0" – energy mode;
- ~ "1" – energy-irrigation mode

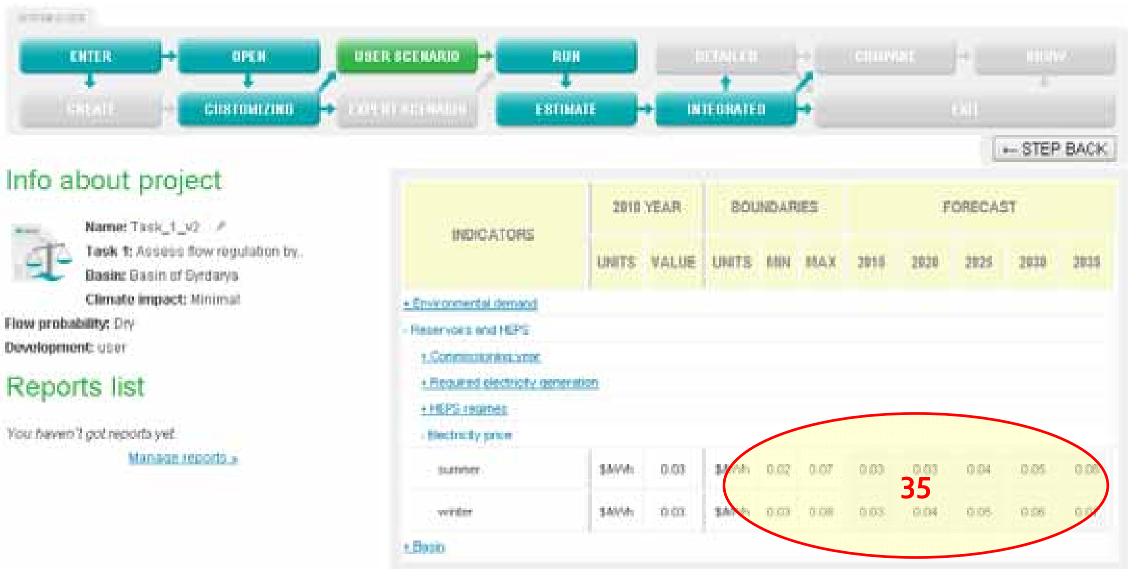
The operation regimes of HEPS reservoirs have an impact on water supply in planning zones, electricity generation, and agricultural production and, consequently, on cost effectiveness and productivity of agricultural land.



How to enter

the electricity prices and what these prices can have an impact on?

To perform this task, open the user scenario's form and use the following path to enter the data: Reservoirs and HEPS -> Electricity price (35). The prices have an impact on the calculation of the cost of electricity generation.



How to enter upward (downward) trends of irrigated areas in the model?

To perform this task, open the user scenario's form and use the following path to enter the data: Basin -> Annual irrigated area growth as compared to previous year, average for five years (36).

Which indicators describe the water balance of rivers and reservoirs in given basin?

The user can get information on those indicators in form of an integrated assessment or by accessing data on water bodies (reservoirs, river reaches). These indicators include:

~ Water resources;
~ Transboundary resources;
~ Water diversion in a basin (Syrdarya or Amudarya);
~ Estimated return flow;
~ Channel loss;
~ Usable water resources (natural resources+return flow-losses);

~ Dynamics of water storage in large reservoirs;

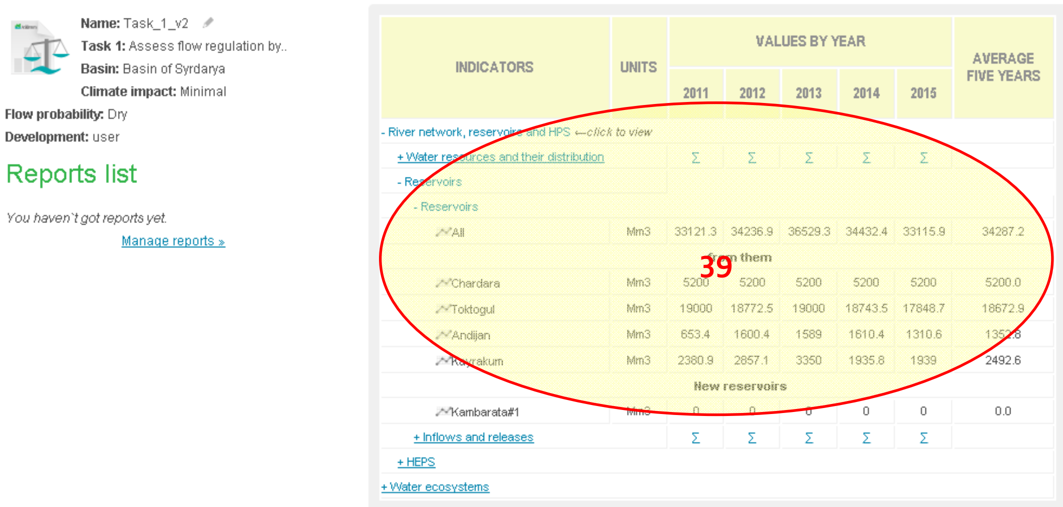
~ Inflow to and releases from large reservoirs.

After running the calculation (37) on the basis of user's scenario, the user can view the calculation results in the mode of integrated assessment.

The indicators of river and reservoir water balance can be viewed using the following path:

(38) River network, reservoirs and HEPS -> Water resources and their distribution.

(39) River network, reservoirs and HEPS -> Reservoirs -> Dynamics of water storage in large reservoirs at the start of year.



(40) River network, reservoirs and HEPS -> Reservoirs -> Inflows and releases

Name: Task_1_v2
Task 1: Assess flow regulation by..
Basin: Basin of Syrdarya
Climate impact: Minimal
Flow probability: Dry
Development: user

Reports list

You haven't got reports yet.

Manage reports »

INDICATORS	UNITS	VALUES BY YEAR 2011	2012	2013	2014	2015	AVERAGE FIVE YEARS
- River network, reservoirs and HPS ←*click to view*							
+ Water resources and their distribution		Σ	Σ	Σ	Σ	Σ	
- Reservoirs							
+ Reservoirs							
- Inflows and releases		Σ	Σ	Σ	Σ	Σ	
inflow							
Toktogul	Mm3	12370.4	13076.1	9819.8	9006.2	8815.4	10617.6
Kayrakum	Mm3	14232.2	15276	11386.2	11228.3	12289.7	12882.5
release							
Toktogul	Mm3	12510.7	13124.7	9955.8	9946.7	9975	11102.6
Kayrakum	Mm3	13789.1	14549.3	12756	11228.3	12289.7	12922.5
+ New reservoirs		Σ	Σ	Σ	Σ	Σ	
+ HEPS							
+ Water ecosystems							

Which indicators describe operation regimes of reservoir hydrosystems with HEPS?

The operation of reservoir hydrosystem with HEPS is characterized by the following indicators:

(41) Electricity production – via HEPS -> Electricity production – total

Name: Task_1_v2
Task 1: Assess flow regulation by..
Basin: Basin of Syrdarya
Climate impact: Minimal
Flow probability: Dry
Development: user

Reports list

You haven't got reports yet.

Manage reports »

INDICATORS	UNITS	VALUES BY YEAR 2011	2012	2013	2014	2015	AVERAGE FIVE YEARS
- River network, reservoirs and HPS ←*click to view*							
+ Water resources and their distribution		Σ	Σ	Σ	Σ	Σ	
+ Reservoirs							
- HEPS							
- Electricity production - total							
Kairakkum HEPS	M kWH/yr	605.3	654.9	581	492.6	549.1	576.6
Naryn HEPS cascade	M kWH/yr	11885.1	12476.6	9554.8	9498.7	9343.7	10551.8
New HEPS							
Kambarata 1	M kWH/yr	1299.4	1314.2	1273.2	1136.3	1215.6	1247.7
+ Deficit of electricity in large HEPS (against energy generation schedule)							
+ Loss of production (for energy) and potential exports							
+ Water ecosystems							

(42) Deficit of electricity production – via HEPS -> Deficit of electricity in large HEPS (against energy generation schedule)

Name: Task_1_v2
Task 1: Assess flow regulation by..
Basin: Basin of Syrdarya
Climate impact: Minimal
Flow probability: Dry
Development: user

Reports list

You haven't got reports yet.

