About a need to develop a regional integrated water-energy model for the estimation of national development options in the countries of Central Asia (The Aral Sea basin)

Anatoly G.Sorokin

Head of Regional Water Management Department
Scientific-Information Center
Interstate Commission for Water Coordination of Central Asia

E-mail: sorant@mail.ru
Internet: www.sic.icwc-aral.uz

- **Plan of actions.**
- **Our experience.**
- **Our approaches**

What we have:

- national development **strategy** (taking into account use of water-energy potential),
- regional energy and water-management structure (uniting and limiting our endeavors),
- general will to regional cooperation and sustainable development in the region.

We have the following objectives:

- to develop the joint program of actions (on regional priorities in the water-energy sector);
- to find mechanisms for regional coordination of national priorities and for solution of questions at issue and contradictions (consensus).

We do not have:

- agreed on (between the countries) **tools of the regional analysis** of the national development scenarios (water-energy sector), taking into account future challenges and destabilizing factors (climate, globalization).

We know:

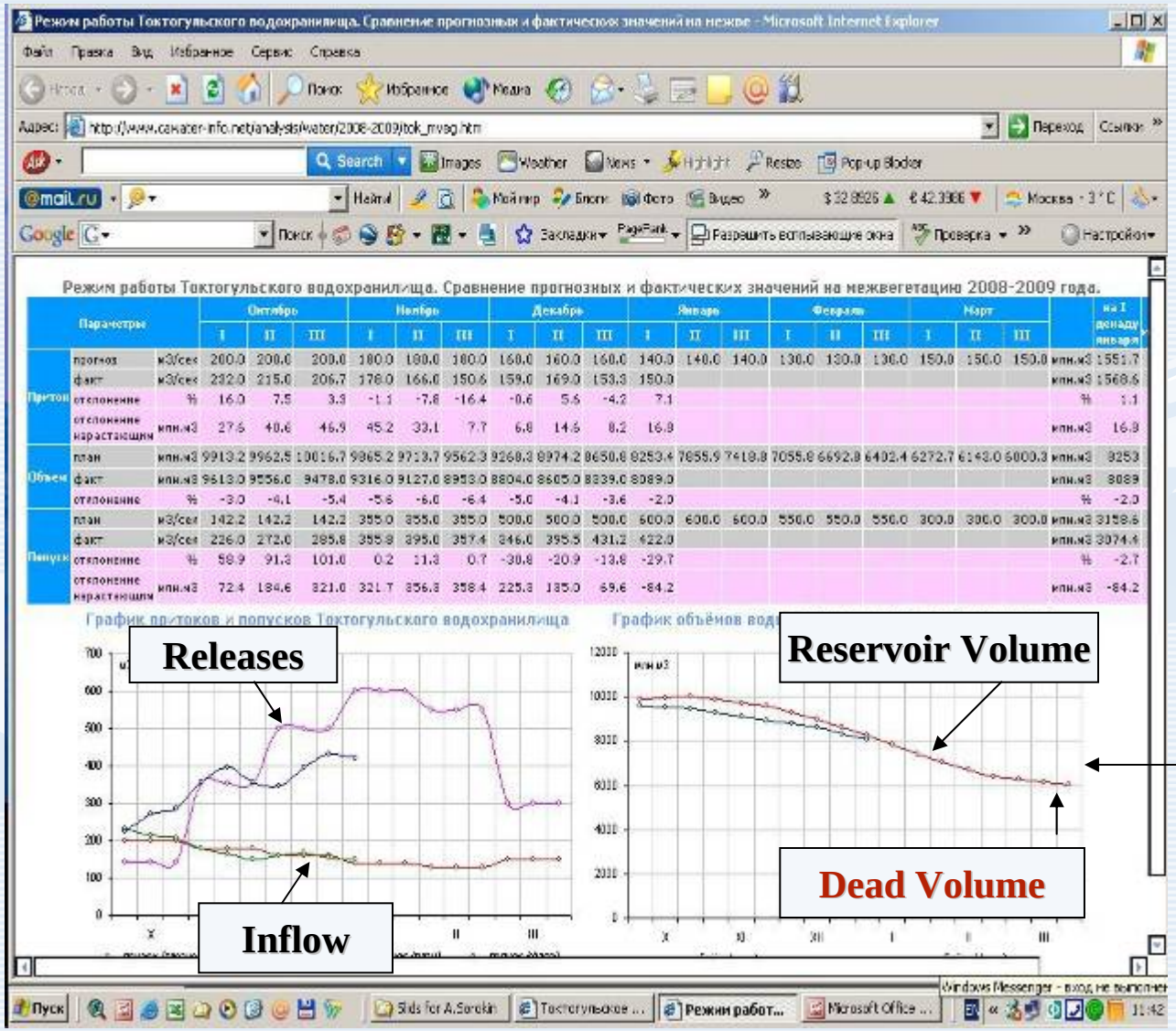
- new **integrated** approaches based on the advanced world experience are needed;
- one must take into account mistakes of the last research and attempts to find the optimal regional scenarios of country development (water sector).

Our experience

- Central Asia Regional Water **Information Base**: Portal and Information System
- Analytical instruments and **models**,
- Modeling **results** for integrated water management in river basins: Chirchik-Akhangaran-Keles basin (**RIVERTWIN**) , **Rogun**

CAREWIB ANALYTICAL DATA (www.cawater-info.net)

