Understanding the Effects of Hydrometeorological Disturbances on River Water Temperature and Salinity at Regional to Continental Scales

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BER Program: ESS
Project: Early Career Project
Project Website: https://sites.google.com/lbl.gov/inaiads

The frequency, duration and intensity of hydrometeorological disturbances such as floods, droughts, and heatwaves are projected to increase with climate change, and can have drastic consequences to water quality in rivers. It is challenging to build generalizable models that analyze and predict how disturbances with variable spatial extent, timing and magnitude affect river water quality across catchments with different attributes . In this presentation, we describe results from a U.S. Department of Energy project iNAIADS that utilizes data-driven methods to understand water quality response and resilience to disturbances.

We examine the effects of heat waves on river water temperature and floods on salinity across basins with different climate, geological, land use and water management attributes using regional to continental-scale datasets. First, we present the use of classical machine learning and deep learning models to predict monthly and daily stream temperatures in the mid-Atlantic and Pacific Northwest regions for temporal predictions and spatiotemporal predictions in unmonitored basins (PUBS) that include pristine and human-impacted catchments. These models show that air temperature is the primary driver of stream temperature, and are used to inform how stream thermal regimes respond to heat waves. We discuss how the models account for the unpredictable timing, duration and spatial extent of extreme events by extrapolating information on water quality at regional scales from limited local observations, while accounting for its variations at both short and long timescales.

We then present an analysis of the response of river salinity (measured as specific conductance, SC), to floods across the continental US using statistical, machine learning and information theory approaches. Although dilution is the prevailing mechanism that regulates *SC* levels during floods, it is found that ~6% of flood events across all sites result in an increase of *SC* relative to the long-term mean. Our results also show that catchment aridity and anthropogenic impacts such as urbanization are primary factors resulting in distinct responses of salinity in rivers to floods. Moreover, we show that antecedent SC levels in the few days preceding the flood is the most dominant factor regulating the response of salinity to floods within individual sites.

We finally present the iNAIADS framework (iNtegration, Artificial Intelligence, Analytical Data Services) which comprises a data integration tool BASIN-3D that can be used to reproducibly synthesize diverse time-series data from distributed sources essential for such analysis, along with reusable analytical and machine learning codes for water quality modeling.