



RESEARCH
PROGRAM ON
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How would the Rogun Dam affect water and energy scarcity in Central Asia?

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Water-Energy-Food Nexus problem in the Amu Darya Basin

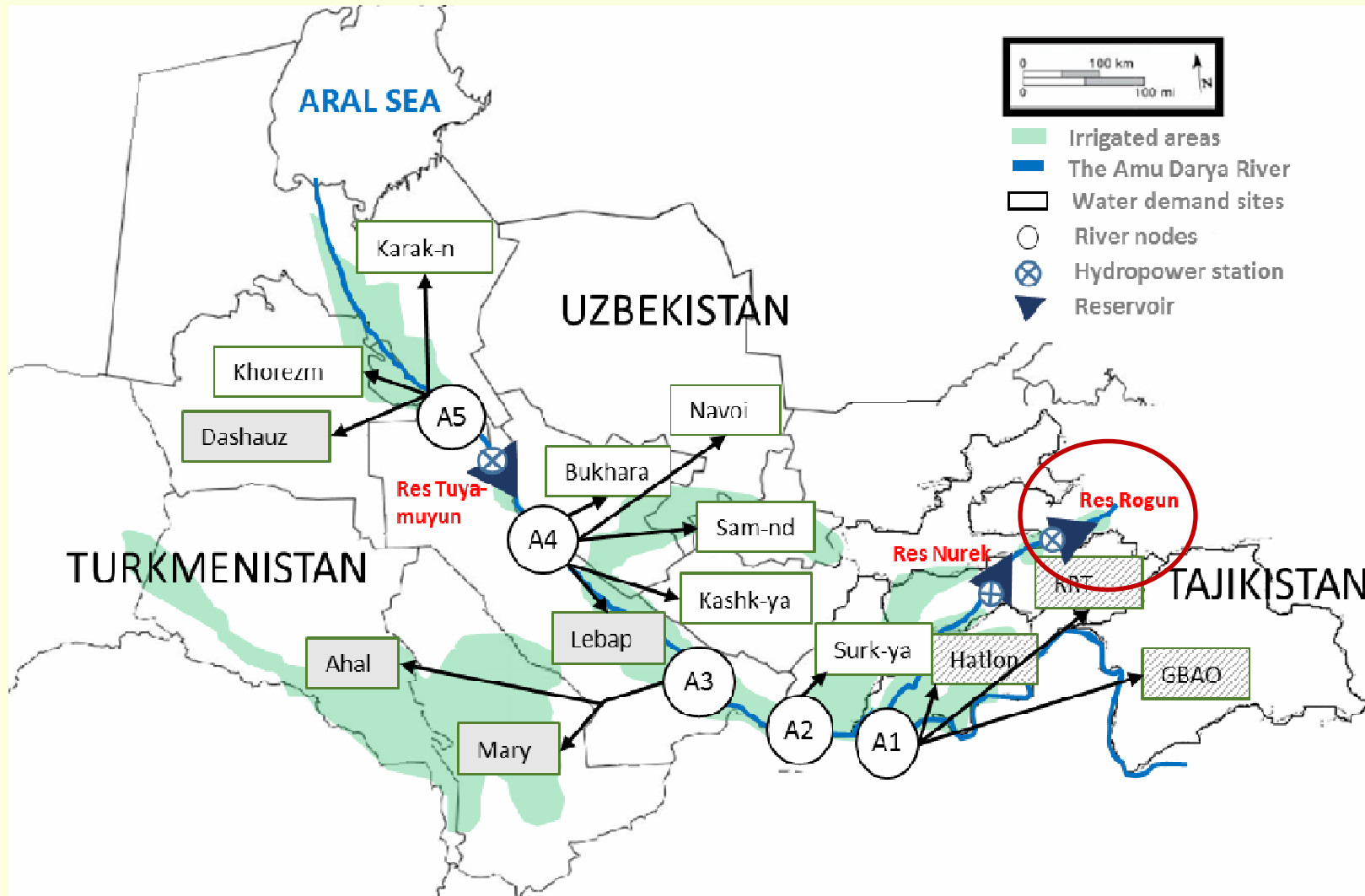
Before 1991:

- Upstream dams were constructed to provide stable water supply for downstream irrigation in summer
- Additional hydropower in summer was delivered to downstream and downstream countries compensated it with gas and coal in winter

After 1991:

- Weakened economic relationships between the riparian countries, problems in in-time payment
- Using upstream reservoirs for increased hydropower production in winter leaving less water in storage for downstream irrigation in summer

River node scheme of the Amu Darya Basin



Source: Bekchanov et al. 2015

Method

A static hydro-economic model of IFPRI (Ringler et al 2004) modified and adapted to the case of the Amu Darya Basin

All economic costs and benefits are at price levels of 2006

Crop-specific
Inter-regional
Seasonal

Objective function:

Irrigation benefit

$$w^{IRR} \cdot \sum_c \sum_r (Price_{c,r} Output_{c,r}(Water_{c,r}) - Costs_{c,r}) +$$

Hydropower
production benefit

$$w^{ENR} \cdot \sum_h \sum_s Energy_{GM}_{h,s} hydropower_prod_{h,s}(Tur_Flow_{h,s}) +$$