Toktogul HPS: Reservoir mode, October 2008 - 2009

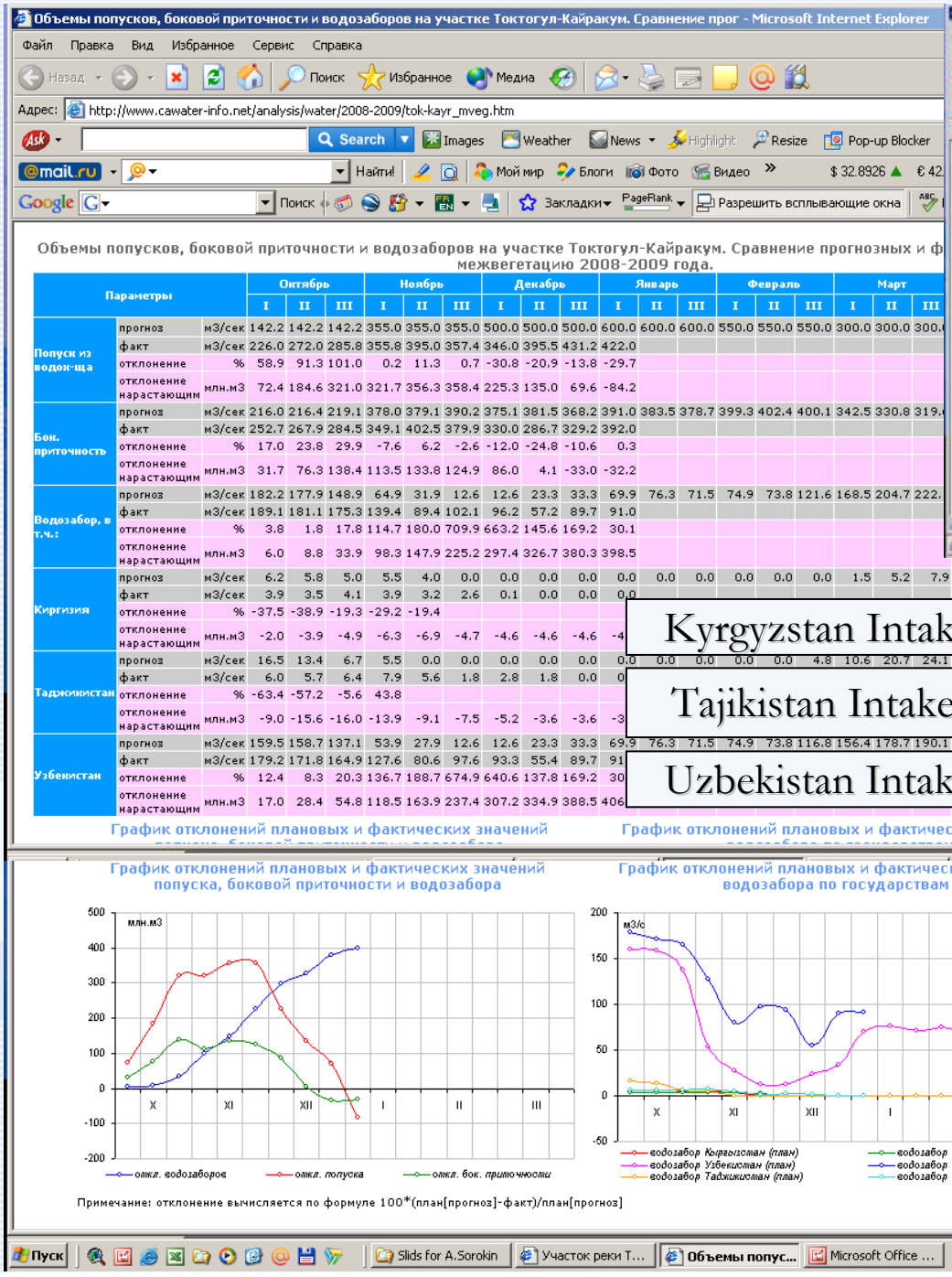


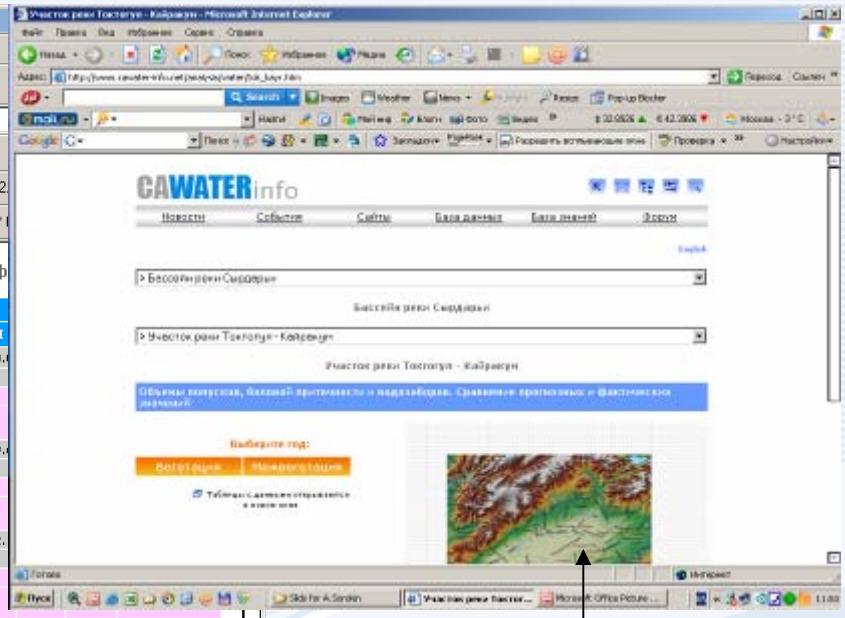
Inflow:
- forecast,
- actual,
- deviation

Reservoir Volume:
- plan, actual, deviation

Releases:
- plan,
- actual,
- deviation

This is a result of large (winter) releases after 1992 and absence of the long-term flow regulation





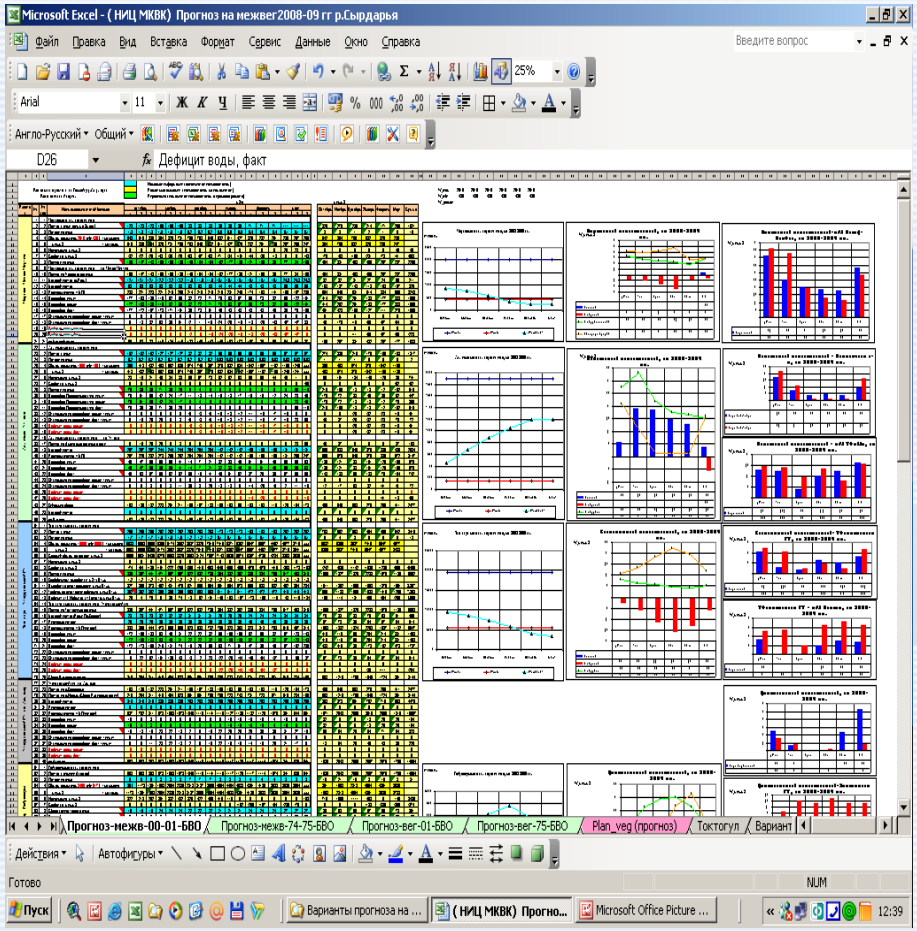
River reach:
Toktogul – Kayrakum

- **Inflow,**
- **Return flow,**
- **Releases,**
- **Intake**

Comparison of actual and planned (forecast) data

Reservoirs and rivers water balances

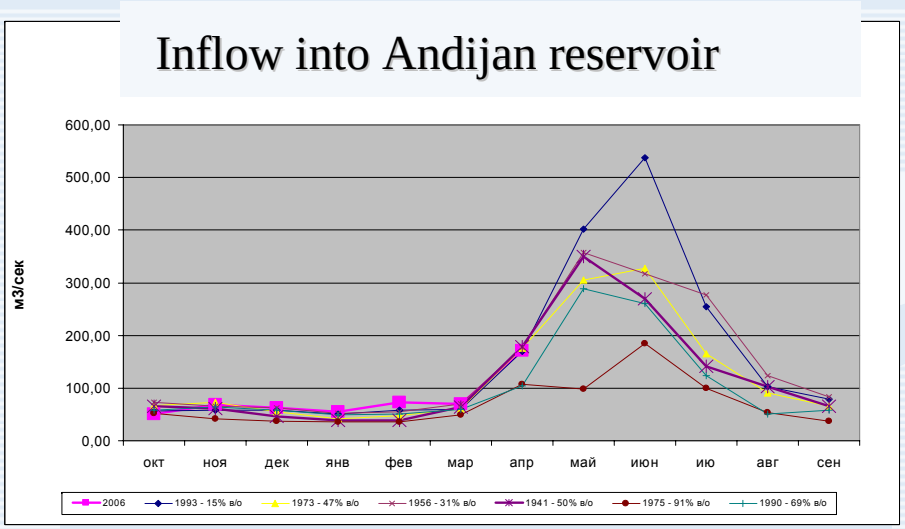
Syrdarya basin: strategies of flow regulation by reservoirs and HPS (Toktogul, Kambarata 1,2)



Estimation of basins' flow probabilities by year-analogue

(river hydrographs, air temperature, rainfall)

Inflow into Andijan reservoir



Hydromet and CAREWIB data

Steps of development of regional basin models in SIC ISWC as a DSS tool for integrated assessment of water situation

Aral Sea Basin Management Model ASB-mm (1 step) – UNDP:

- Social-economic base of Globesing model (M.Misarovich)
- Hydrologic model in GAMS
- Interface (Resource Analysis, The Netherlands, SIC ISWC)

ASB-mm (2 step) – Projects NATO SFP 974357 INTAS - 0511:

- Aral Sea Coastal Zone (Priaralye) and Aral Sea

INTEGRATED model (RIVERTWIN) – new modeling concept (Chirchic-Ahangaran basin):

- Adaptation of EU models - HBV, QUAL2K, EPIC, WEAP,…
- Blocs of runoff formation, groundwater, industrial and urban zones,
- Ecologic model,
- GIS-interface (integration and interpretation of modeling results)
- Interface for BWO "Syrdarya"