Manage reports »

INDICATORS	UNITS	VALUES BY YEAR 2011	2012	2013	2014	2015	AVERAGE FIVE YEARS
- River network, reservoirs and HPS ←*click to view*							
+ Water resources and their distribution		Σ	Σ	Σ	Σ	Σ	
+ Reservoirs							
- HEPS							
+ Electricity production - total							
- Deficit of electricity in large HEPS (against energy generation schedule)							
Kairakkum HEPS	M kWH/yr	4.7	1.7	4.6	4.3	4.1	3.9
Naryn HEPS cascade	M kWH/yr	136.7	40.1	136.4	164	149.2	125.3
New HEPS							
Kambarata 1	M kWH/yr	304.1	289.3	330.3	467.2	387.8	355.7
+ Loss of production (for energy) and potential exports							
+ Water ecosystems							

(43) Loss of production – via HEPS -> Loss of production (for energy) and potential exports

Name: Task_1_v2
Task 1: Assess flow regulation by..
Basin: Basin of Syrdarya
Climate impact: Minimal
Flow probability: Dry
Development: user

Reports list

You haven't got reports yet.

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INDICATORS	UNITS	VALUES BY YEAR					AVERAGE FIVE YEARS
		2011	2012	2013	2014	2015	
- River network, reservoirs and HPS ←*click to view*							
+ Water resources and their distribution		Σ	Σ	Σ	Σ	Σ	
+ Reservoirs							
- HEPS							
+ Electricity production - total							
+ Deficit of electricity in large HEPS (against energy generation schedule)							
- Loss of production (for energy) and potential exports							
Kairakkum HEPS	M kWH/yr	322.9	369	297.2	224	274.7	297.6
Naryn HEPS cascade	M kWH/yr	[illegible]	8168.1	5311.5	5318.9	5186.4	6328.8
New HEPS							
Kambarata 1	M kWH/yr	0	0	0	0	0	0.0
+ Water ecosystems							

43

Working with the Socio-Economic model (SEm)

Socio-Economic Model (SEM) is software to select and estimate water-management, agricultural and environmental development scenarios for the Aral Sea basin by 2035 based on food safety and efficiency related to national socio-economic development scenarios of riparian countries. The model operates jointly with WAm and PZm.

How to enter the population growth trends in the model and what these trends can have an impact on?

Open the user's scenario form after opening the project (Task 4) and use the following path: WAm parameters -> Basin of Syrdarya -> Basin -> Annual population growth as compared to previous year, average for five years (44).

Info about project

Name: Task_4_v1
Task 4: Socio-economic assessment..
Basin: Basin of Aral Sea
Planning zone: Tashkent-Chirchik, Tashkent-SyrDarya
Climate impact: Minimal**Flow probability:** Dry
Development: user

Reports list

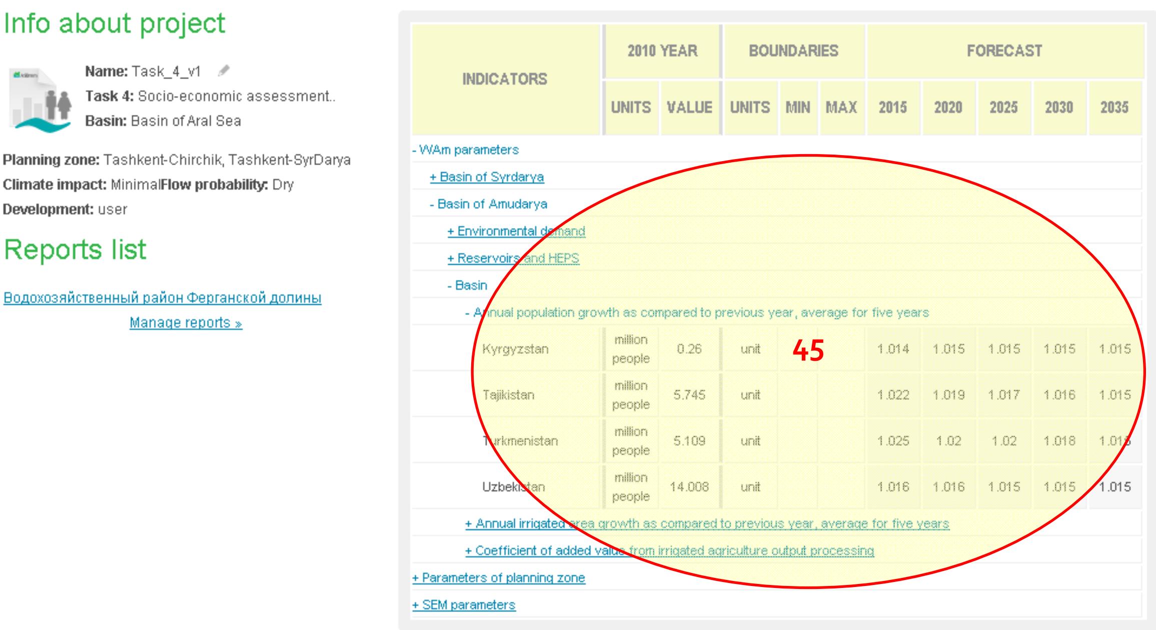
Водохозяйственный район Ферганской долины

Manage reports »

INDICATORS	2010 YEAR		BOUNDARIES			FORECAST				
	UNITS	VALUE	UNITS	MIN	MAX	2015	2020	2025	2030	2035
- WAm parameters										
- Basin of Syrdarya										
+ Environmental demand										
+ Reservoirs and HEPS										
- Basin										
- Annual population growth as compared to previous year, average for five years										
Kazakhstan	million people	3	unit			1.019	1.018	1.017	1.018	1.015
Kyrgyzstan	million people	2.907	unit			1.014	1.015	1.015	1.015	1.015
Tajikistan	million people	1.918	unit			1.02	1.018	1.016	1.015	1.015
Uzbekistan	million people	15.116	unit			1.016	1.016	1.015	1.015	1.015
+ Annual irrigated area growth as compared to previous year, average for five years										
+ Coefficient of added value from irrigated agriculture output processing										
+ Basin of Amudarya										
+ Parameters of planning zone										
+ SEM parameters										

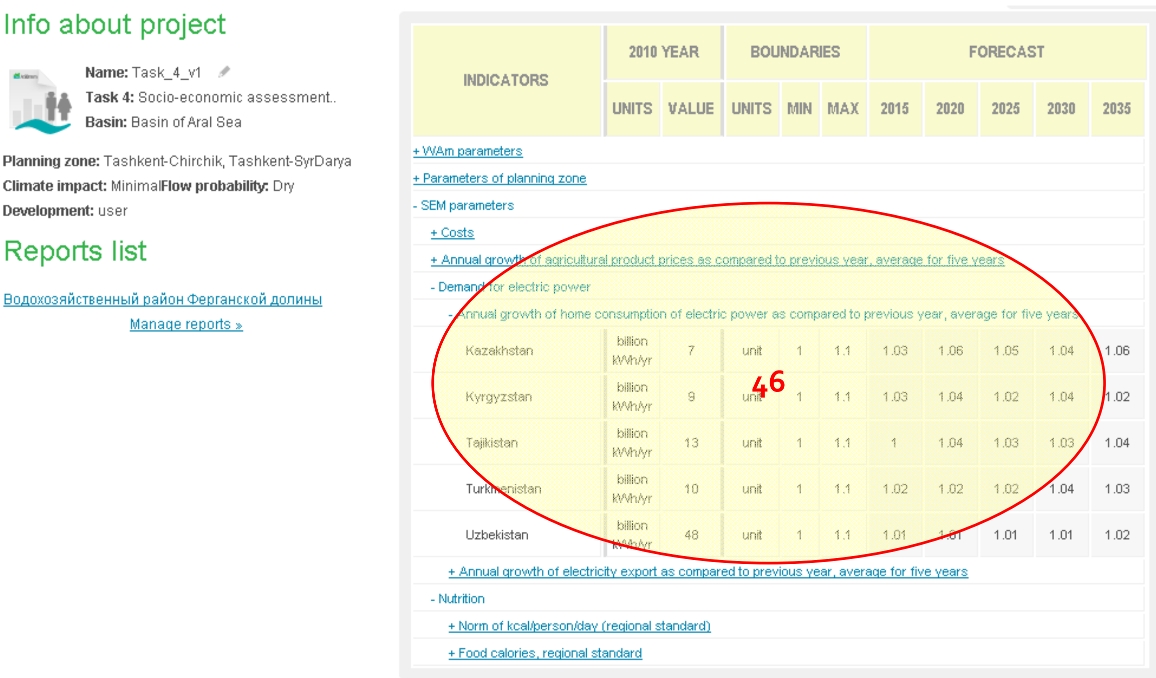
44

After entering the data, the same procedure should be repeated for the Amudarya basin using the following path: WAm parameters -> Basin of Amudarya -> Basin -> Annual population growth as compared to previous year, average for five years (45).

