Hydrologic Forecasting for Characterization of Nonlinear Response of Freshwater Wetlands to Climatic and Land Use Change in the Susquehanna River Basin

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The objectives of this research project are to characterize nonlinear responses to global climate change in linked aquatic and terrestrial ecosystems through: (1) selection of a linked terrestrial-aquatic ecosystem that provides critical ecosystem services and ecological functions; (2) characterization of various global change scenarios, incorporating both climate and land cover, and a method of assessing their effect on the identified ecosystem through the primary forcing factor of hydrology (both alone and in conjunction with other human-associated stressors); (3) identification of potential nonlinear ecological responses (sensu Scheffer et al., 2002) in the selected ecosystem as a result of these changes; and (4) estimation of the resultant change in ecosystem services on a watershed and Basin-wide scale in the Susquehanna River Basin (SRB).

The general approach to investigating the response of freshwater wetlands to climatic and land use change is based on the tools and products of four previous U.S. Environmental Protection Agency Science To Achieve Results (EPA STAR) grants, and involves the following series of activities:

1. Develop scenarios of climate and land cover change, operating on a scale of decades, relevant to the SRB.
2. Using these scenarios, in conjunction with a coupled surface-ground water model, develop a number of predictive hydrologic scenarios for a collection of 11-digit HUC watersheds representing a range of human-associated land uses in the SRB.
3. Characterize the relationships between hydrologic and landcover parameters and ecosystem characteristics and services in wetlands of various types in the SRB, focusing on those with preliminary evidence of non-linearity and/or thresholds.
4. Utilize the predicted hydrologic scenarios to forecast changes in ecosystem services across the entire SRB, clearly identifying where and when non-linearities and/or thresholds in response occur, utilizing a series of unique statistical tools to develop a probability surface.

The investigators will develop a unique analytical method for prediction of climate and land cover change impacts, incorporating the forecasting of hydrologic conditions, which can be used to identify thresholds and non-linearities in the functional performance of freshwater wetlands. Any set of hydrologic/land cover change conditions can then be placed on the probability surface, allowing the statistical model to be used in a predictive fashion. The method could be applied to a wide variety of aquatic ecosystems for which state changes occur over either a spatial or temporal extent, or both.

EPA Grant Number: R833013