



# **Aral Sea BEAM – A **decision support system** combining hydrology and economics**

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# BEAM – its scope

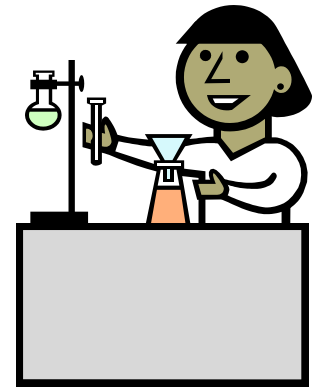
- EC IFAS/USAID (2011-2012), WB (2013-)
- Covers **Aral Sea Basin**; includes important reservoir and hydropower facilities in the basin
- **Benefits sharing** in focus through optimization of economic welfare – basin wide and/or by individual country
- Water uses include **irrigation**, **hydropower**, industry, domestic use, and nature (flows to the Aral Sea and other terminal lakes)
- It explores ways to improve the **3 E's** (Effectiveness, Efficiency, Equity) – they address questions raised by key stakeholders in water resource management in the region
- Model routes water through the river system using economic **optimization** criteria (programmed in GAMS)

# BEAM – combines hydrology and economics



# BEAM – is a decision support system

- It may be used by **policy makers, researchers and others** when
  - Negotiating about water allocation
  - Considering major investment projects in the water, food and energy sectors
  - Exploring consequences of climate change for the economic development in the basin
  - ...



# BEAM – optimizes **economic welfare**

- Optimization is used to allocate water across space and time to **maximize economic welfare subject to constraints**
  - Basin-wide welfare is defined as the sum of economic welfare added in the agriculture and energy sectors
  - Economic welfare in agriculture is measured in terms of value added
  - Economic welfare in the energy sector is measured as the sum of producers and consumers surplus
- **Decision variables** in objective function developed are crop areas and water use (by crop type) and reservoir/hydropower releases, and construction of new thermal power facilities
- **Constraints** are many, including agricultural production constraints, energy market integration constraints and individual country optimization (constraints on the extent of regional cooperation)
- Environmental, domestic, and industrial water uses are implemented as constraints

# How does BEAM investigate questions?

- Questions are investigated through **scenarios**
  - A scenario is a set of model assumptions
- Various **assumptions** may be modified by the user, including:
  - Gas prices
  - Crop sales prices
  - Hydrological conditions
  - New reservoirs and hydropower facilities
  - Level of investments in irrigation efficiency improvements
  - Nukus agreement
  - Market and land reforms
  - WSS investment costs

# BEAM – allows scenarios and sensitivity analyses

BEAM - Basin Economic Allocation Model    All queries    New query

## New query

Name of query

Crop prices (USD/ton)	
Cotton	<input type="text" value="1000.0"/>
Wheat	<input type="text" value="300.0"/>
Rice	<input type="text" value="500.0"/>
Alfalfa	<input type="text" value="100.0"/>
Vegetables	<input type="text" value="40.0"/>
Fruit	<input type="text" value="450.0"/>
Other	<input type="text" value="75.0"/>

Electricity price (USD/MWh)	
m1	<input type="text" value="37.0"/> <input type="text" value="70.0"/>
m2	<input type="text" value="37.0"/> <input type="text" value="65.0"/>
m3	<input type="text" value="35.0"/> <input type="text" value="60.0"/>
m4	<input type="text" value="35.0"/> <input type="text" value="50.0"/>
m5	<input type="text" value="34.0"/> <input type="text" value="40.0"/>
m6	<input type="text" value="32.0"/> <input type="text" value="30.0"/>
m7	<input type="text" value="30.0"/> <input type="text" value="30.0"/>
m8	<input type="text" value="30.0"/> <input type="text" value="40.0"/>
m9	<input type="text" value="32.0"/> <input type="text" value="50.0"/>
m10	<input type="text" value="33.0"/> <input type="text" value="55.0"/>
m11	<input type="text" value="34.0"/> <input type="text" value="60.0"/>
m12	<input type="text" value="35.0"/> <input type="text" value="65.0"/>

Nature extra (mm <sup>3</sup> /year)	
Aral North	<input type="text" value="1000.0"/>
Aral South	<input type="text" value="3000.0"/>
Golden Lake	<input type="text" value="500.0"/>

**Flexible crops**

Cotton	<input checked="" type="checkbox"/>
Wheat	<input checked="" type="checkbox"/>
Rice	<input checked="" type="checkbox"/>
Alfalfa	<input checked="" type="checkbox"/>

**New reservoirs in use**

Dashtijum	<input type="checkbox"/>
Rogun	<input type="checkbox"/>
Kambarata	<input type="checkbox"/>
Yavan	<input type="checkbox"/>
Naryn cascade	<input type="checkbox"/>
Vakhsh cascade	<input type="checkbox"/>

Rainfall base year	
<input type="text" value="Dry (2000/2001)"/>	↓

**Demography**

<input type="text" value="Baseline (2009)"/>	↓
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**Reservoir operation**

<input type="text" value="Optimized"/>	↓
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**Irrigation investments**

<input type="text" value="None"/>	↓
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**Baseline Toktogul and Nurek**

<input type="text" value="Base year discharge"/>	↓
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**Flexible crop flexibility**

<input type="text" value="Medium"/>	↓
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**Input prices (% of baseline)**

Labor	<input type="text" value="100.0"/> %
Capital	<input type="text" value="100.0"/> %
Fertiliser	<input type="text" value="100.0"/> %
Diesel	<input type="text" value="100.0"/> %

# BEAM – facilitates reporting

- Excel output format facilitates flexible reporting of results

- Comparison of baseline and economic optimum
- Comparison of baseline and economic optimum with water scarcity