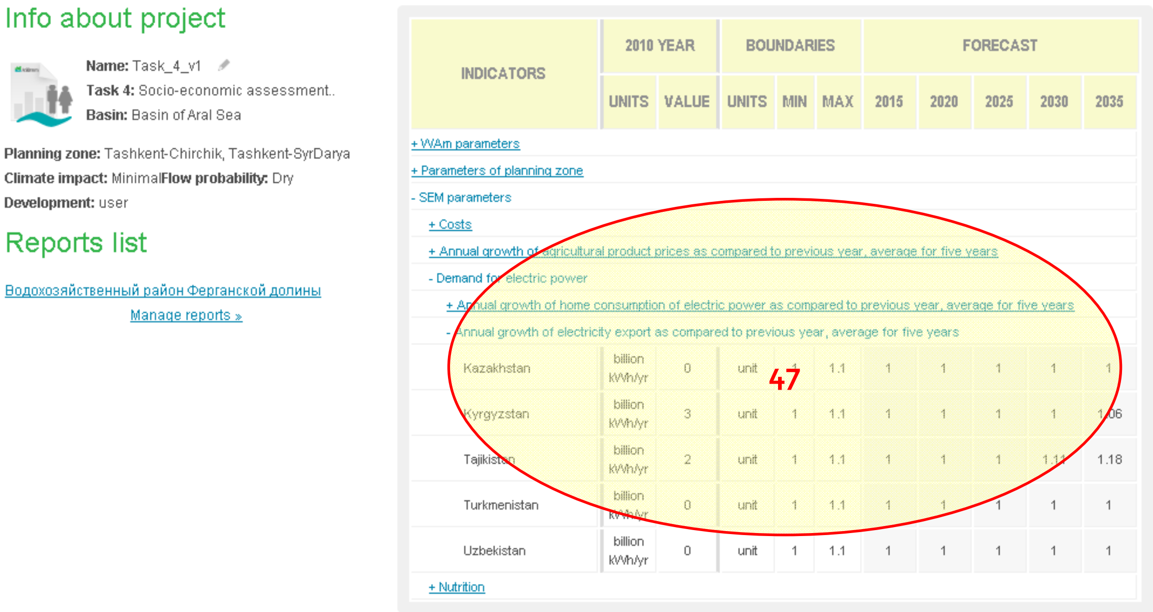


Can the user enter the electricity demand trend in the basin countries? How can this be done? To this end, the user should open the user's scenario form after opening the project of given type and use the following paths to access the indicators:

(46) Home consumption: SEM parameters -> Demand for electric power -> Annual growth of home consumption of electric power as compared to previous year, average for five years

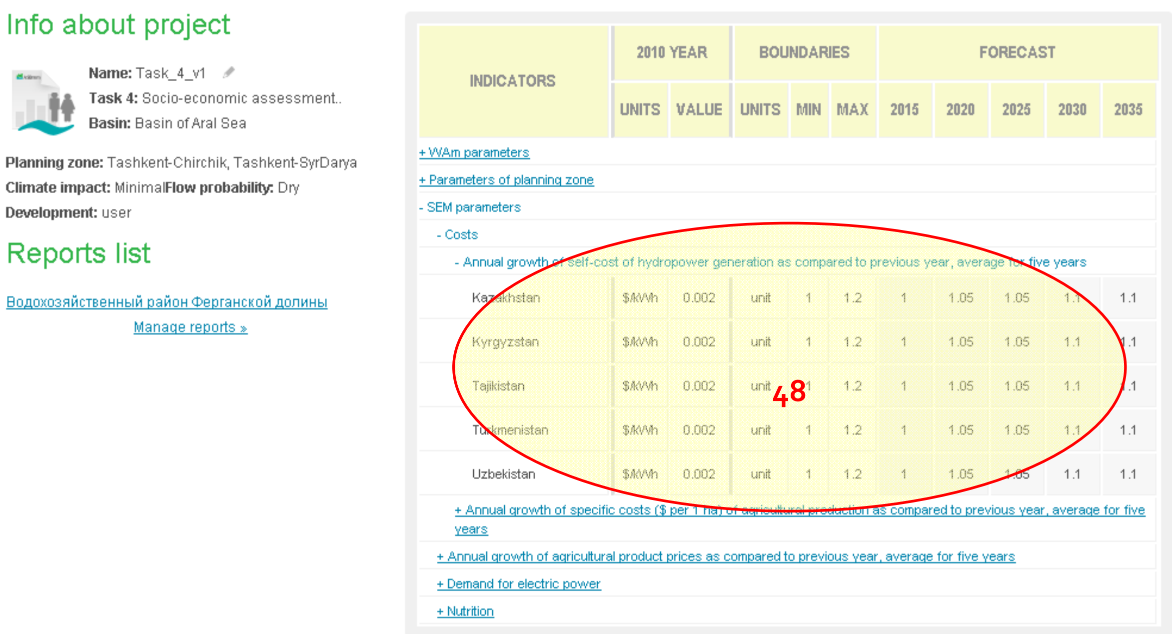


(47) SEM parameters -> Demand for electric power -> Annual growth of electricity export as compared to previous year, average for five years



How to enter the costs of hydropower generation and what these costs can have an impact on?

Open the user's scenario form after opening the project (Task 4) and use the following path to access the parameter: Export - SEM parameters -> Costs -> Annual growth of self-cost of hydropower generation as compared to previous year, average for five years (48).

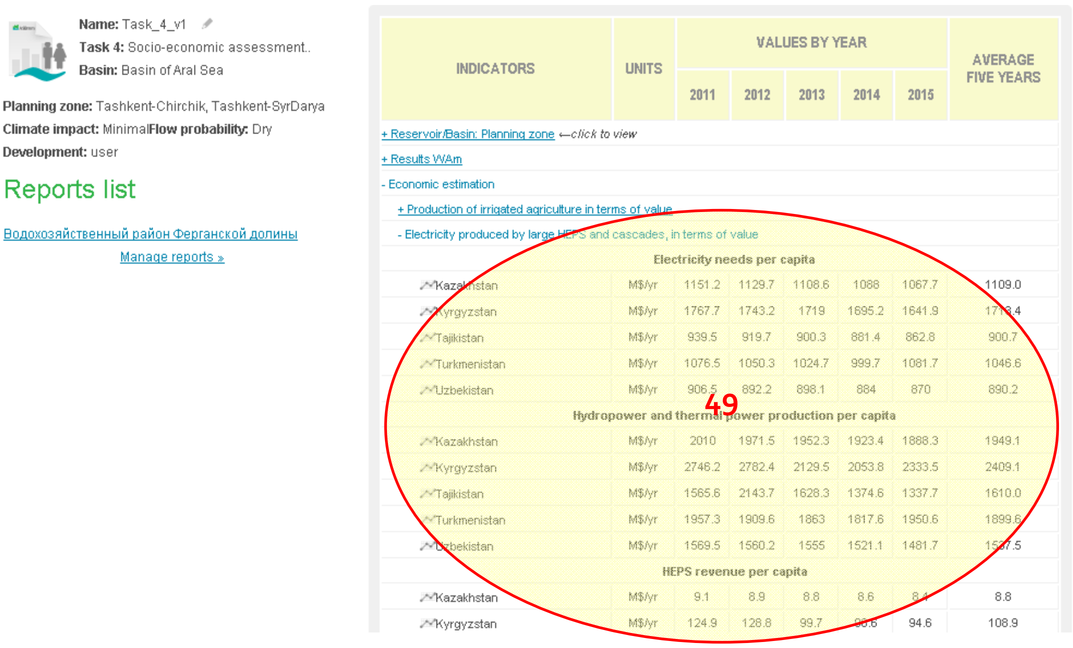


Which economic indicators are used to estimate the operation of HEPS and their impact on water supply of different users in river basins?

The operation of HEPS is estimated against the following indicators:

- Electricity needs per capita;
- Hydropower and thermal power production per capita;
- HEPS revenue per capita;
- Deficit of hydropower production;
- Lost hydropower production benefit (revenue).

These indicators can be accessed through the integrated assessment form of the Task 4: Economic estimation -> Electricity produced by large HEPS and cascades, in terms of value (49).