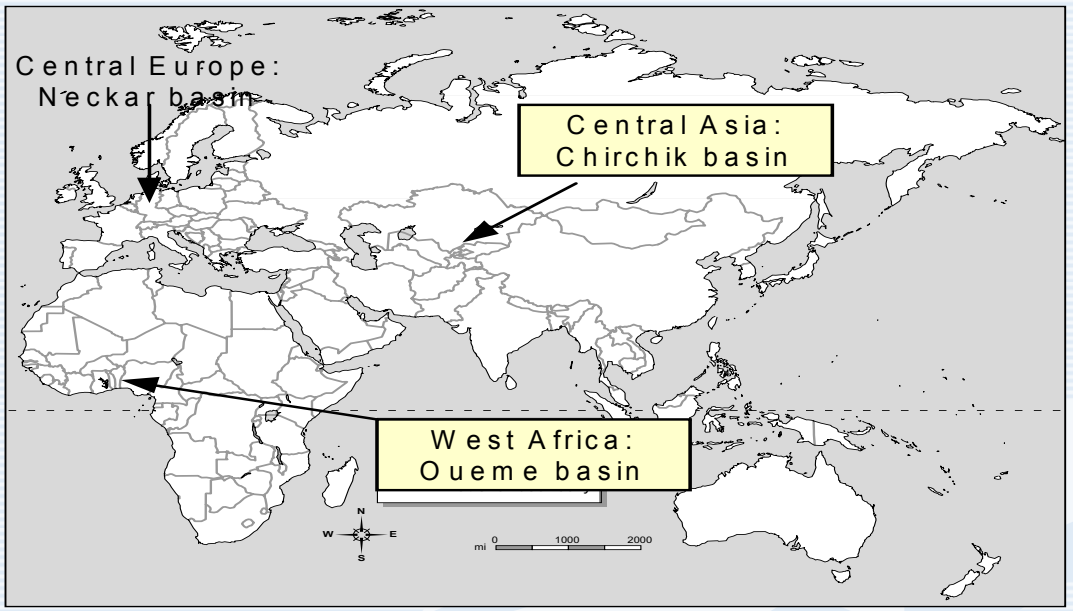
NEXT STEP – Adaptation of new modeling concept for Aral Sea Basin, including – Syrdarya basin, Amudarya model

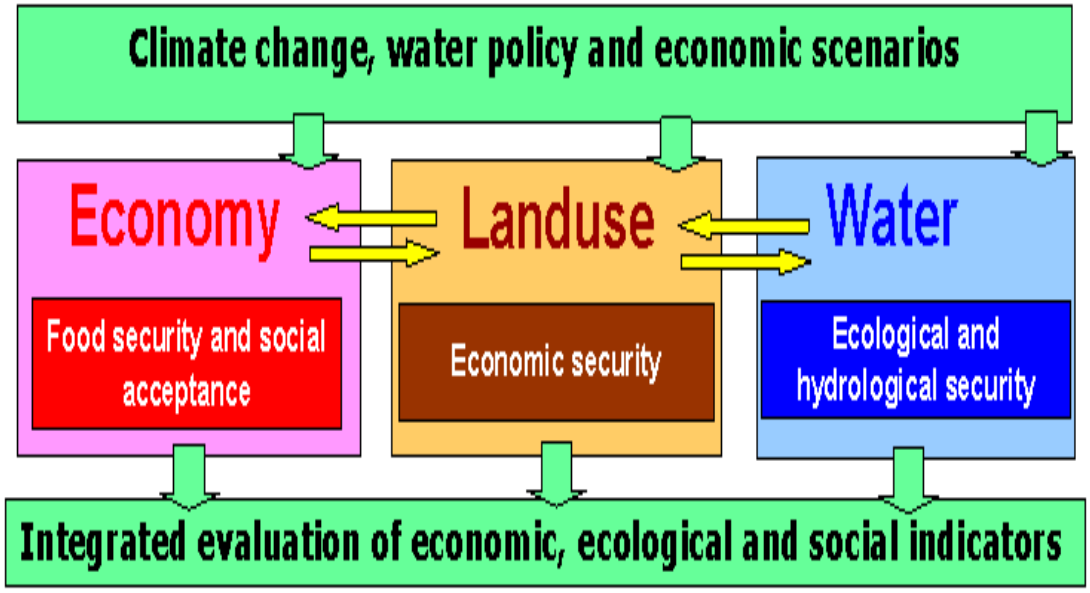
A REGIONAL MODEL FOR INTRGRATED WATER MANAGEMENT IN TWINNED RIVER BASINS (RIVERTWIN) – CHIRCHIK-AHANGARAN BASIN

- HBV - runoff formation model
- HydRWT - water-energy model
- QUAL-Chirchik - ecological model
- Reqwat - agricultural water use module
- SEM - economic block
- DB - scenarios and data (climatic block, water block, land use, hydropower,…)
- Interface – input dada, scenario selection (Business as Usual Optimistic, from user), visualization and analysis of the results

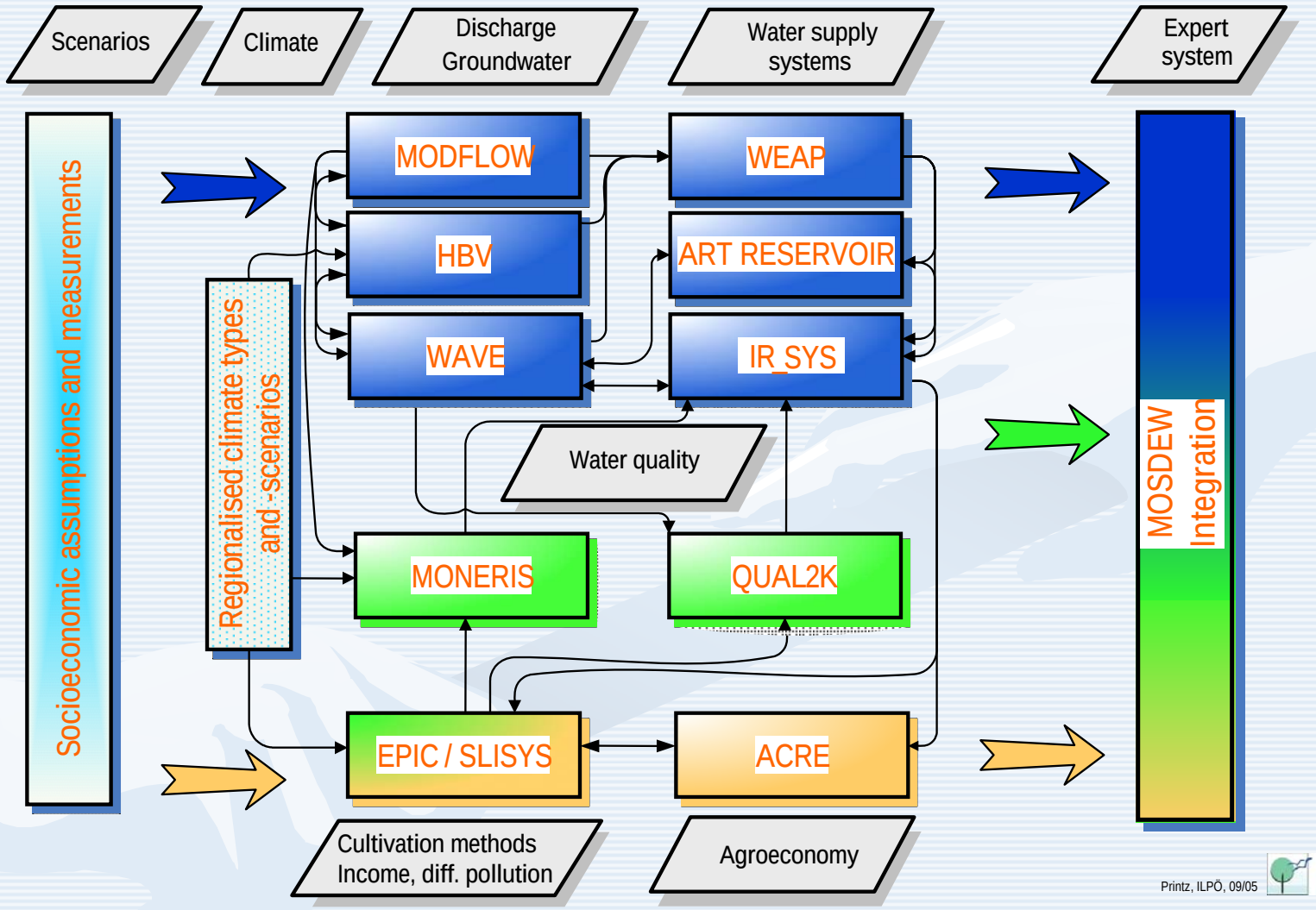
Chirchik-Ahangaran basin is an object of management, natural-anthropogenic system, consists of following sub-systems:

