WEF Nexus Modeling: Applying PyWR in Central Asia

Bunyod Holmatov, PhD
Researcher – Data Analysis and Innovation in Water Management
December 4, 2023
Islamabad, Pakistan
Central Asia

Covers five former Soviet Republics;
Total pop – 76 million

2022 GDP

<table>
<thead>
<tr>
<th>Country</th>
<th>GDP/cap (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tajikistan</td>
<td>1,050</td>
</tr>
<tr>
<td>Kyrgyz Republic</td>
<td>1,600</td>
</tr>
<tr>
<td>Uzbekistan</td>
<td>2,250</td>
</tr>
<tr>
<td>Turkmenistan</td>
<td>7,300</td>
</tr>
<tr>
<td>Kazakhstan</td>
<td>11,200</td>
</tr>
</tbody>
</table>

Data source:

Image source: https://astanatimes.com/2017/05/central-asian-integration-more-real-than-ever/
Central Asia (cont’d)

Image source: http://www.cawater-info.net/infographic/index_e.htm
Central Asia and Pakistan

- Large water consumption by agriculture (WB, 2023):

<table>
<thead>
<tr>
<th>Ag freshwater withdrawals (% of total freshwater)</th>
<th>2018 value</th>
<th>2019 value</th>
<th>2020 value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pakistan</td>
<td>94%</td>
<td>94%</td>
<td>94%</td>
</tr>
<tr>
<td>Uzbekistan</td>
<td>92%</td>
<td>92%</td>
<td>92%</td>
</tr>
<tr>
<td>Turkmenistan</td>
<td>94%</td>
<td>59%</td>
<td>61%</td>
</tr>
</tbody>
</table>


- Downstream Central Asian countries have a high dependence on external water resources

- Similar water stress levels:

<table>
<thead>
<tr>
<th>Level of water stress</th>
<th>2020 freshwater withdrawal as proportion of available freshwater resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pakistan</td>
<td>116</td>
</tr>
<tr>
<td>Uzbekistan</td>
<td>170</td>
</tr>
<tr>
<td>Turkmenistan</td>
<td>135</td>
</tr>
</tbody>
</table>
WEFE Nexus in Central Asia

**Upstream countries** – mostly energy (fall - winter) and food

**Downstream countries** – food and environment (spring-summer)

Timing of water demand & operational rules of multipurpose reservoirs

Emerging WEFE Nexus Challenges in Central Asia

New interventions

- expanding agricultural lands
- construction of new dams
- construction of Qosh Tepa canal by Afghanistan
- weak regional cooperation

WEFE Nexus modeling in Central Asia

Trends from a global review:
- WEF Nexus modeling is not in short supply
- over ~100 studies used Nexus modeling;

Other general observations from the review:
- WEF Nexus is driven by the water sector;
- stakeholders are not sufficiently engaged;
- very few practical outcomes (less than 3% of ALL reviewed documents)
WEFE Nexus modeling in Central Asia

NEXUS Gains (CGIAR initiative)
Realizing Multiple Benefits Across Water, Energy, Food and Ecosystems (Forests, Biodiversity)
Consists of 5 WPs

Within WP1: Modeling Nexus tradeoffs and benefits. We are using PyWR to model multi-scenario simulation to understand impact of interventions in different basin.

PyWR is a model for solving network resource allocation problems at discrete timesteps using a linear programming approach - https://www.waterstrategy.org/

Helps track resource stocks and flows within the system.

Pywr - water resources module includes hydropower (separate modules for energy and food)
WEFE Nexus modeling in Central Asia – Amudarya River basin (work in progress)

Challenges:
- limited data;
- access to data;
- quality of data;
- stakeholder buy-in and cooperation;
WEFE Nexus modeling in Central Asia – Chirchik River basin (work in progress)

- small scale & good data availability;
- collaborating with SIC-ICWC (a parity collective body of Central Asian states);
- results can be used to expedite stakeholder buy-in and support for larger scale studies
Lessons learned

- WEFE Nexus analysis and modeling: learning by doing
- Small scale may be practical to start (systems are human constructs)
- Stakeholder involvement is crucial
- Good quality data is a pre-requisite for meaningful results
- Share experiences/outcomes (social learning)
- Think of who will use the model (Nexus is about technical and also governance)
- Patience
Thank you for your attention!

Bunyod Holmatov
b.holmatov@cgiar.org