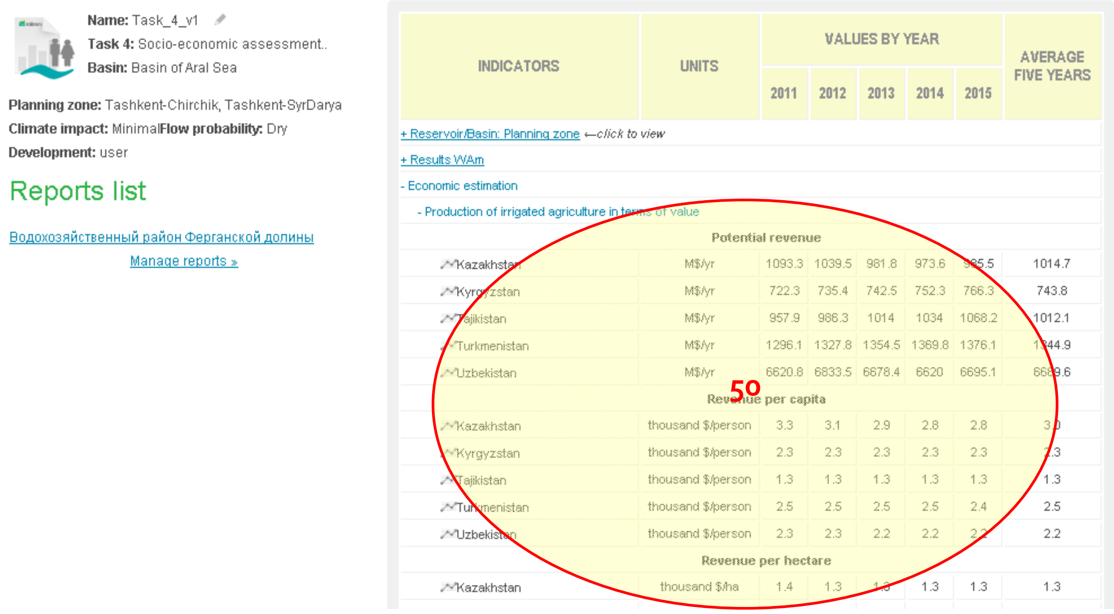


Which socio-economic indicators are used to assess production and losses of output in irrigated agriculture and processing sector?

The production and losses of output in irrigated agriculture and processing sector are assessed through the following indicators:

- Potential revenue;
- Revenue per capita;
- Revenue per hectare;
- Revenue per one cubic meter of water diverted;
- Loss of revenue;
- Value added in irrigated agriculture and processing sector;
- Losses in irrigated agriculture and processing sector;
- Increase or loss of jobs.

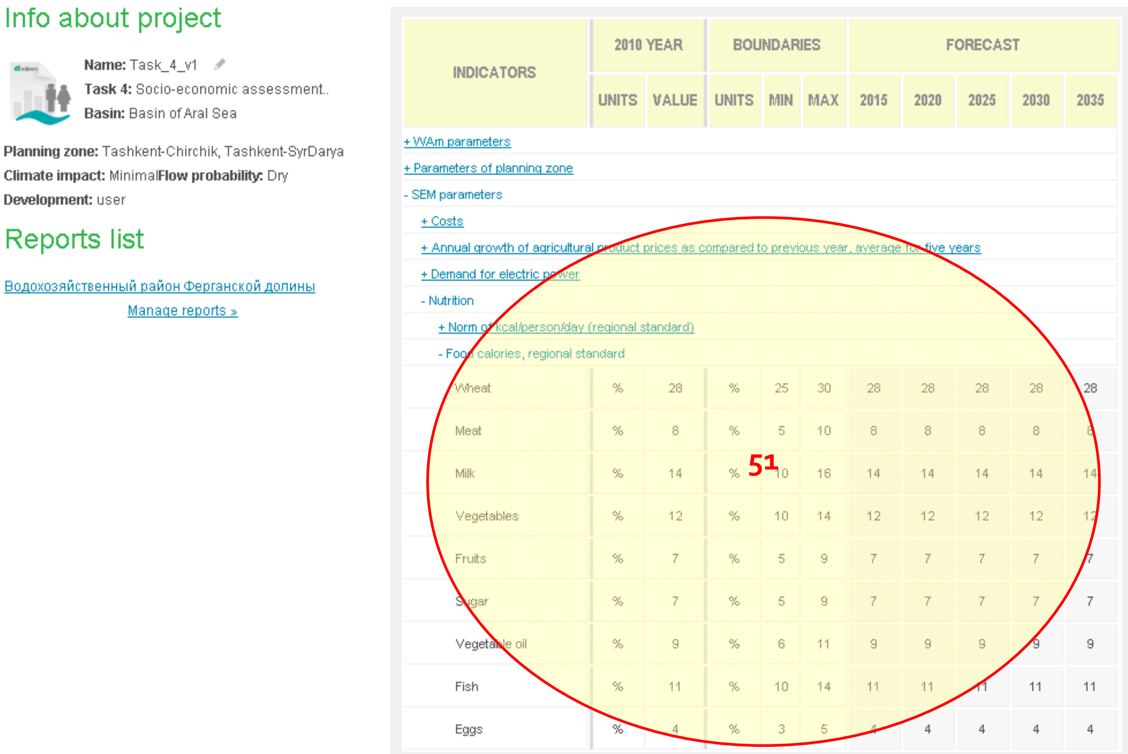
Those indicators can be assessed through the integrated assessment form of the Task 4: Economic estimation -> Production of irrigated agriculture in terms of value (50).



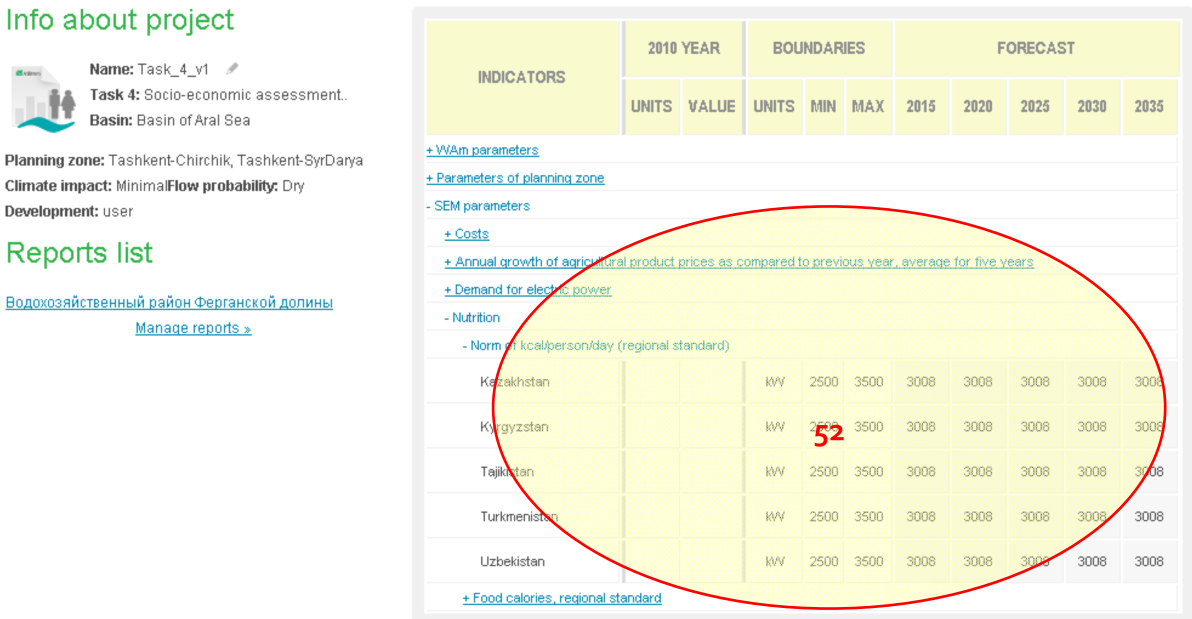
How to fill in the food basket for the region and set the norm of calories per person?

Open the user's scenario form after opening the project (Task 4) and use the following path to access the parameters:

(51) Food basket: SEM parameters -> Nutrition -> Food calories.



(52) Norm of calories per person: SEM parameters -> Nutrition -> Norm of kcal/person/day.


Info about project

Name: Task_4_v1
Task 4: Socio-economic assessment..
Basin: Basin of Aral Sea

Planning zone: Tashkent-Chirchik, Tashkent-SyrDarya
Climate impact: Minimal**Flow probability:** Dry
Development: user

