Climate and humans as amplifiers of hydro-ecologic change: science and policy implications for intensively managed landscapes

Efi Foufoula-Georgiou
Department of Civil and Environmental Engineering, University of California, Irvine

Abstract. Agricultural intensification and climatic trends in many intensively managed landscapes have contributed to hydrologic regime shifts and a cascade of changes to water quality and river ecosystems. Informing management and policy to mitigate undesired consequences requires a careful analysis that includes data-based inference and conceptual/physical modeling at a range of spatio-temporal scales. Here we present a comprehensive analysis of climatic, hydrologic, and ecologic trends in the Minnesota River basin, a 45,000 km^2 basin undergoing continuous agricultural intensification and suffering from declining water quality and aquatic biodiversity. We show that: (a) reversing environmental degradation rests on properly managing the underlying driver of change, i.e., increased streamflows and reduced water storage due to agricultural drainage practices; (b) strategic positioning of even minimal upstream water storage results in multiple non-linear improvements in downstream water quality; and (c) "optimization" between ecosystem services and economic considerations requires a systems approach that sees beyond a single stream to the whole watershed, favoring the adoption of minimal complexity rather than highly parameterized models for scenario evaluation and comparison. Science-based approaches informing management and policy are urgent in this region calling for a new era of watershed management in response to accelerating stressors at the intersection of the food-water-energy-environment nexus.