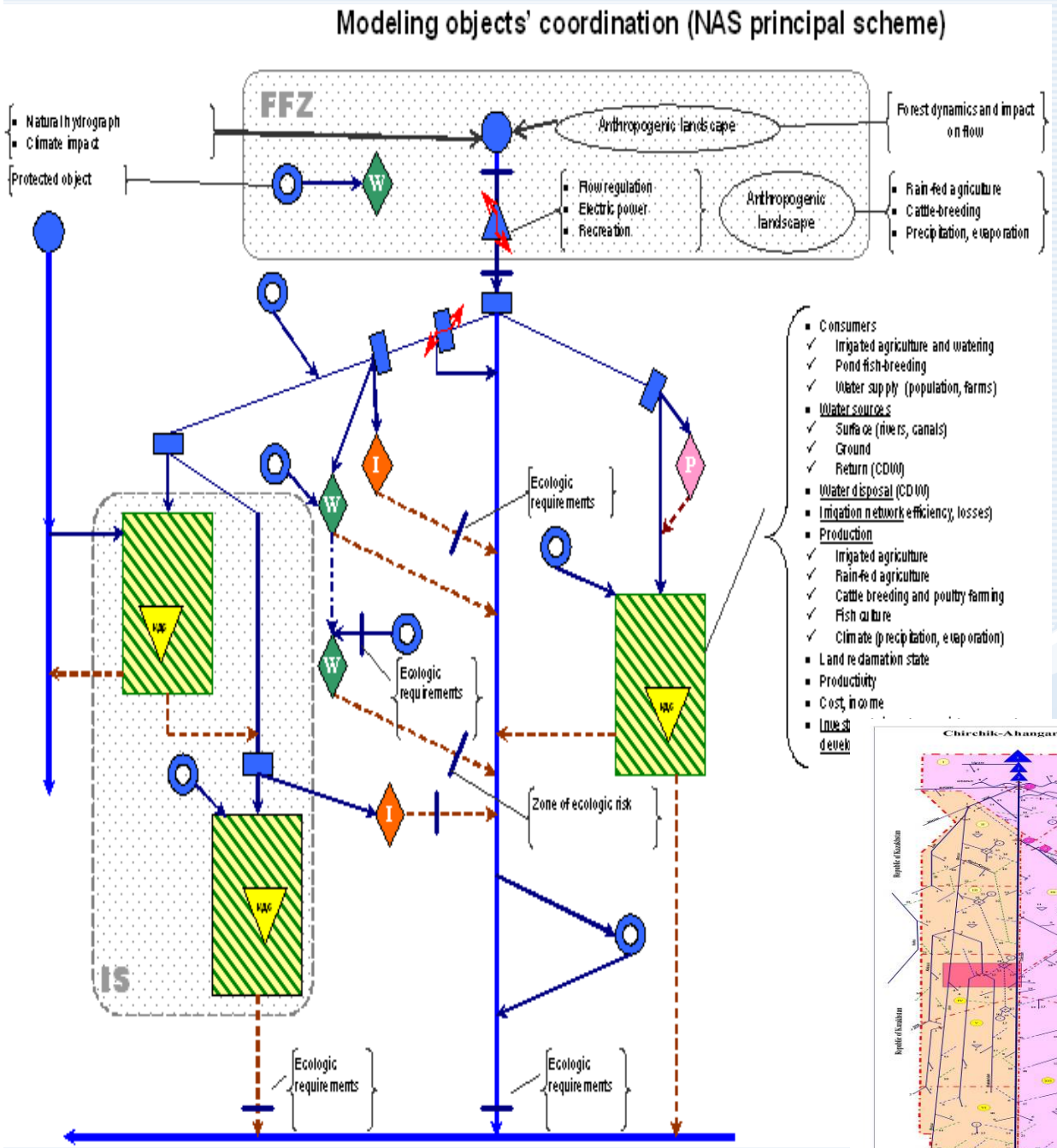
- Water resources formation
- Water resources distribution
- Water resources use
- Water resources protection



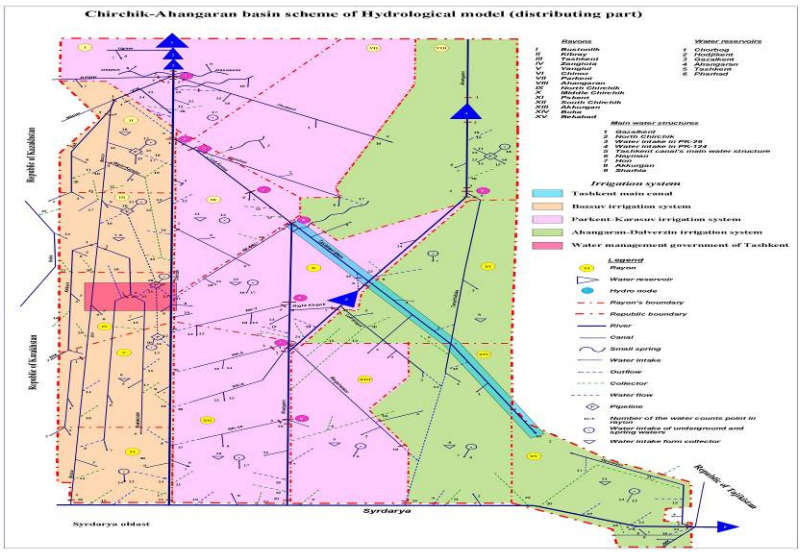


INTEGRATED COUPLING SCHEME CHIRCHIK RIVER BASIN

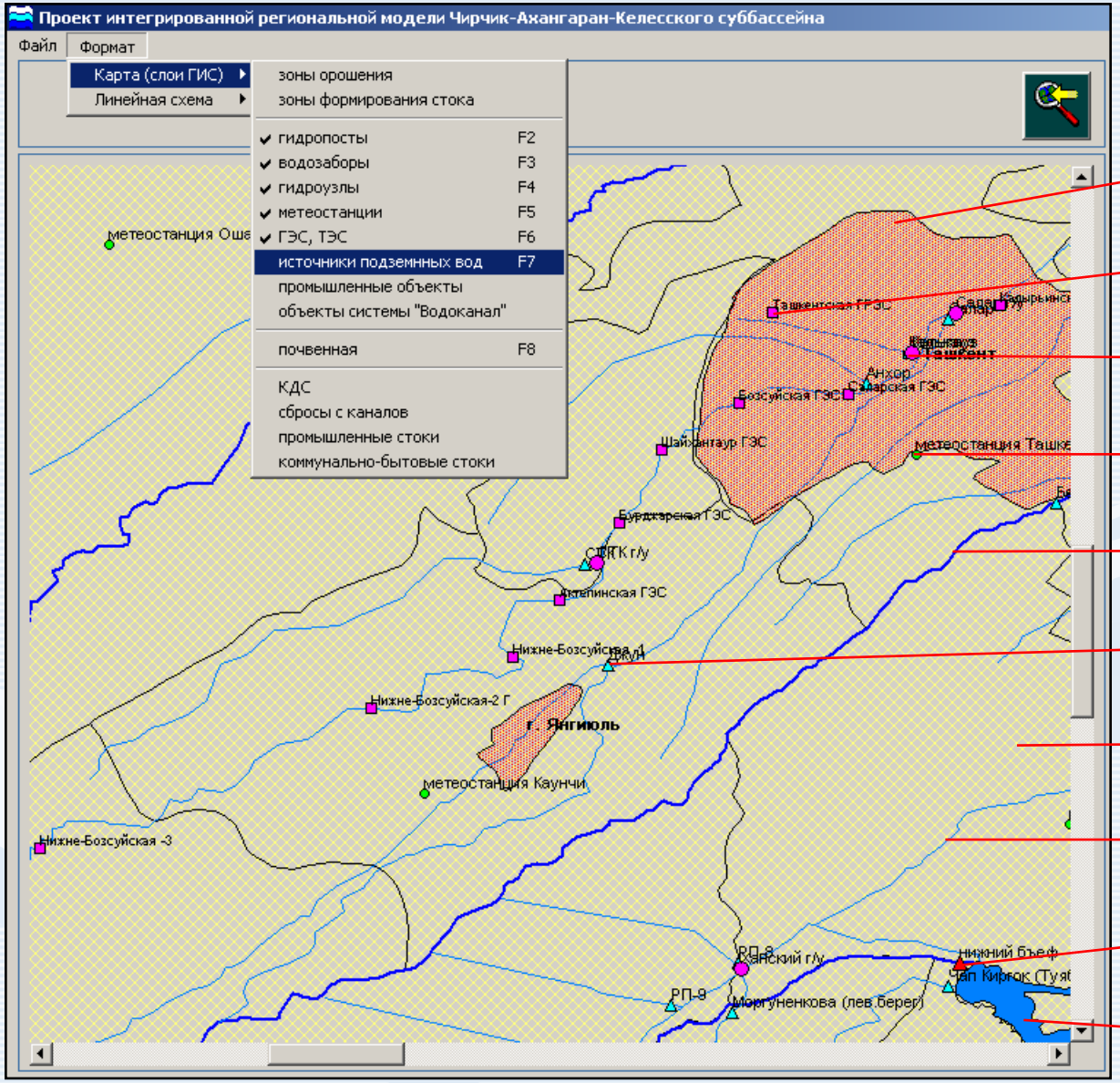




- water formation zones
- ground water deposits
- rivers
- reservoirs
- irrigation systems
- water works
- power station
- cities
- wastes



GIS layers in the interface window (RIVERTWIN)