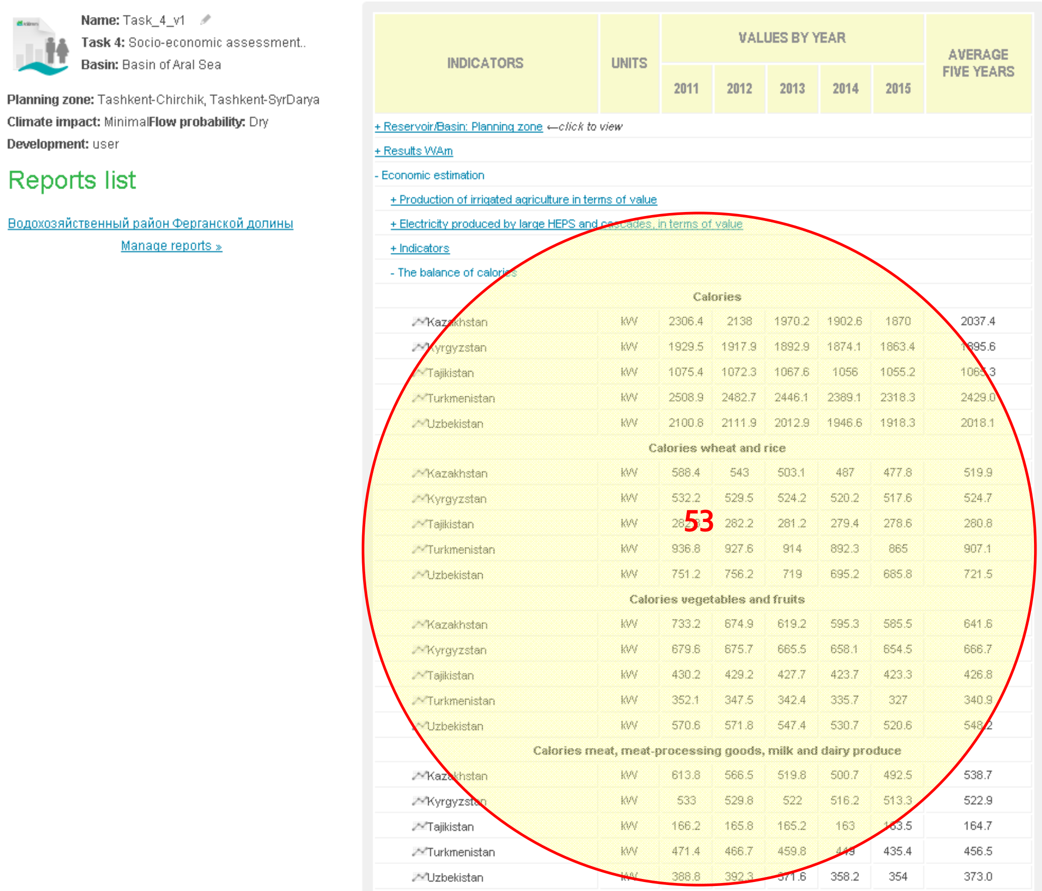
Reports list

Водохозяйственный район Ферганской долины
Manage reports »

INDICATORS	2010 YEAR		BOUNDARIES			FORECAST				
	UNITS	VALUE	UNITS	MIN	MAX	2015	2020	2025	2030	2035
+ WAm parameters										
+ Parameters of planning zone										
- SEM parameters										
+ Costs										
+ Annual growth of agricultural product prices as compared to previous year, average for five years										
+ Demand for electric power										
- Nutrition										
- Norm of kcal/person/day (regional standard)										
Kazakhstan			kW	2500	3500	3008	3008	3008	3008	3008
Kyrgyzstan			kW	2500	3500	3008	3008	3008	3008	3008
Tajikistan			kW	2500	3500	3008	3008	3008	3008	3008
Turkmenistan			kW	2500	3500	3008	3008	3008	3008	3008
Uzbekistan			kW	2500	3500	3008	3008	3008	3008	3008
+ Food calories, regional standard										

Which indicators estimate food security in the basin?

Food security can be estimated by comparing the norm per person and the estimated indicators of calories in general and by foodstuff items. Those indicators can be assessed through the integrated assessment form of the Task 4: Economic estimation -> The Balance of calories (53).


Name: Task_4_v1
Task 4: Socio-economic assessment..
Basin: Basin of Aral Sea

Planning zone: Tashkent-Chirchik, Tashkent-SyrDarya
Climate impact: Minimal**Flow probability:** Dry
Development: user

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Водохозяйственный район Ферганской долины
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INDICATORS	UNITS	VALUES BY YEAR					AVERAGE FIVE YEARS
		2011	2012	2013	2014	2015	
+ Reservoir/Basin: Planning zone ←click to view							
+ Results WAm							
- Economic estimation							
+ Production of irrigated agriculture in terms of value							
+ Electricity produced by large HEPS and cascades, in terms of value							
+ Indicators							
- The balance of calories							
Calories							
Kazakhstan	kW	2306.4	2138	1970.2	1902.6	1870	2037.4
Kyrgyzstan	kW	1929.5	1917.9	1892.9	1874.1	1863.4	1895.6
Tajikistan	kW	1075.4	1072.3	1067.6	1056	1055.2	1065.3
Turkmenistan	kW	2508.9	2482.7	2446.1	2389.1	2318.3	2429.0
Uzbekistan	kW	2100.8	2111.9	2012.9	1946.6	1918.3	2018.1
Calories wheat and rice							
Kazakhstan	kW	588.4	543	503.1	487	477.8	519.9
Kyrgyzstan	kW	532.2	529.5	524.2	520.2	517.6	524.7
Tajikistan	kW	[illegible]	282.2	281.2	279.4	278.6	280.8
Turkmenistan	kW	936.8	927.6	914	892.3	865	907.1
Uzbekistan	kW	751.2	756.2	719	695.2	685.8	721.5
Calories vegetables and fruits							
Kazakhstan	kW	733.2	674.9	619.2	595.3	585.5	641.6
Kyrgyzstan	kW	679.6	675.7	665.5	658.1	654.5	666.7
Tajikistan	kW	430.2	429.2	427.7	423.7	423.3	426.8
Turkmenistan	kW	352.1	347.5	342.4	335.7	327	340.9
Uzbekistan	kW	570.6	571.8	547.4	530.7	520.6	548.2
Calories meat, meat-processing goods, milk and dairy produce							
Kazakhstan	kW	613.8	566.5	519.8	500.7	492.5	538.7
Kyrgyzstan	kW	533	529.8	522	516.2	513.3	522.9
Tajikistan	kW	166.2	165.8	165.2	163	163.5	164.7
Turkmenistan	kW	471.4	466.7	459.8	449	435.4	456.5
Uzbekistan	kW	388.8	392.3	371.6	358.2	354	373.0

Viewing the results

Output forms of ASBMM

The results of calculations are available in two formats, such as an integrated assessment and the output of water-related information. The integrated assessment presents annual data in five-year periods of forecast. The set of output parameters is determined by type of project. Some of information is available in both annual and monthly dimension. Such data are marked by "∑" (54). The output forms for each type of project are described below (55).

Evaluation of the flow regulation by reservoir hydrosystem with HEPS and the water balance of river basins

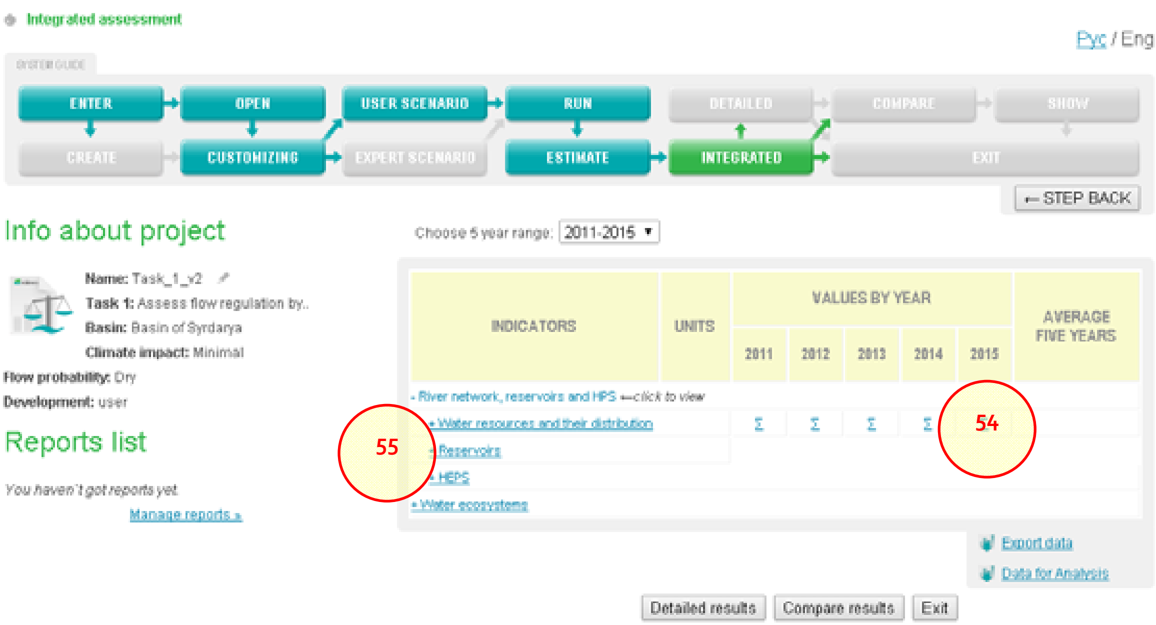
The calculation parameters are grouped into the following categories:

1. **Water resources and their distribution** (55)
   ~ Water resources;
   ~ Transboundary resources of Syrdarya/Amudarya and tributaries;
   ~ Water diversion in Syrdarya/Amudarya basin;
   ~ Estimated return flow into Syrdarya/Amudarya and tributaries;
   ~ Channel losses;
   ~ Usable water resources (natural resources+return flow-losses).

2. **Reservoirs** (55)
   ~ Dynamics of water storage in large reservoirs at the start of year;
   ~ Inflows and releases.

