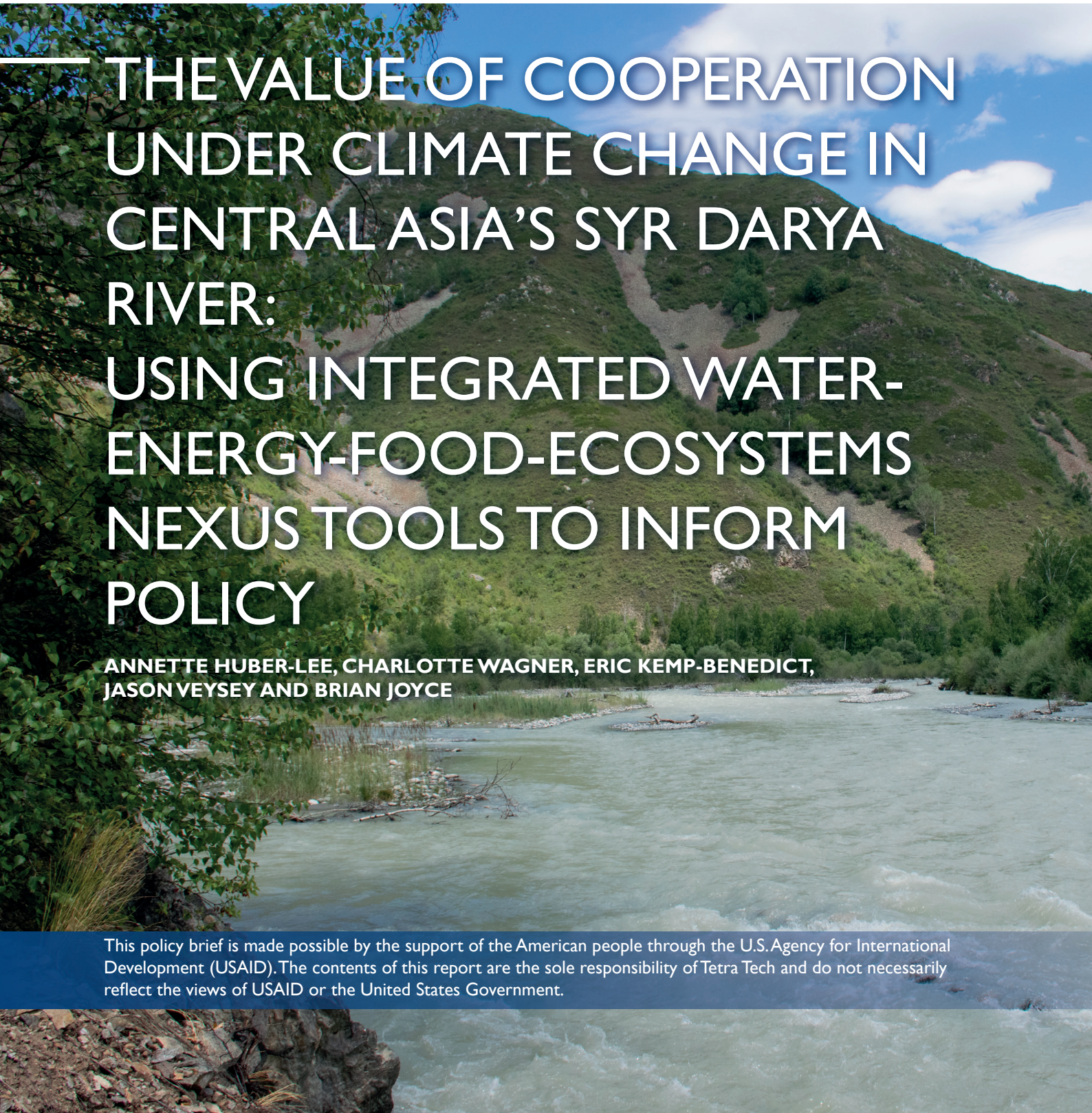

THE VALUE OF COOPERATION UNDER CLIMATE CHANGE IN CENTRAL ASIA'S SYR DARYA RIVER: USING INTEGRATED WATER-ENERGY-FOOD-ECOSYSTEMS NEXUS TOOLS TO INFORM POLICY

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HIGHLIGHTS

- Cooperation in the water-energy-food-ecosystems nexus among countries sharing the Syr Darya River Basin can lead to increased water availability, lower greenhouse gas emissions, and higher GDP and agricultural value added, which could improve livelihoods.
- Integrated modeling tools that capture the connections between policy and infrastructure for water, agriculture, energy and the macroeconomy yield more holistic results than traditional siloed modeling approaches, leading to better-informed decision-making on investments and improved policies.