TOWNS

HPP, TPP

STRUCTURES

METEOSTATIONS

RIVERS

INTAKES

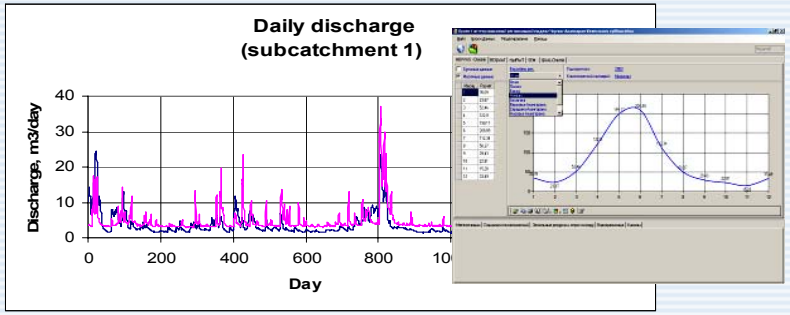
DISTRICTS

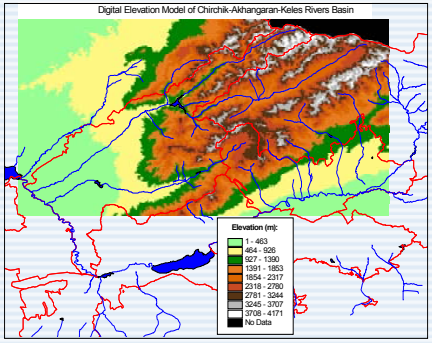
CANALS, COLLECTORS

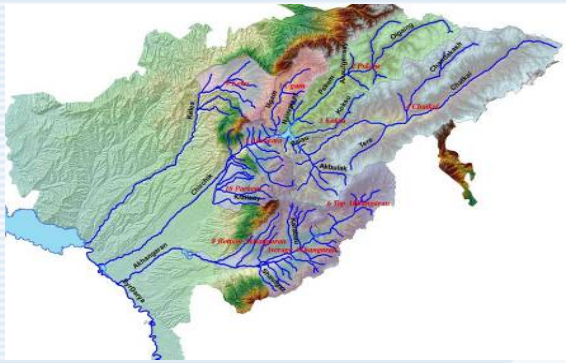
HYDROPOSTS

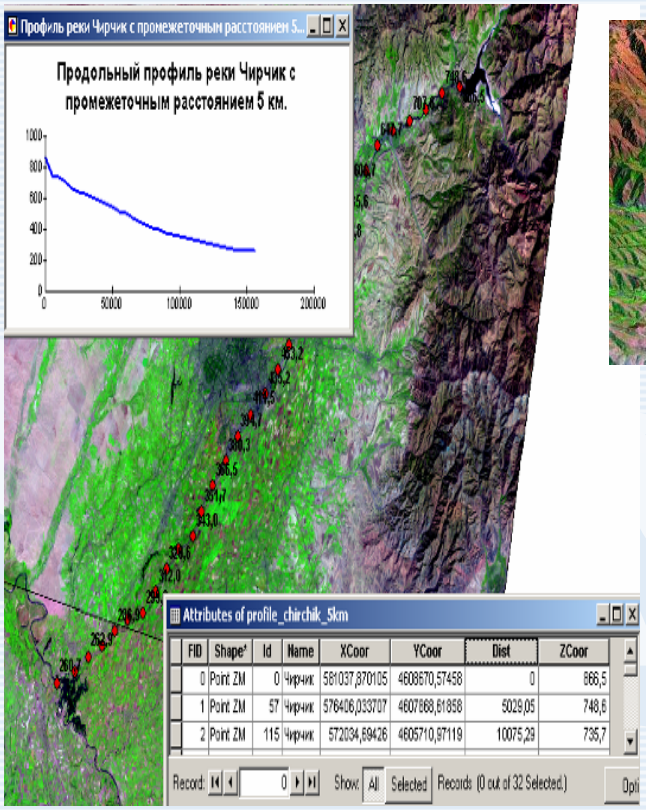
RESERVOIRS

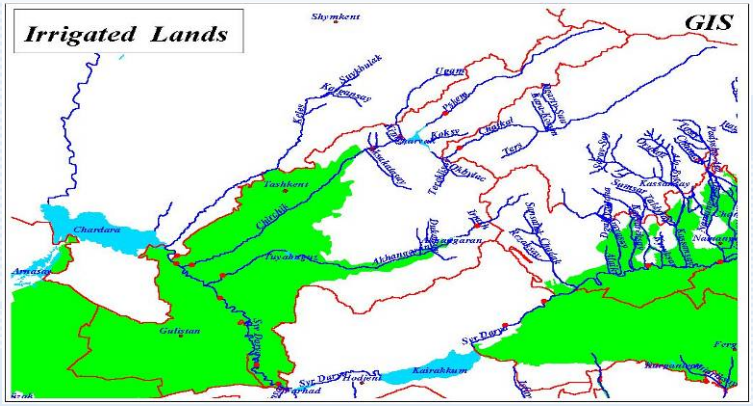
RIVERTWIN Models

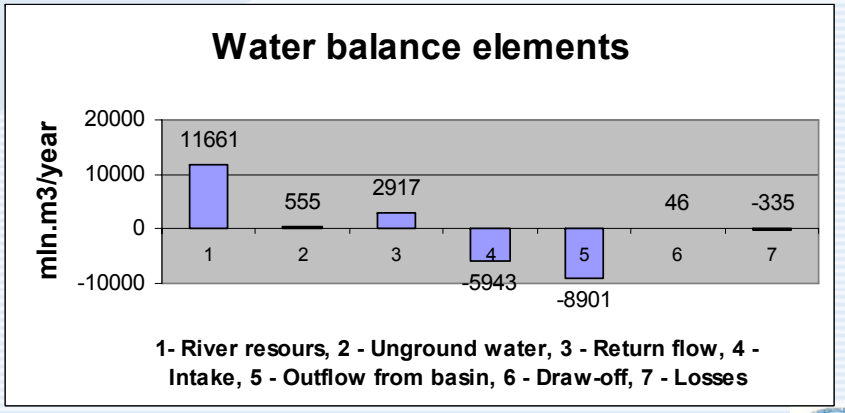










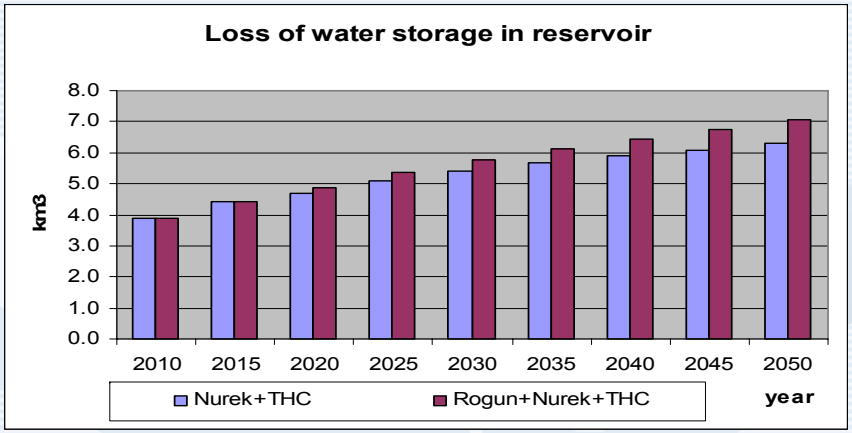


The impact of Rogun HPS (full reservoir level is 1290 m) **on economic indicators of development of the countries within the Amudarya basin for the period up to 2050 (million $/year)** / SIC ICWC, V.Dukhovny, A.Sorokin

Scenarios for a joint operation of Rogun and Nurek HPSs	Increase (+) and decrease (-) of production of irrigated farming	Effect of electricity generated at Rogun HPS	Total effect in the basin
Combined	+ 19	195	214
Irrigation	+ 57	188	245
Power	**- 79**	195	116

MODELING

Combined mode:
Rogun works in a power mode and Nurek in a compensatory irrigation mode**.**
At a joint **power mode** of Rogun and Nurek, additional **damages** in irrigation are observed.