3. **HEPS** (55)
   ~ Electricity generation – total;
   ~ Deficit of electricity generation by large HEPS (against energy generation schedule);
   ~ Loss of production (for energy sector) or potential export.

4. **Water ecosystems** (55)
   ~ Emergency-environmental releases;
   ~ Water availability of Prearalie;
   ~ Water supply to water ecosystems;
   ~ Water supply to the Aral Sea.



Assessment of water availability and agricultural output losses:

1. **Water balance (56)**

Water requirements of PZ

- ~ Irrigated agriculture;
- ~ Domestic use;
- ~ Industrial use;
- ~ Rural water supply

Local water resources

- ~ Local rivers and streams;
- ~ Groundwater extraction;
- ~ Reuse from collector drainage in PZ

Calculated parameters

- ~ Water demand of PZ from large rivers (transboundary);
- ~ Return flow from PZ to large rivers;
- ~ Potential collector drainage flow formed in PZ

2. **Productivity of irrigated agriculture (56)**

- ~ Irrigated area;
- ~ Potential agricultural production;
- ~ Loss of agricultural production due to water deficit;
- ~ Agricultural production;
- ~ Cost of agricultural production;
- ~ Net agricultural production;
- ~ Value added in irrigated agriculture;
- ~ Value added in processing sector, including per crop

3. **Estimated investments in PZ (56)**

- ~ Reconstruction of irrigation network;
- ~ Development of new land for agriculture;
- ~ Investment in improved water management (IWRM);

~ Area of new land developed for agriculture.

Info about project

Name: Task_3_v1
Task 3: Assess water availability..
Basin: Basin of Syrdarya
Planning zone: Tashkent-Chirchik
Climate impact: Minimal **Flow probability:** Dry
Development: user

Reports list

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Choose 5 year range: 2011-2015

INDICATORS	UNITS	VALUES BY YEAR					AVERAGE FIVE YEARS
		2011	2012	2013	2014	2015	
- PZ water balance ←click to view		Σ	Σ	Σ	Σ	Σ	
Water requirements of PZ							
Irrigated agriculture	Mn3	3677.8	3911	3996.1	4200.1	4526.9	4062.4
Domestic user	Mn3	983.6	984.2	984.9	985.6	986.3	984.9
Industrial use	Mn3	2078.5	2083.1	2087.7	2092.3	2096.9	2087.7
Rural water supply	Mn3	609.3	609.9	610.6	611.3	612	610.6
Filling of reservoirs	Mn3	1127.4	1123.2	1023.9	1106.2	1109.3	1114.0
Total[1]	Mn3	8456.5	8691.4	8683.3	9055.5	9311.4	8839.6
Local water resources in the PZ							
Reuse from collector drainage (fixed amount assumed)	Mn3	313.5	310.2	320.2	303.8	304.2	310.4
Groundwater extraction	Mn3	738.5	742.4	746.3	750.2	754.1	746.3
Local rivers/streams	Mn3	404	411.9	242.3	208.8	240	301.4
Water releases from reservoirs	Mn3	1127.4	1123.2	1023.9	1106.2	1109.3	1114.0
Total[2]	Mn3	2583.5	2587.7	2332.8	2449	2407.7	2472.1
[3] Water demand of PZ from Large Rivers (transboundary) [1] - [2]	Mn3	5873	6103.7	6350.4	6606.5	6903.7	6367.5
[4] Water supply from Large Rivers for PZ	Mn3	2600	2594.8	2441.2	2436.3	2431.5	2500.8
[6] Return flow from PZ to Large Rivers	Mn3	2137	2118	2190	2080.8	2087.4	2122.6
[7] Potential collector drainage flow formed in PZ	Mn3	2475.8	2443.3	2515.7	2380.2	2377.8	2438.6
+ Productivity of irrigated agriculture							
+ Estimated investments in planing zone							

56

Socio-economic assessment of the development of the region

1. Production of irrigated agriculture in terms of value (57)

~ Potential revenue;
~ Revenue per capita;
~ Revenue per hectare;
~ Revenue per one cubic meter of water diverted;
~ Loss of revenue;
~ Value added in irrigated agriculture and processing sector;
~ Losses in irrigated agriculture and processing sector;
~ Loss of jobs.

Info about project

Name: Task_4_v1
Task 4: Socio-economic assessment..
Basin: Basin of Aral Sea
Planning zone: Tashkent-Chirchik, Tashkent-SyrDarya
Climate impact: Minimal **Flow probability:** Dry
Development: user

Reports list

Водохозяйственный район Ферганской долины

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Choose 5 year range: 2011-2015

INDICATORS	UNITS	VALUES BY YEAR					AVERAGE FIVE YEARS
		2011	2012	2013	2014	2015	
+ Reservoir/Basin: Planning zone ←click to view							
+ Results WAm							
- Economic estimation							
- Production of irrigated agriculture in terms of value							
Potential revenue							
Kazakhstan	M$/yr	1093.3	1039.5	981.8	973.6	985.5	1014.7
Kyrgyzstan	M$/yr	722.3	735.4	742.5	752.3	766.3	743.8
Tajikistan	M$/yr	957.9	986.3	1014	1034	1068.2	1012.1
Turkmenistan	M$/yr	1296.1	1327.8	1354.5	1369.8	1376.1	1344.9
Uzbekistan	M$/yr	6620.8	6833.5	6678.4	6620	6695.1	6689.6
Revenue per capita							
Kazakhstan	thousand $/person	3.3	3.1	2.9	2.8	2.8	3.0
Kyrgyzstan	thousand $/person	2.3	2.3	2.3	2.3	2.3	2.3
Tajikistan	thousand $/person	1.3	1.3	1.3	1.3	1.3	1.3
Turkmenistan	thousand $/person	2.5	2.5	2.5	2.5	2.4	2.5
Uzbekistan	thousand $/person	2.3	2.3	2.2	2.2	2.2	2.2
Revenue per hectare							
Kazakhstan	thousand $/ha	1.4	1.3	1.3	1.3	1.3	1.3
Kyrgyzstan	thousand $/ha	2	2.1	2.1	2.1	2.2	2.1
Tajikistan	thousand $/ha	1.4	1.4	1.5	1.5	1.6	1.5
Turkmenistan	thousand $/ha	0.7	0.7	0.7	0.7	0.7	0.7
Uzbekistan	thousand $/ha	1.5	1.6	1.6	1.5	1.6	1.6

2. Electricity produced by large HEPS and cascades, in terms of value (58)

- ~ Electricity needs per capita;
- ~ Hydropower and thermal power production per capita;
- ~ HEPS revenue per capita;
- ~ Deficit of hydropower production;
- ~ Lost hydropower production benefit (revenue).

Info about project

Name: Task_4_v1
Task 4: Socio-economic assessment..
Basin: Basin of Aral Sea

Planning zone: Tashkent-Chirchik, Tashkent-SyrDarya
Climate impact: Minimal**Flow probability:** Dry
Development: user

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Водохозяйственный район Ферганской долины
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Choose 5 year range: 2011-2015

+ Reservoir/Basin: Planning zone ←click to view
+ Results WAm
- Economic estimation
+ Production of irrigated agriculture in terms of value
- Electricity produced by large HEPS and cascades, in terms of value

58

INDICATORS	UNITS	VALUES BY YEAR					AVERAGE FIVE YEARS
		2011	2012	2013	2014	2015	
Electricity needs per capita							
Kazakhstan	M$/yr	1151.2	1129.7	1108.6	1088	1067.7	1109.0
Kyrgyzstan	M$/yr	1767.7	1743.2	1719	1695.2	1641.9	1713.4
Tajikistan	M$/yr	939.5	919.7	900.3	881.4	862.8	900.7
Turkmenistan	M$/yr	1076.5	1050.3	1024.7	999.7	1081.7	1046.6
Uzbekistan	M$/yr	906.5	892.2	898.1	884	870	890.2
Hydropower and thermal power production per capita							
Kazakhstan	M$/yr	2010	1971.5	1952.3	1923.4	1888.3	1949.1
Kyrgyzstan	M$/yr	2746.2	2782.4	2129.5	2053.8	2333.5	2409.1
Tajikistan	M$/yr	1565.6	2143.7	1628.3	1374.6	1337.7	1610.0
Turkmenistan	M$/yr	1957.3	1909.6	1863	1817.6	1950.6	1899.6
Uzbekistan	M$/yr	1569.5	1560.2	1555	1521.1	1481.7	1537.5
HEPS revenue per capita							
Kazakhstan	M$/yr	9.1	8.9	8.8	8.6	8.4	8.8
Kyrgyzstan	M$/yr	124.9	128.8	99.7	96.6	94.6	108.9
Tajikistan	M$/yr	51.4	67.4	56.7	47.7	45.8	53.8
Turkmenistan	M$/yr	0	0	0	0	0	0.0
Uzbekistan	M$/yr	3.8	4.2	3.8	3.4	2.9	3.6
Deficit of hydropower production							
Kazakhstan	M$/yr	0	0	0	0	0	0.0
Kyrgyzstan	M$/yr	45.5	34.4	63.3	64.5	67.7	55.1
Tajikistan	M$/yr	73.8	51.1	36.1	58.7	70.6	58.1

3. Indicators (59)

- ~ Population;
- ~ Water resources per capita;
- ~ Irrigated area per capita;
- ~ Hydropower per capita.