INTRODUCTION

Over several decades starting from 1960, the total area of the Aral Sea decreased ninefold due to rapid development of agriculture, and the construction of numerous multi-purpose reservoirs and irrigation canals, among other factors. These factors, in turn, have radically changed the timing and water flow to the sea via the Syr Darya and Amu Darya River Basins. Climate change and its impacts in the region on dry periods and rainfall patterns add additional layers of stress and uncertainty to this situation.

Fostering cooperation in water-energy-food-ecosystems (WEFE) nexus planning among the five countries of Central Asia (Kazakhstan, Kyrgyz Republic, Tajikistan, Turkmenistan, and Uzbekistan) is an effective approach to mitigate the threats that this situation pose to the watershed's economy and ecosystems. According to an adelphi/CAREC review (Rethinking Water in Central Asia), Central Asian (CA) countries lose USD 4.5 billion annually in three categories: agricultural losses, inefficient electricity trade, and lack of access to finance due to non-cooperation. **Thus, cooperation based on well-informed decision-making can bring environmental and economic benefits to the countries of the region.**

Within the framework of the USAID's Regional Water and Vulnerable Environment Activity, integrated modeling was applied to the Syr Darya River Basin, accounting for the complex connections between water, food, energy and ecosystems and how they play out in the macroeconomy to support better decision-making for greater stability, economic prosperity, and healthy ecosystems. These models and findings were shared with local experts to ensure their ability to apply similar approaches to their future work in water and natural resource management.

Traditionally, water systems have been modeled in isolation, presenting tradeoffs between water for agriculture versus water for hydropower, for example. This study used *an integrated system* of tools, such as the Low Emission Analysis Platform (LEAP); the Water and Evaluation Planning software (WEAP); and a macroeconomic module, MACRO. In combination, this approach enables users to employ a holistic view to examine resource availability to identify and inform policies and infrastructure *for maximizing benefits* for water supply, energy production and economic prosperity. This approach is called **LEAP-WEAP-MACRO**.

NARRATIVES

Together with representatives from national governments and basin stakeholders in the Syr Darya River Basin, the Regional Activity co-developed six narratives for the future development of the Syr Darya River basin for all four countries of the basin - Kazakhstan, Kyrgyz Republic, Tajikistan and Uzbekistan. Each narrative was run through four different climate projections, resulting in 24 scenarios. In this brief, three of those narratives are presented that illustrate the best examples of the advantages of integrating LEAP, WEAP and MACRO for analyzing future narratives through 2050:

- (S0) **Business as usual (BAU)**: based on existing policies and plans by the four countries, as well as a future pursuit of national interest in hydropower and agriculture expansion in the Syr Darya basin.
- (S1) **Efficiency**: improved water efficiency in agriculture, increased energy efficiency and expanded renewable energy, pursuit of climate mitigation and adaptation.
- (S2) **Cooperation**: Efficiency scenario and joint international planning on water, energy and agriculture.

These three narratives were modeled with and without integration across the LEAP, WEAP and MACRO models to explore the degree to which integrating water, food, and energy investments and policies can produce more realistic results and to analyze the impact of cooperation across the countries in the Syr Darya River Basin.

COMPARING RESULTS WITH AND WITHOUT WEFE NEXUS INTEGRATION

Hydropower production and irrigation timing determine water availability from hydro dams to meet different demands. Yet, standalone water and energy models typically oversimplify factors such as the availability of hydropower and how peak energy demands affect that supply. *Integrated* water and energy models can provide more realistic results and support better planning decisions.

In the integrated model, WEAP provides key inputs on annual and sub-annual variation of hydropower production, while the energy model in LEAP incorporates climate change and water scarcity impacts – factors that are typically overlooked in siloed models. For example, *integrating LEAP and WEAP* (as opposed to using LEAP only) under scenario **S2 on cooperation** in the Kyrgyz Republic shows, among other things, significantly higher water availability (+21%) for hydropower generation by 2050.