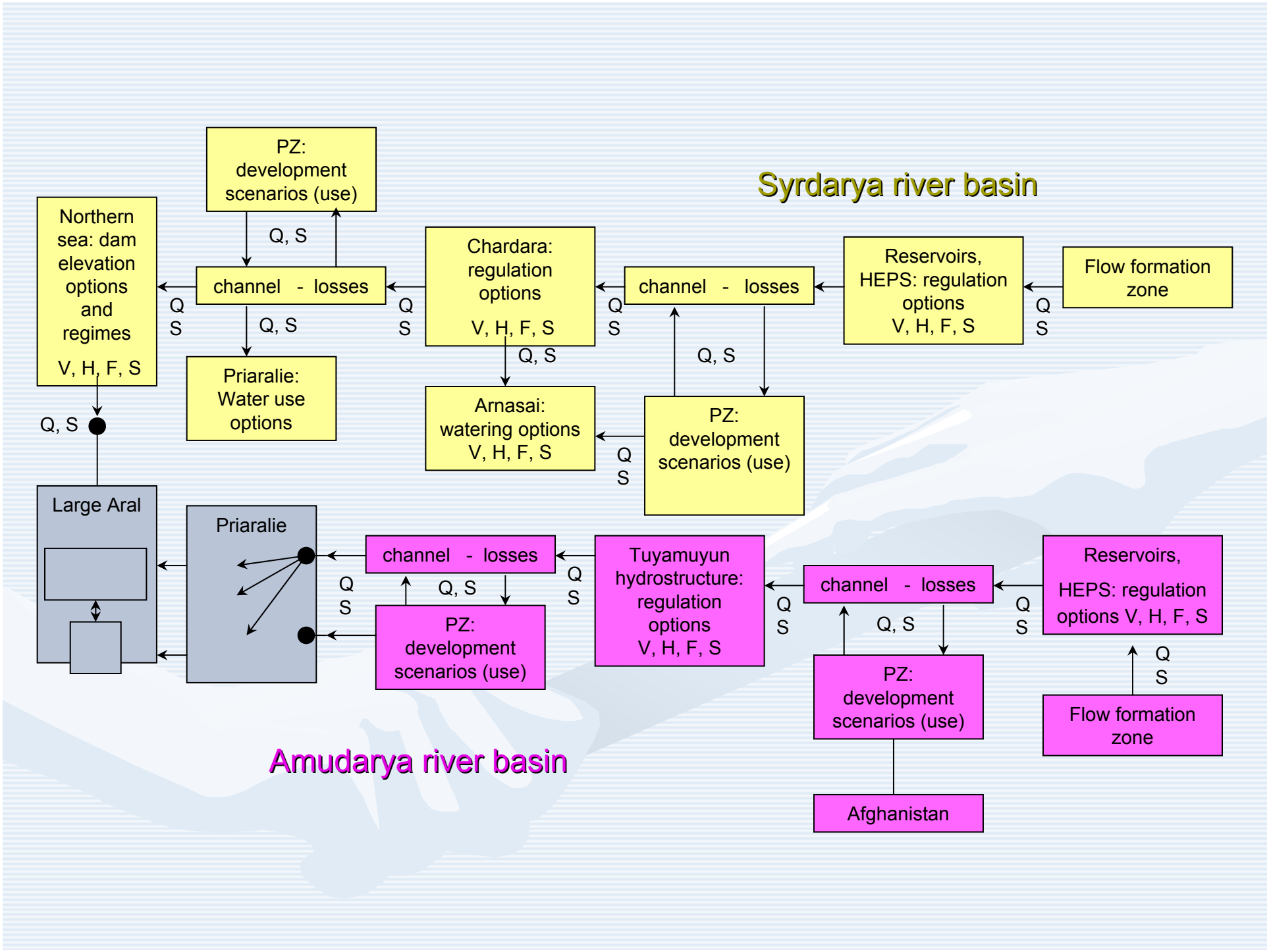
Losses of regulating capacity of reservoirs (storage losses from sedimentation) / Project INCO JAYHUN, STC 'Toza Darya', A.Sorokin

Variant 1: Nurek and Tuyamuyun

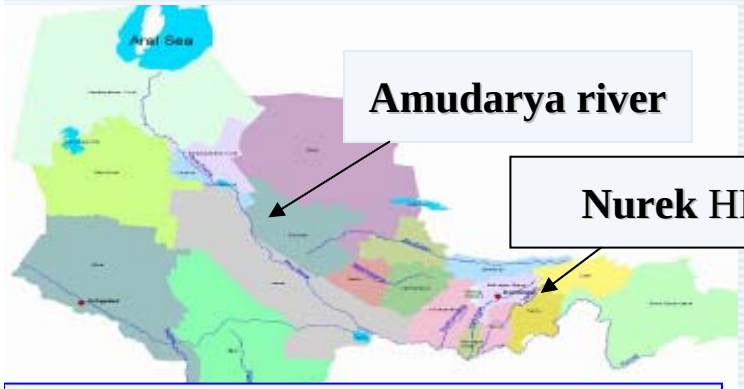
Variant 2: Rogun, Nurek, Tuyamuyun

Our approaches

- To the modeling
- To analysis of Scenarios for Future Development of the Aral Sea Basin
- To search of the alternative decisions (consensus)


Syrdarya river basin
PZ: development scenarios (use)
Q, S
Northern sea: dam elevation options and regimes
V, H, F, S
channel - losses
Q S
Q, S
Priaralie: Water use options
Chardara: regulation options
V, H, F, S
Q S
Q, S
Arnasai: watering options
V, H, F, S
channel - losses
Q S
Q, S
PZ: development scenarios (use)
Reservoirs, HEPS: regulation options
V, H, F, S
Q S
Flow formation zone
Q, S
Large Aral
Priaralie
channel - losses
Q S
Q, S
PZ: development scenarios (use)
Tuyamuyun hydrostructure: regulation options
V, H, F, S
Q S
channel - losses
Q S
Q, S
PZ: development scenarios (use)
Afghanistan
Reservoirs, HEPS: regulation options V, H, F, S
Q S
Flow formation zone
Amudarya river basin

AMUDARYA RIVER BASIN



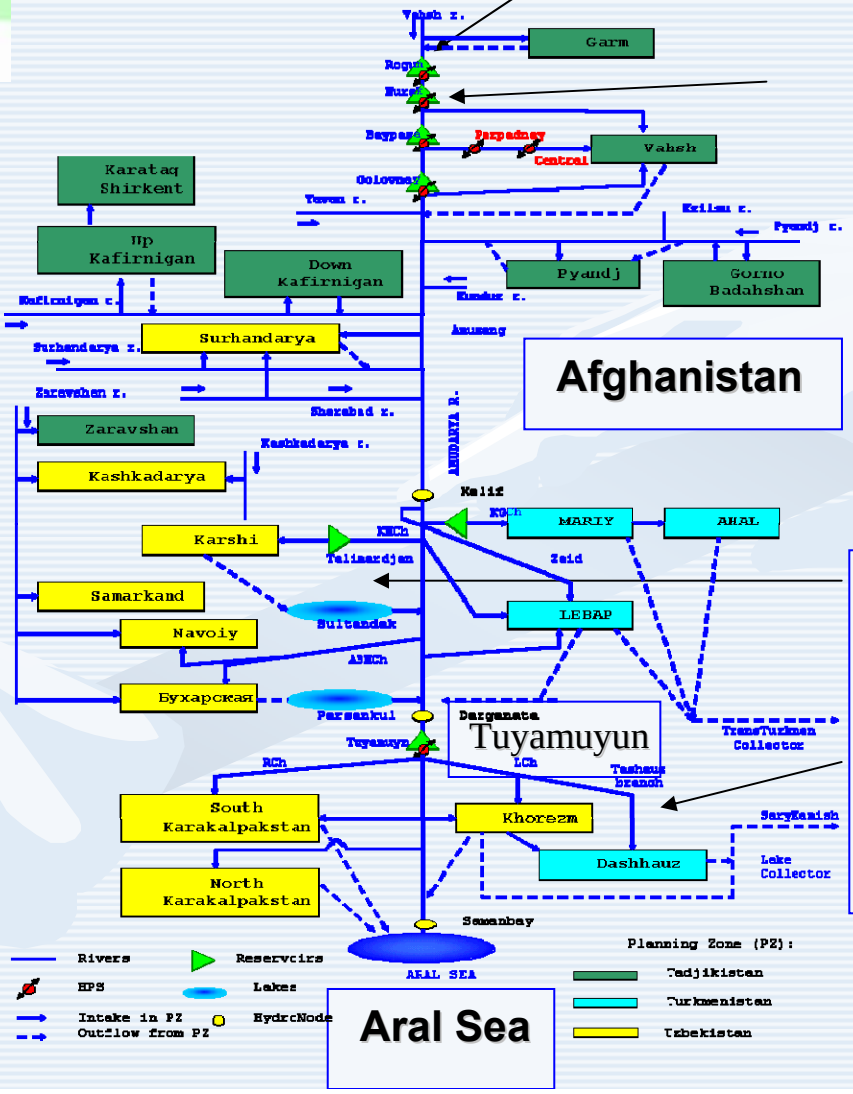
Amudarya river

Nurek HPS

Rogun – new HPS (Tajikistan)

- Contradiction of water users (hydropower, irrigation, ecology),
- Climate change,
- New water users (Afghanistan),
- Losses of regulating capacity of reservoir (sedimentation),
- Uncertainty in water losses

- Long-term agreements, **joint planning and observance of HPS modes,**
- **Automation** and dispatching of hydrological stations, improvement of forecasts,
- On-line estimation of water availability and consequences of reservoir management.