Info about project

Name: Task_4_v1
Task 4: Socio-economic assessment..
Basin: Basin of Aral Sea

Planning zone: Tashkent-Chirchik, Tashkent-SyrDarya
Climate impact: Minimal**Flow probability:** Dry
Development: user

Reports list

Водохозяйственный район Ферганской долины
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Choose 5 year range: 2011-2015

+ Reservoir/Basin: Planning zone ←click to view
+ Results WAm
- Economic estimation
+ Production of irrigated agriculture in terms of value
+ Electricity produced by large HEPS and cascades, in terms of value
- Indicators

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INDICATORS	UNITS	VALUES BY YEAR					AVERAGE FIVE YEARS
		2011	2012	2013	2014	2015	
Population							
Kazakhstan	million people	3.3	3.4	3.4	3.5	3.6	3.4
Kyrgyzstan	million people	3.2	3.2	3.3	3.3	3.4	3.3
Tajikistan	million people	7.7	7.8	8	8.2	8.3	8.0
Turkmenistan	million people	5.1	5.2	5.4	5.5	5.6	5.4
Uzbekistan	million people	29.1	29.6	30.1	30.5	31	30.1
Water resources per capita							
Kazakhstan	m3/person	0.1	0.1	0.1	0.1	0.1	0.1
Kyrgyzstan	m3/person	2.5	2.8	2.2	1.9	1.8	2.2
Tajikistan	m3/person	2.2	2.2	2.1	2	1.9	2.1
Turkmenistan	m3/person	0.4	0.4	0.4	0.4	0.4	0.4
Uzbekistan	m3/person	0.7	1.1	0.6	0.3	0.2	0.6

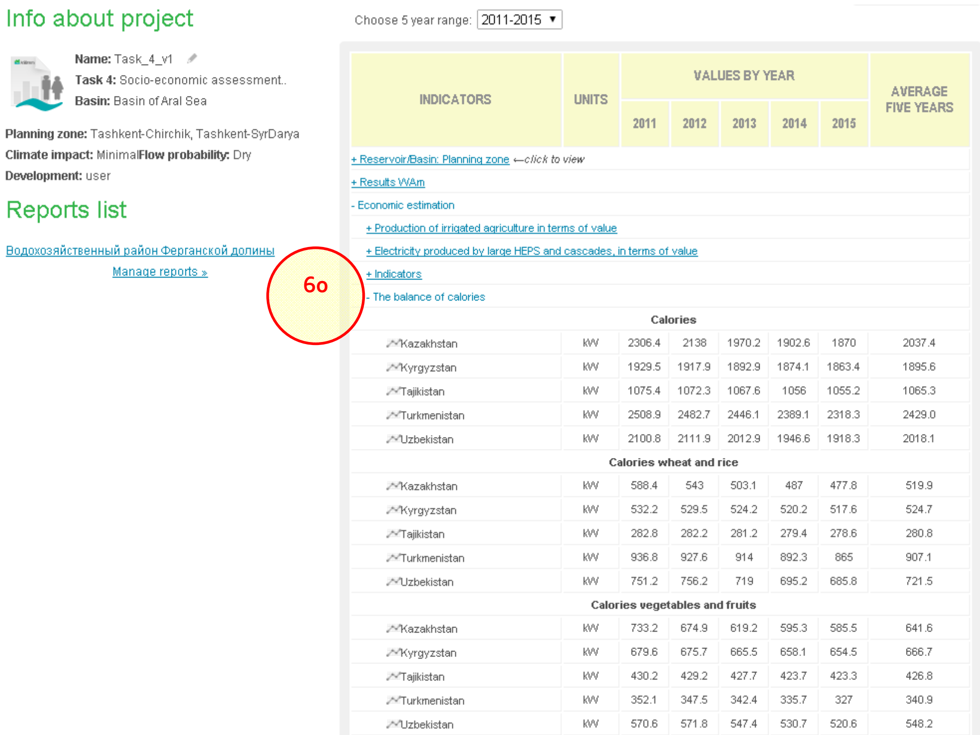
4. The balance of calories (60)

~ Calories;

~ Wheat and rice calories;

~ Vegetables and fruits calories;

~ Meat, meat products, milk and dairy produce calories.

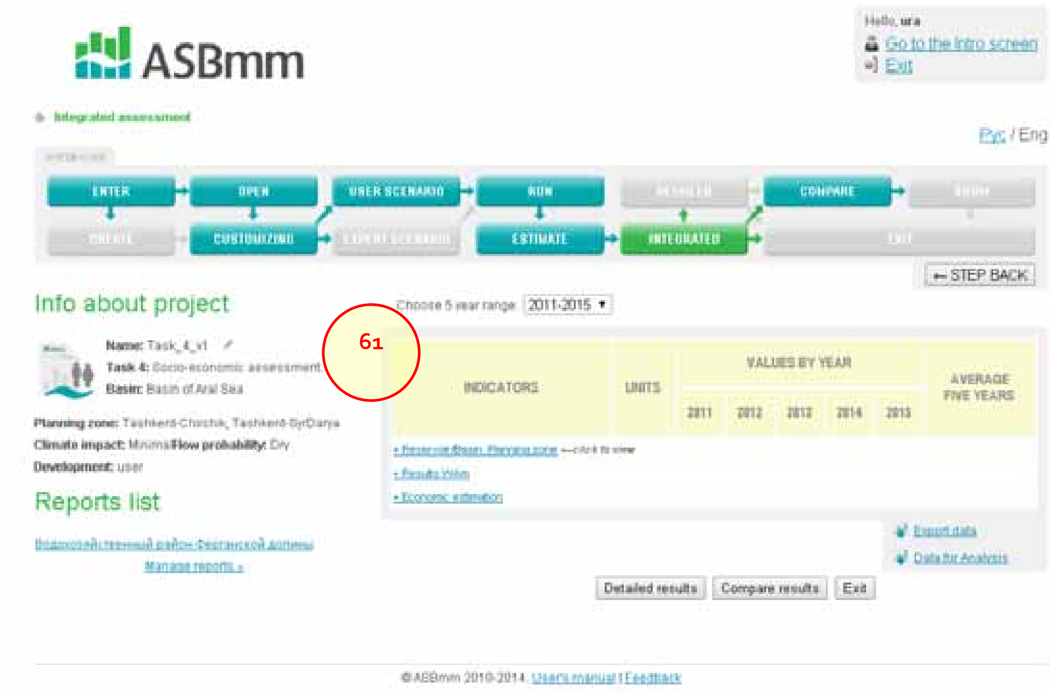


INDICATORS	UNITS	VALUES BY YEAR					AVERAGE FIVE YEARS
		2011	2012	2013	2014	2015	
Calories							
Kazakhstan	kW	2306.4	2138	1970.2	1902.6	1870	2037.4
Kyrgyzstan	kW	1929.5	1917.9	1892.9	1874.1	1863.4	1895.6
Tajikistan	kW	1075.4	1072.3	1067.6	1056	1055.2	1065.3
Turkmenistan	kW	2508.9	2482.7	2446.1	2389.1	2318.3	2429.0
Uzbekistan	kW	2100.8	2111.9	2012.9	1946.6	1918.3	2018.1
Calories wheat and rice							
Kazakhstan	kW	588.4	543	503.1	487	477.8	519.9
Kyrgyzstan	kW	532.2	529.5	524.2	520.2	517.6	524.7
Tajikistan	kW	282.8	282.2	281.2	279.4	278.6	280.8
Turkmenistan	kW	936.8	927.6	914	892.3	865	907.1
Uzbekistan	kW	751.2	756.2	719	695.2	685.8	721.5
Calories vegetables and fruits							
Kazakhstan	kW	733.2	674.9	619.2	595.3	585.5	641.6
Kyrgyzstan	kW	679.6	675.7	665.5	658.1	654.5	666.7
Tajikistan	kW	430.2	429.2	427.7	423.7	423.3	426.8
Turkmenistan	kW	352.1	347.5	342.4	335.7	327	340.9
Uzbekistan	kW	570.6	571.8	547.4	530.7	520.6	548.2

Comparison of the results

ASBMM software allows comparing the results of calculations both within the project (different five years) and between similar projects. The structure of comparison forms inherits the structure of output forms and a set of calculated parameters for the respective project. To view the results of the comparison, perform the following steps:

