Climate Resilience of Critical Infrastructures: Applications to Water and Connected Sectors

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Background/Objectives. The water sector connects to all other infrastructure sectors and is key to adaptive capacity in the face of a changing climate. Projections of water use indicate up to 40% gaps between current supplies and projected demands. Given the interconnectedness between the water sector and water's indispensable role in a climate resilient future, there will be significant impacts to national and global security. Although the large-scale dynamics between sectors is well-recognized, there is still limited understanding about the unique role of water for supporting the resilience of other connected infrastructures. To address this gap, our team undertook a systems analysis approach to map out key supply and demand relationships between climate, water, and associated critical infrastructure sectors that require adequate consideration across scales.

Approach/Activities. Our systems analysis leveraged insights from multiple disciplines: 1) hydrology and water resources, 2) climate change projections, and 3) water-related requirements for connected infrastructure. These dynamics were mapped into a causal loop diagram that describes the specific inputs, outputs, and transformations across sectors. Inputs capture dependencies on natural resources, outputs include possible waste-related products, and transformations encapsulate spatial and temporal dynamics within and across sectors. The resulting map served as the basis for an exploratory sensitivity analysis to identify key vulnerabilities associated with water across sectors.

Results/Lessons Learned. Water plays both a direct and indirect role for many infrastructure sectors. For example, within the energy sector, water is used directly as an energy source in marine and hydropower energy as well as an indirect carrier for transporting waste heat (i.e., for cooling purposes) for more traditional, steam-driven engines. Direct and indirect uses of water also span agricultural production and manufacturing, including chemical production. Disruptions to water supply (driven by climate or human-induced water stress) are moderated by existing mitigations and adaptations within sectors. However, persistent water stress can lead to significant costs – from short-term infrastructure performance issues below initial design specifications as well as long-term shifts in siting of infrastructure to regions with water availability. Unintended consequences may also arise from increased burden of water-climate dynamics (e.g., weather whiplash resulting in higher mobilization of contaminants that drive increases in water treatment costs).