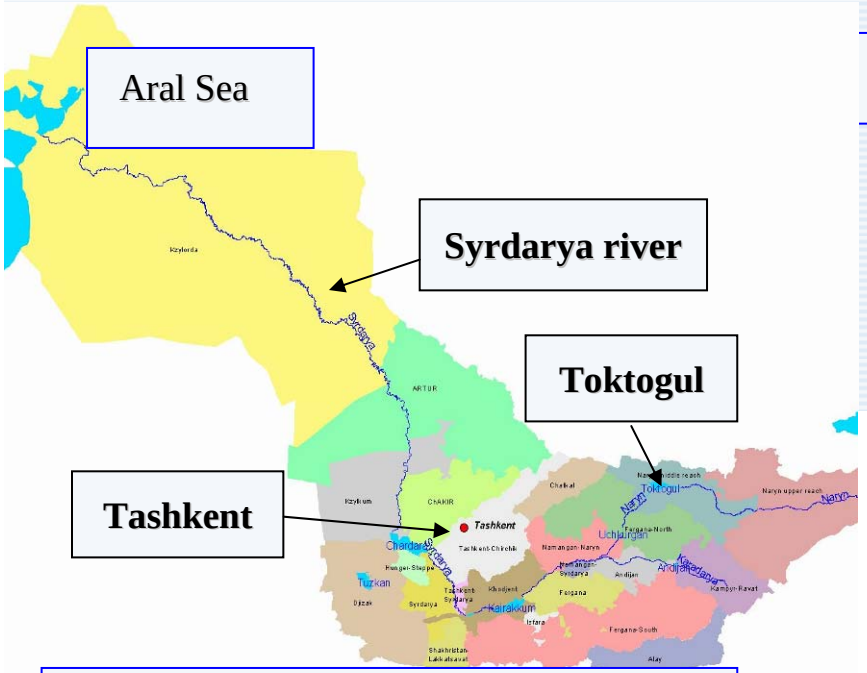


Afghanistan

Aral Sea

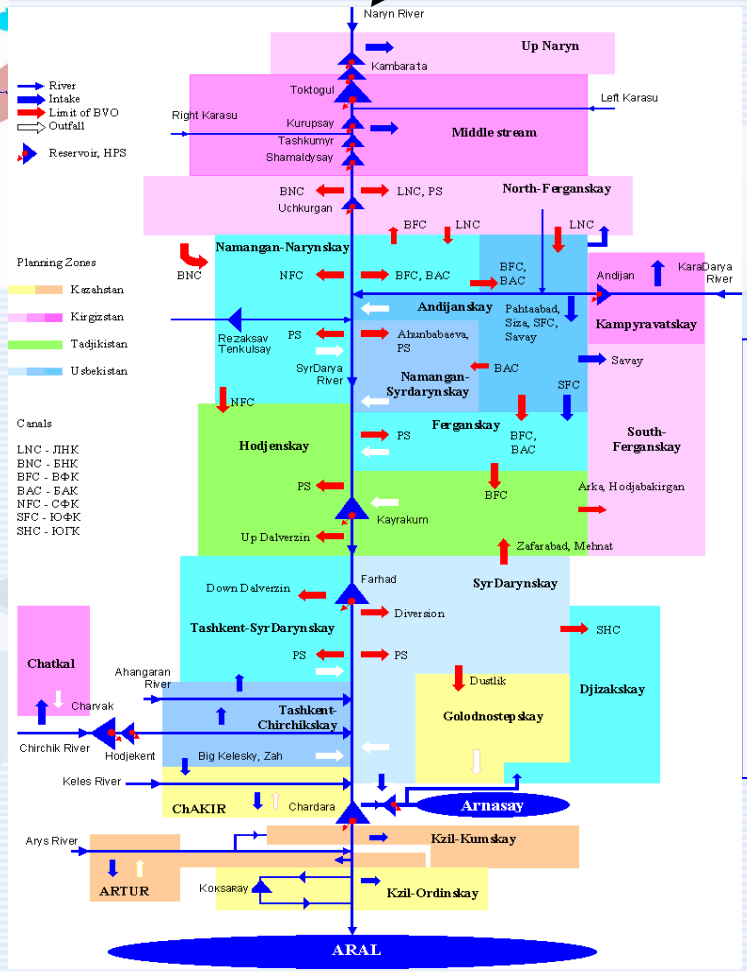
Decrease of water availability, mistakes (Turkmenistan, Uzbekistan)

SYRDARYA RIVER BASIN



Kambarata 1,2 – new HPS (Kyrgyzstan)

Toktogul HPS (Kyrgyzstan)



Decrease of water availability, mistakes (Uzbekistan, Kazahstan and Tajikistan)

- Contradiction of water users (hydropower, irrigation, ecology),
- Climate change,
- **Lack of compensating reservoirs for irrigation purposes**

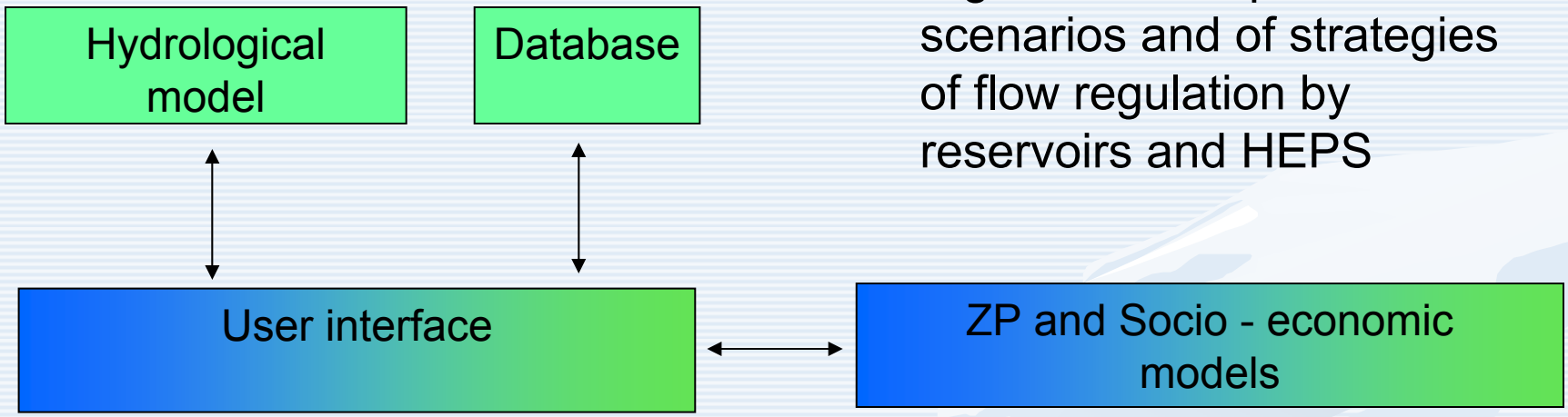
Risk of decrease in hydropower and water availability, **mistakes**

Need for:
- Regional cooperation
- IWRM decision support

Development of a set of basin models

IWRM decision support

Evaluation of national and regional development scenarios and of strategies of flow regulation by reservoirs and HEPS



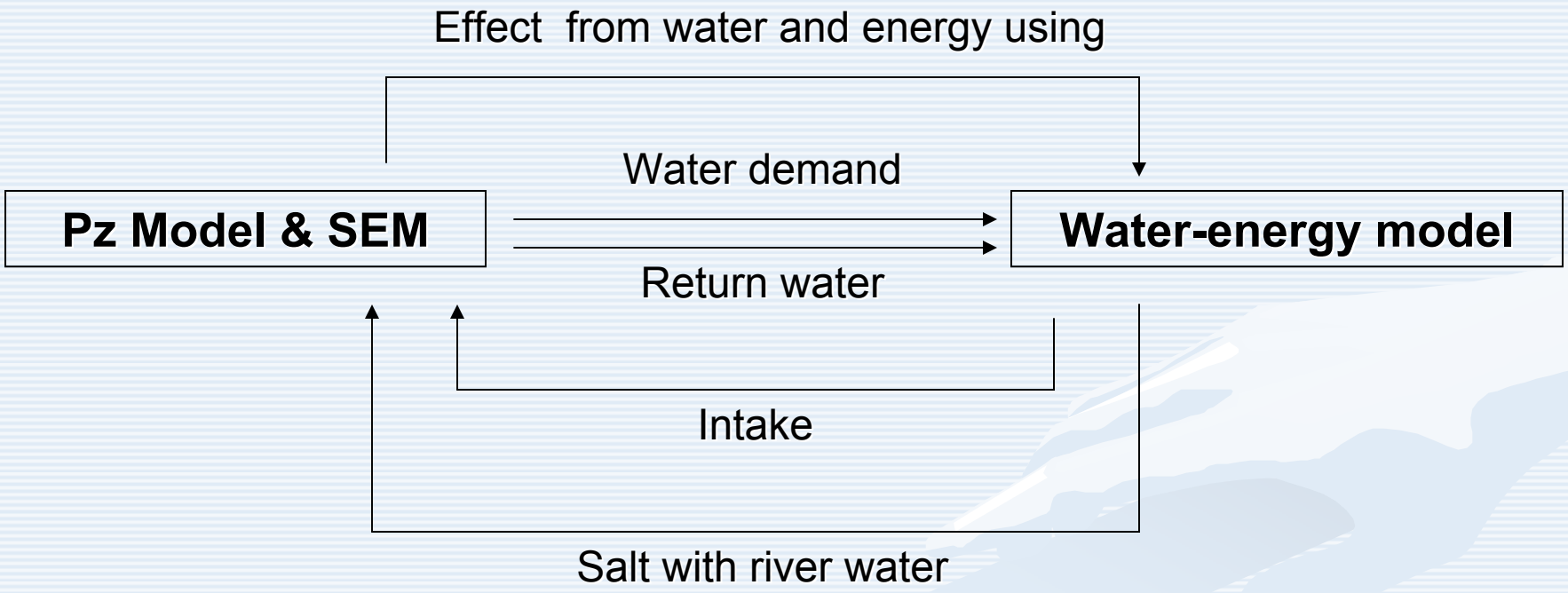
Water demands considered:

