Water Intersections with Climate Security

THREE WORLDVIEWS TO ADVANCE COMPLEX SYSTEMS ANALYSIS

Climate change is expected to impact water resources across the world. Increasing temperatures and changing precipitation patterns to melting of glaciers and permafrost and sea level rise will influence the availability of water for various societal and ecological needs. Analyzing the complex nature of water intersections with climate security requires a more nuanced approach that considers the various mechanisms for impacts. In particular, the adoption of three intersecting worldviews — environmental resource, infrastructure resilience, and regional dynamics — has the potential to break down disciplinary silos to promote more robust, combined systems thinking to advance national and global security priorities.

EMERGING CONCERNS:

Water plays several roles, many of which are expected to be impacted by climate change. From shifting Arctic ice floes and infectious diseases to extreme weather impacts on current infrastructures, communities across the globe will likely need to mitigate and adapt to new system states. There are also increasing concerns about how climate-driven solutions (e.g., clean energy production) could influence regional trade and supply chains. The traditional study of these issues has been rooted in separate disciplines (e.g., hydrology, meteorology, epidemiology, engineering, economics, and political science). However, the complex nature of water intersections with climate security (WICS) requires the adoption of a system approach that breaks down conventional silos to better advance understanding across disciplines, scales, and sectors.

INTERSECTING WORLDVIEWS OF WICS:

Water supports various environmental activities, from influencing primary productivity to animal migration and even local topography (***Environmental Resource*** worldview). Similarly, water is required for a number of societal needs, from drinking water and sanitation to producing food, energy, and a number of other products (***Infrastructure Resilience*** worldview). Water can also play a key role in regional activities, from influencing border tensions to impacting supply chains (***Regional Dynamics*** worldview). Understanding these interactions requires consideration of myriad factors like availability and quality of water, biomes, demographics, technologies, social demands, economics, and regulations (to name a few). Given the changing nature of various system conditions,

disease hazard impacts food security/access
compound events mission readiness
water availability governance infrastructure
cascading failures arctic adaptive capacity
drought resource driven conflict contaminants
community well-being water quality
scarcity extreme weather rising sea levels
cloud seeding floods agriculture
population dynamics multi-sector dynamics
energy and carbon transitions weaponization
migration hydropower/pumped hydro ecosystems

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WORLDVIEW	WATER-RELATED PRIORITIES
Environmental Resource	Understanding touchpoints to primary productivity (e.g., vegetation growth), animal migration, and changing topographies (e.g., movement of ice floes and sediment dynamics)
Infrastructure Resilience	Provisioning of water for drinking, sanitation, and hygiene to supporting critical infrastructure needs spanning energy, food, chemical, and manufacturing activities
Regional Dynamics	Influencing tensions between physical resources and associated broader societal capabilities and adaptive capacity, including those stemming from supply chain and trade dynamics

each worldview can help highlight relevant, region-specific and time-variant factors for understanding an issue of interest. For example, understanding drought impacts might require not only understanding possible competition between multiple sectors (e.g., food and energy) but also supply chain impacts and infectious disease implications from longer-term animal migration. Similarly, investments that aim to mitigate carbon emissions (e.g., clean hydrogen) could require additional water investments that could ultimately influence supply chain and trade dynamics. Since climate change disruptions can range from acute to chronic, implementation of the three worldviews enables a more disciplined approach to ensure the capture of non-linear feedbacks in risk assessments and solution development activities rooted in WICS.

Sandia is maturing a suite of technologies, spanning from multi-source data fusion to complex systems modeling, that can enable more rigorous evaluation of WICS through the three worldviews. These approaches will enable us to more systematically evaluate and advance insights and solutions to support water-climate research in support of national and global security priorities.

CONTACT INFORMATION:
For more information about WICS, please contact Thushara Gunda, **tgunda@sandia.gov**.