Environmental
flow benefit

$$environ_ben_per_water \sum_s environ_flow_s \rightarrow \max$$

c-crop, r-region

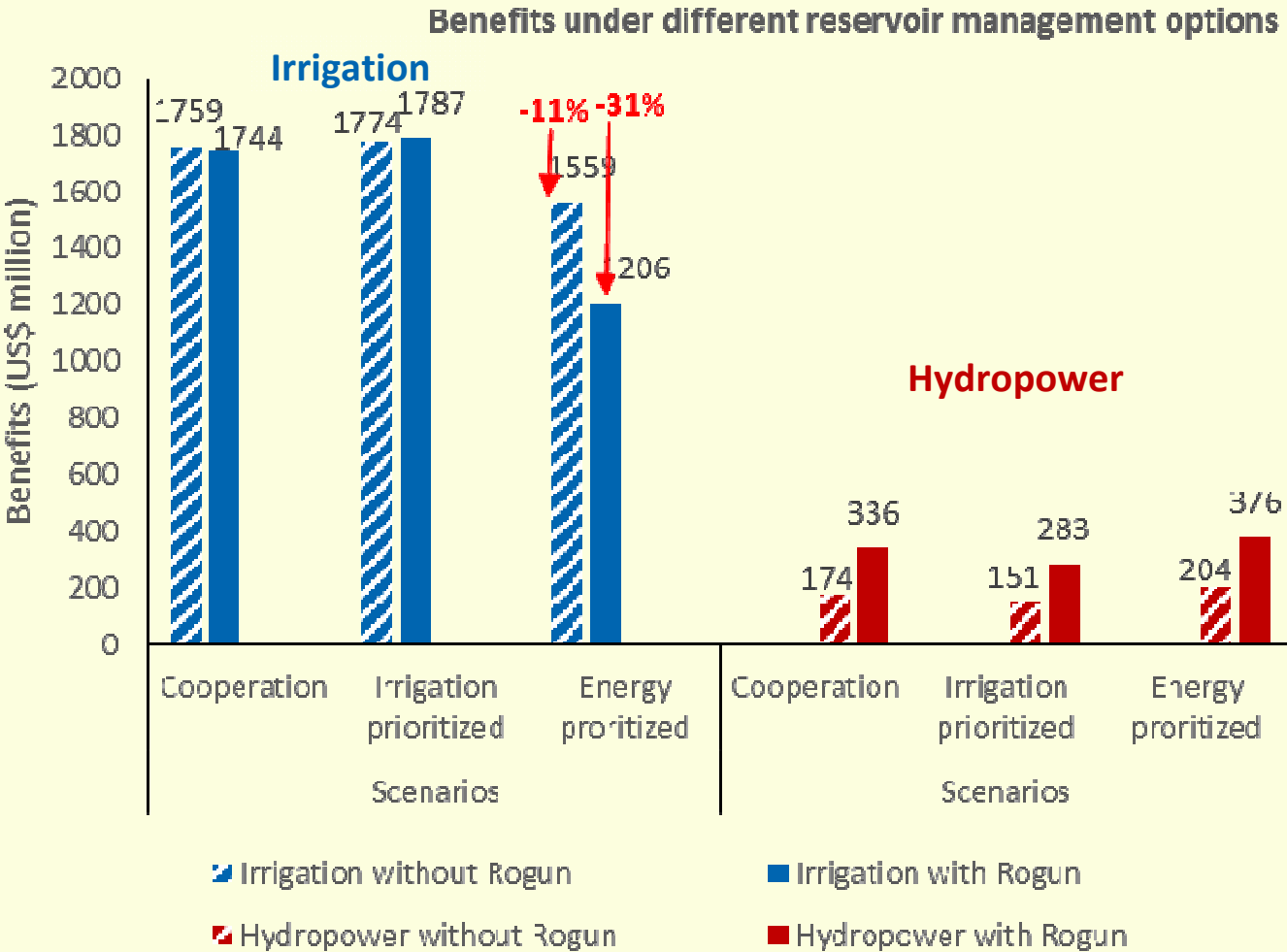
h-hydropower station, s-season (month)

Source: Bekchanov et al. 2015

Main components in the model:

- Water flow and uses along the river
- Crop production and revenues depending on cropland pattern and water uses (surface, ground, return flow)
- Detailed surface, ground, drainage water linkages at conveyance and at field level
- Hydropower production and revenues depending on reservoir water releases
- Reservoir head and water volume relationships
- Environmental flow and benefits

Trade-offs of water uses between irrigation and power production



Source: Bekchanov et al. 2015

Conclusions:

- No considerable additional irrigation benefits from Rogun dam even if irrigation is prioritized
- Unilateral approach to water use to achieve additional energy production gains by prioritizing upstream hydropower production comes at much higher irrigation benefit losses (-11 to -30%)
- Further vulnerability (to achieve political gains), safety (earthquakes and consequent flooding), highly lowering costs of solar power technology may also reduce attractiveness of investing in big hydropower production projects
- Cooperation in the Amu Darya basin is more essential to improve food and energy security than hydraulic developments