- population,
- ecosystems
- Aral Sea,
- irrigated agriculture,
- hydropower,
- industry

- Syrdarya basin
- Amudarya basin

Dedicated to special user audience
- decision makers
- researchers

Connection between models



Check on conformity

water-energy demand ⟺ **available water resource**

How to decide task ?

•The **integrated** approach + basin covering,
•A line of **criteria** + system of additional parameters,
• Hydro-**ecological** + **water-power** management,
• Orientation to **regional effect** + **minimization of damages** (in the countries, sectors).
• The compensatory mechanism

Pareto Principle:

Any change of mode, which will not cause damage, but has at least one water user gets a benefit is improve of regime

The population growth rate tends to decrease and *for 2020* it will make *0.98 %/year*

Large-scale regional integration

Unit water consumption *-9,4* thousand m*3*/ha

Rate of increase in Gross Domestic Product.

6-8% 2000-2010

8-10% 2010-2015

~ 6% 2015-2020

Unit water consumption in KhBC - *0,08* thousand m*3*/man/year *(220* l/daily*)*

Optimistic scenario

The population growth rate tends to decrease and *for 2020* it will make *1.9 %/year*

Small-scale regional integration

Unit water consumption –*12* thousand m3/ha

Rate of increase in Gross Domestic Product:

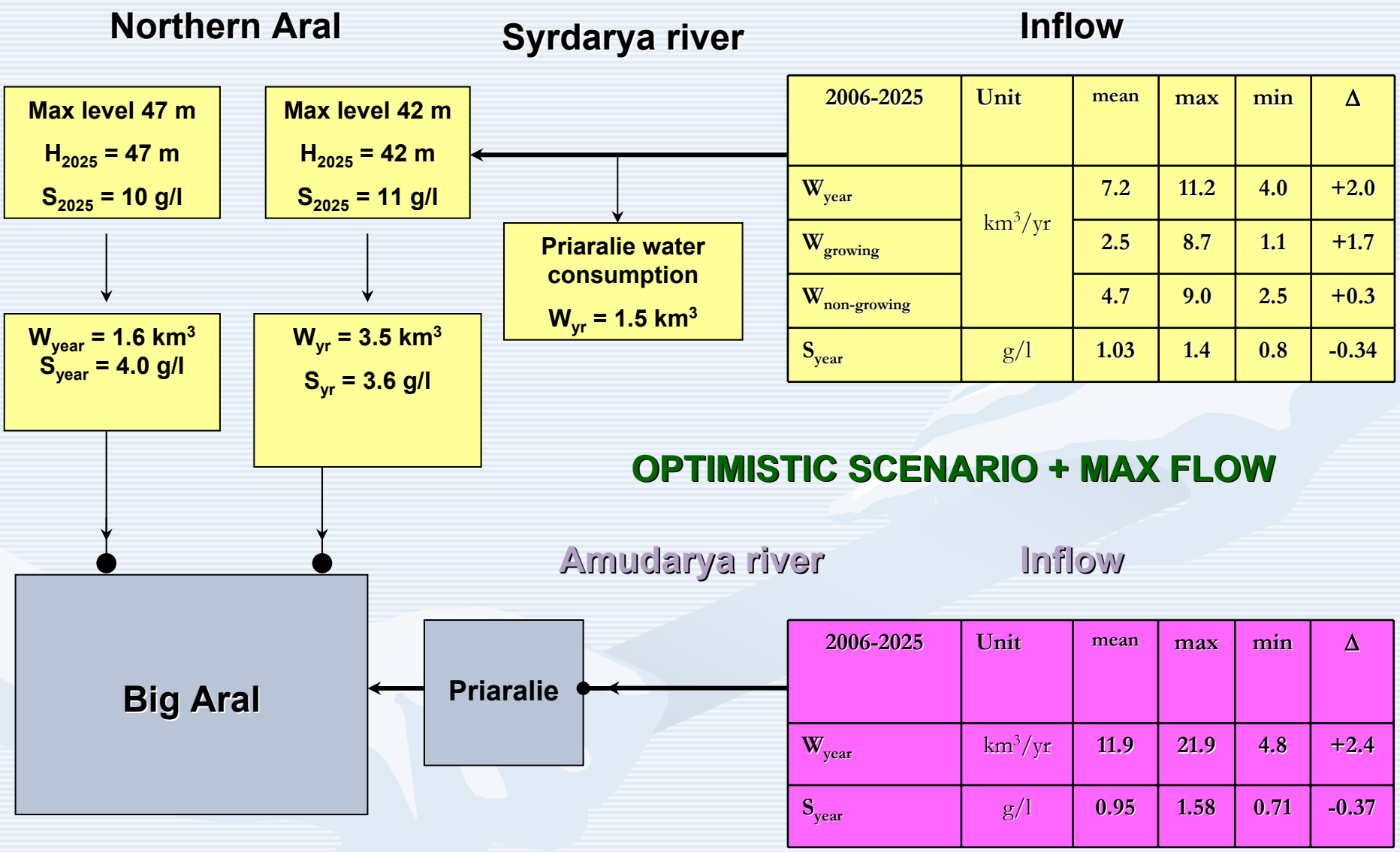
4-6% 2000-2010

6-5% 2010-2015

~ 5% 2015-2020

Unit water consumption in KhBC – *0,1* thousand m3/man/year (*280* l/daily)

Pessimistic Scenario



2006-2025	Unit	mean	max	min	Δ
W_{year}	km^3/yr	7.2	11.2	4.0	+2.0
$W_{growing}$		2.5	8.7	1.1	+1.7
$W_{non\text{-}growing}$		4.7	9.0	2.5	+0.3
S_{year}	g/l	1.03	1.4	0.8	-0.34

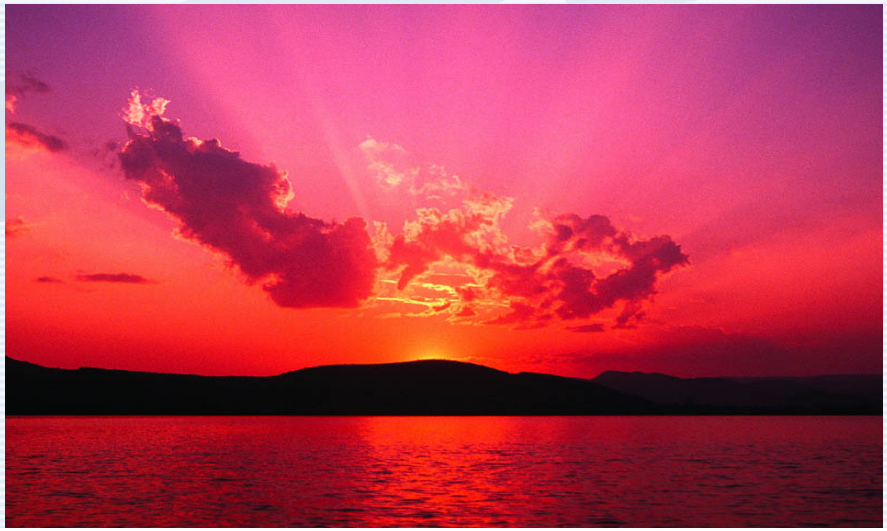
2006-2025	Unit	mean	max	min	Δ
W_{year}	km^3/yr	11.9	21.9	4.8	+2.4
S_{year}	g/l	0.95	1.58	0.71	-0.37

We can:

- collect a regional **team** from the national experts and qualified experts in modeling,
- build the regional integrated **model,** necessary for all (with the agreed principles of management, target functions, regional restrictions – ecology, etc., and also with obligations to achieve the general development potentials – water conservation, energy saving, allocation of water for the environment, etc.),
- and create necessary **informational support**.

THANK YOU for ATTENTION !

www.cawater-info.net



Aral sea. Evening