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Basin Economic Allocation Model (BEAM): An economic model of water use developed for the Aral Sea Basin

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The water resources of the Aral Sea basin are under increasing pressure, particularly from the conflict over whether hydropower or irrigation water use should take priority. The purpose of the BEAM model is to explore the impact of changes to water allocation and investments in water management infrastructure on the overall welfare of the Aral Sea basin.

The BEAM model estimates welfare changes associated with changes to how water is allocated between the five countries in the basin (Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan and Uzbekistan; water use in Afghanistan is assumed to be fixed). Water is allocated according to economic optimization criteria; in other words, the BEAM model allocates water across time and space so that the economic welfare associated with water use is maximized. The model is programmed in GAMS.

The model addresses the Aral Sea Basin as a whole – that is, the rivers Syr Darya, Amu Darya, Kashkadarya, and Zarafshan, as well as the Aral Sea. The model representation includes water resources, including 14 river sections, 6 terminal lakes, 28 reservoirs and 19 catchment runoff nodes, as well as land resources (i.e. irrigated croplands). The model covers 5 sectors: agriculture (crops: wheat, cotton, alfalfa, rice, fruit, vegetables and others), hydropower, nature, households and industry. The focus of the model is on welfare impacts associated with changes to water use in the agriculture and hydropower sectors.

The model aims at addressing the following issues of relevance for economic management of water resources:
• Physical efficiency (estimating how investments in irrigation efficiency affect economic welfare).
• Economic efficiency (estimating how changes in how water is allocated affect welfare).
• Equity (who will gain from changes in allocation of water from one sector to another and who will lose?).

Stakeholders in the region have been involved in the development of the model, and about 10 national experts, including staff from the International Fund for Saving the Aral Sea (IFAS), have been trained in using the model. The model is publicly accessible through a web-based user interface that allows users to investigate scenarios and perform sensitivity analyses.

Preliminary results suggest that:
1. At the margin, hydropower water use increases basin-wide welfare more than irrigation water use.
2. Under normal or average hydrological conditions, water scarcity is not a significant problem in the basin.
3. Under dry hydrological conditions, water scarcity is significant. Under these conditions, preliminary results suggest that cotton irrigation is less effective than other uses, particularly in Turkmenistan.
4. Investments in irrigation efficiency can have a significant impact on the effectiveness of water use for irrigation, thereby increasing the welfare of irrigation regions during dry periods.