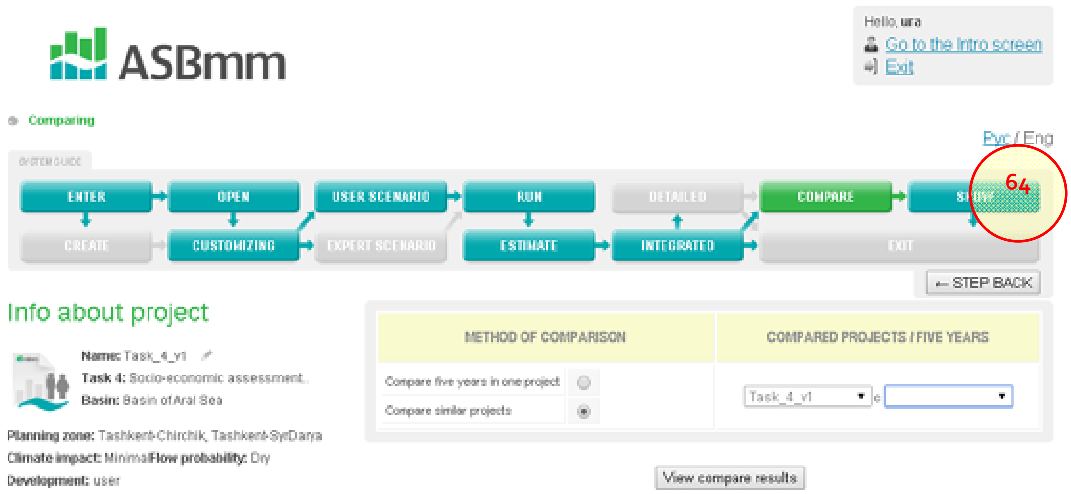
(61) On the integrated assessment page follow the link - Compare results



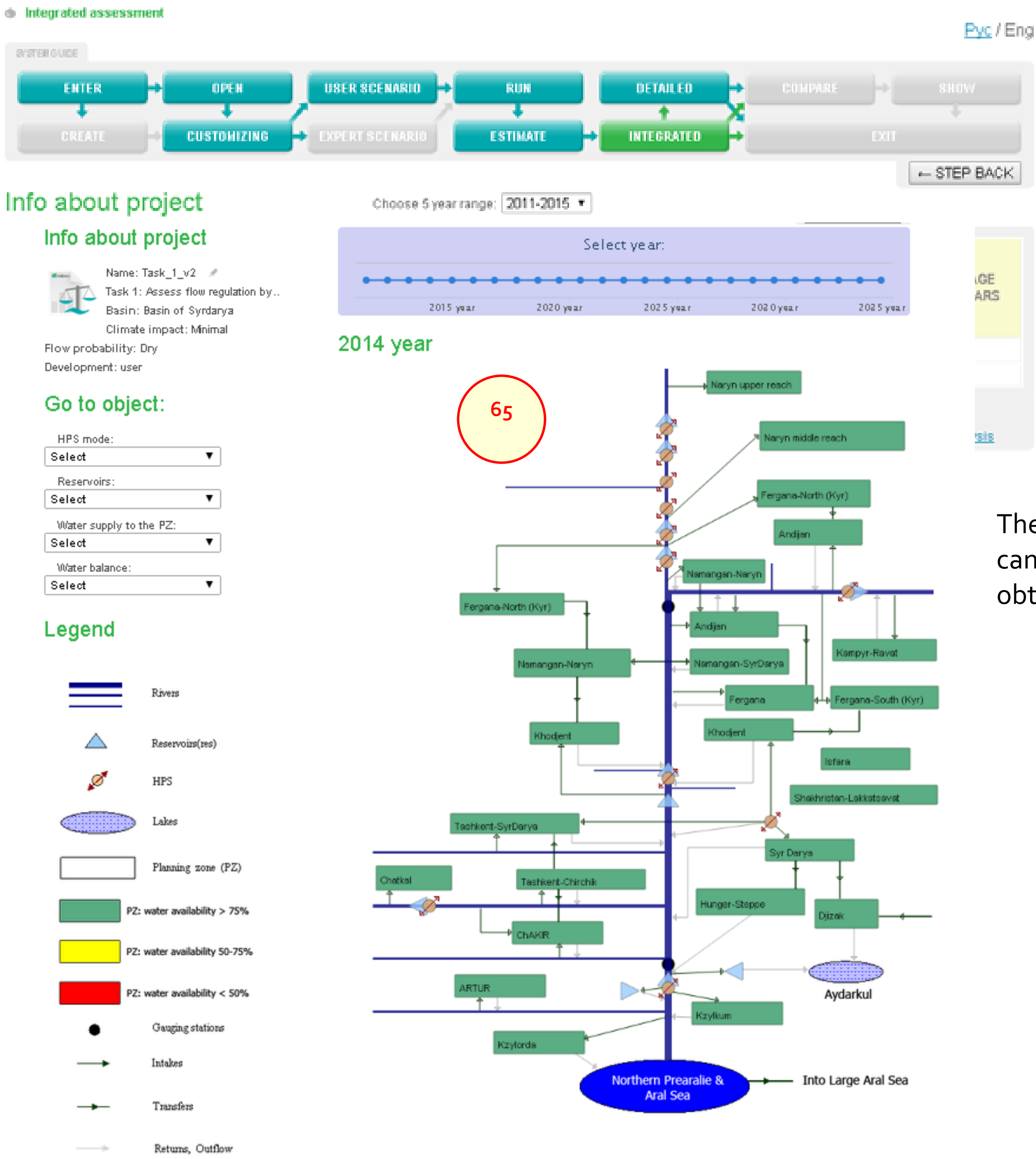
(62) Choose a method of comparison - Compare five years in one project or Compare similar projects

(63) Select Compared projects/ five years

(64) Follow the link - View compared results



Viewing the information about the project



The user can obtain information on water bodies, regimes of which are modeled by the system. This information is available for the project type "Assessment of flow regulation by reservoir hydrosystem with HEP and water balance of river basins" and "Socio-economic assessment of the development of the region." To view this information, the user should follow the link - Detailed results (by project) in the form of an integrated evaluation (65).

Navigation by water objects is possible using the graphical schemes of Syr Darya and Amu Darya river basins (65).

The following reports are available by project:

(66) HEPS operation regime

HEPS operation regime. Toktogul HEPS. 2014 year

PARAMETER	UNITS	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	VEGETATION	NON VEGETATION	FOR YEAR
Water regime of HEPS																
Water discharge at HEPS, Mm3/month		995	995	707	774	796	950	1105	1018	442	398	774	995	4732	5217	9949
Wastewater from HEPS, Mm3/month		495	495	277	424	516	680	805	718	212	98	334	495	2662	2887	5549
Lost releases for energy, Mm3/month		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Deficit of releases for energy generation		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Energy regime of HEPS																
Electricity generation, MkWh		397	390	274	296	302	365	433	405	177	165	319	404	1903	2024	3927
Lost electricity generation through water releases for energy, MkWh		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lost electricity generation through sterile spills		197	194	107	162	196	261	315	285	85	40	137	201	1063	1117	2180
Electricity generation deficit		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

(67) Reservoir operation regime

Reservoir operation regime,. Toktogul. 2014 year

PARAMETER	UNITS	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	VEGETATION	NON VEGETATION	FOR YEAR
Inflow to reservoir-actually,mln.m3		341.3	286	357.4	221.3	849.9	1696	1882.2	1345.1	864.6	466.3	363.9	332.4	5254.5	3751.9	9006.4
outflow from reservoir-actually, mln.m3		994.5	994.5	707.2	773.5	795.6	950.3	1105	1018.3	442	397.8	773.5	994.5	4731.1	5215.6	9946.7
Capacity of reservoir-actually mln.m3		17019	16310	15960	15408	15462	16208	16985	17312	17735	18744	18334	17672	106782	96367	203149

(68) River water balance

River water balance. Karadarya river. 2014 year

PARAMETER	UNITS	X	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	VEGETATION	NON VEGETATION	FOR YEAR
Inflow from an upstream reach, Mm3		111	98	108	125	367	575	554	338	212	176	146	128	1554	1384	2938
Lateral inflow from rivers, Mm3		15	18	26	41	86	36	21	15	17	10	16	15	94	222	316
Water diversion in given site, Mm3		2	116	5	18	27	53	382	65	40	10	5	3	505	221	726
Loses in given site, Mm3		78	105	107	109	102	152	163	156	143	143	83	51	739	653	1392
Discharge to a downstream reach, Mm3		118	103	208	407	708	831	569	489	137	230	176	104	1705	2375	4080
Change in water volume (within reservoir site), Mm3		84	29	26	-152	-205	-128	-215	-48	78	89	64	87	55	-346	-291