Extreme Events Alter the Future of Freshwater Salinization Syndrome

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Human activities have altered the sources, transport, and transformation of salt ions contributing to the anthropogenic salt cycle. A major process in the anthropogenic salt cycle is freshwater salinization. Freshwater salinization is increasing in groundwater, streams, rivers, and lakes around the world due to factors such as irrigation, road salts, sea level rise, groundwater pumping, resource extraction, and human-accelerated weathering of geologic materials. The suite of impacts of freshwater salinization on the natural and built environment is called Freshwater Salinization Syndrome (FSS). One major symptom of FSS is the mobilization of diverse mixtures of chemicals of concern called ‘chemical cocktails’, which can impact aquatic life, infrastructure, and clean drinking water. Although there have been increasing salinization trends over time in many prominent freshwater ecosystems, less is known regarding the impacts of extreme events on watershed-scale FSS responses across space and time. Here, we explore spatial and temporal responses of FSS in watersheds to different weather and climatic events such as: floods, tropical storms, hurricanes, droughts, winter road salt events, and saltwater intrusion in the Chesapeake Bay region. In some cases, salt pollution and associated chemical cocktails increase in concentrations and fluxes along flowpaths in response to hydrologic events, whereas there can also be attenuation and dilution of salt pollution based on land use and management decisions. We develop a typology for predicting watershed-scale FSS responses to extreme events across space and time and discuss implications for anticipating the effects of extreme events on influencing the trajectory, spread, and severity of FSS in the future. We also highlight the potential for ecosystem recovery from FSS and resilience in response to extreme

events. Anticipating responses of FSS to climate change and variability will be critical for developing effective salt restoration and mitigation strategies to protect drinking water, habitat, food production, and infrastructure in the future.