Similarly, when comparing the integrated results to using the WEAP model alone, there is a substantial difference in water storage and water availability to meet demands, particularly for irrigation. Figure 1 compares the WEAP model alone versus the integrated models (WEAP-LEAP-MACRO) for water storage across the Syr Darya River Basin. The integrated model shows significantly higher levels of storage (Figure 1), due to the more nuanced dispatch of hydropower using LEAP, revealing a 20% increase in water availability. That increase in water availability allows for more demands to be met – particularly for agriculture – shown by the increases in water delivered (Figure 2).

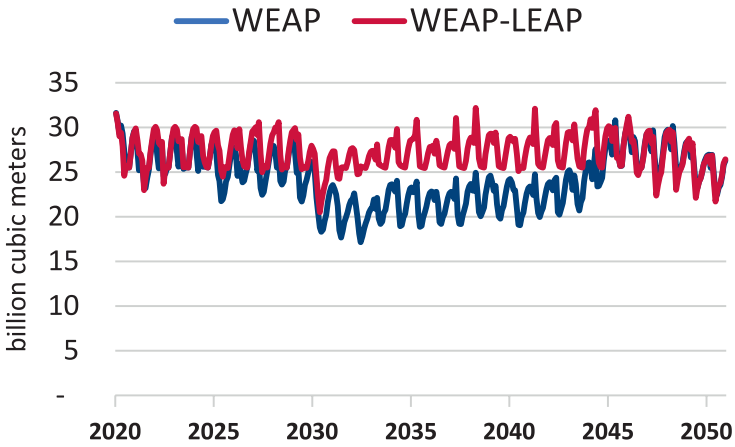

Figure 1. Comparison of water storage in billion cubic meters, with and without integration of models

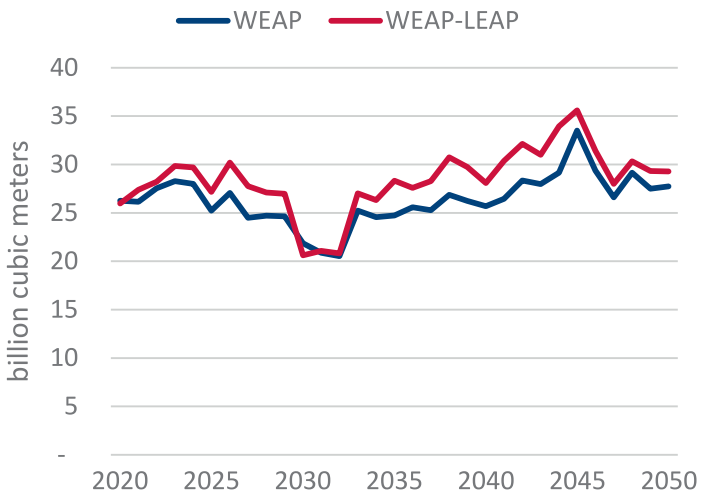

Figure 2. Comparison of water supply volumes, with and without model integration, in billions of cubic meters

IMPACT OF COOPERATION WITH INTEGRATED MODELING

The integrated approach demonstrates the value of water planning cooperation – particularly when factoring in climate change – resulting in more water for storage, greater energy availability and reduced greenhouse gas emissions by increasing the ability to generate energy through water flow rather than burning coal. For example, one of the findings is that cooperation (S2) can boost agricultural production compared to BAU (S0) for Uzbekistan, Kazakhstan and the Kyrgyz Republic through 2050.

The modeling results strongly suggest that pursuing national interests in isolation in shared basins will likely increase water stress throughout the region. To counter those stresses, implementing water and energy measures together with holistic basin planning increases water availability for agriculture and other needs while strengthening climate mitigation efforts.

Furthermore, a WEFE nexus analysis linking water, food, energy, ecosystems and economy can provide the following useful policy insights:

1. Central Asia's hydropower is best studied *in a linked energy-water model that* encompasses competing water demands and alternative energy supplies;
2. Integrated modeling demonstrates *the economic consequences* of climate-related constraints on agricultural production;
3. Economic analysis expands the scope of water and energy planning to *encompass the whole economy,* including the benefits of using resources more efficiently.

In summary, resource planning with a WEFE nexus approach can increase the resilience of the region, incorporating the competing demands and requirements of different sectors while also improving each sector. Integrated tools like WEAP, LEAP and MACRO possess great value for decision-makers, helping chart the path toward improved economic outcomes and provide strong evidence to support cooperation.

For more information on this research, please visit:

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Key Documents

Password: usaidwave2021

USAID Regional Water and Vulnerable Environment Activity

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