American Water Resources Association
2010 SUMMER SPECIALTY CONFERENCE
GIS & Water Resources VI
March 29 – 31, 2010
Orlando, FL

Tuesday, March 30
1:30 PM – 3:00 PM
SESSION 18: Water Quality II

Optimizing the Chlorophyll Monitoring Program in the Neuse Estuary Through the Use of a Hierarchical Spatio-Temporal Bayesian Model - Ibrahim Alameddine, Duke University, Durham, NC (co-authors: Song S. Qian, Eric S. Money)

The collection of monitoring data has the fundamental purpose of gaining a better understanding of the system being monitored and in reducing the uncertainty about the environment of interest, given a set of financial and technical constraints. Many state and federal agencies have come in recent years under increased pressure to downscale existing monitoring programs, with very little scientific input to guide them through the process. The use of recent advances in the field of geostatistics has a great potential in helping managers better examine existing monitoring networks by allowing for the incorporation of the spatio-temporal correlations of environmental variables as one measure in the redesign process. In this respect, we have developed a hierarchical spatio-temporal Bayesian model that explores the use of entropy as an information measure to optimize the existing chlorophyll monitoring program in the Neuse River Estuary in North Carolina. The adopted methodology does not place any constraints on the spatial random field defined for chlorophyll, thus making it particularly valuable to adopt in flow-complex water bodies similar to the Neuse River Estuary. The model is used to reassess the existing monitoring network in the study area by reducing redundancies caused by the spatial and temporal correlations, while also emphasizing information richness rather than data richness as a measure of the useful of the optimized monitoring network. The results identify the stations that hold the maximum amount of information (as measured by entropy), while also highlighting the stations whose removal will result in the least loss of information. The model was also used to locate locations that would benefit most from the addition of new stations in case the existing monitoring program was to be augmented.

Cleaning House: Collaboration Among Federal Agencies to Restore Impaired Waters on Public Lands - Jamie Fowler , U.S. Environmental Protection Agency, Washington , DC (co-authors: Jamie Fowler, Douglas J. Norton, Seth Mann, Eric Monschein, Dwight Atkinson)

More than 43,000 waterbodies in the United States have been identified as not meeting water quality standards and listed on states' Clean Water Act (CWA) Section 303(d) impaired waters lists. A portion of these impaired waters are found on federally-managed public lands. Over the past several years, the U.S. Environmental Protection Agency (USEPA) conducted several national assessments utilizing Geographic Information System (GIS) data and tools to show where federal properties co-occur with impaired waters reported by states through 2002 under CWA Section 303(d). Consistent with the CWA of 1972, the overarching goal of these assessments is to restore and maintain integrity of waters of the United States, with the focus on properties managed by federal agencies. This presentation focuses on national assessments carried out jointly with the U.S. Forest Service (USFS) and U.S. Fish and Wildlife Service (USFWS). The analyses summarized counts, linear and area statistics on co-occurrence of impaired waters both within and near various property types, and were formatted into several products designed to help federal agencies and their collaborators use the findings in planning and implementing sound water quality protection and restoration practices at local, regional and national scales. Products include national GIS databases of co-occurring impaired waters and an agency's properties; a browsable, read-only version for general audiences; and summary spreadsheets relating property names, impaired water bodies, pollutants, and measurements to one another on any geographic basis. Overall, the collaboration between federal agencies in these assessments has led to an increased awareness of impaired waters issues on federally-managed lands, better targeting and planning for impaired waters restoration, new collaborative restoration projects, and data for tracking strategic performance measures for protecting and restoring impaired waters by participating agencies.

Assessment of Atmospheric Nitrogen Deposition on Estuarine Nutrient Enrichment Using Modeling and Monitoring - Michele Cutrofello, RTI International, Washington, DC (co-authors: Keith Little, Marion Deerhake, Randy Waite, Anne Rea)

Estuaries are vital components of coastal ecosystems and provide valuable services, including fish nurseries, fishing, and boating. Estuaries tend to be nitrogen-limited, and many receive large nitrogen loads from human activities, causing eutrophication. Two atmospheric deposition case studies - the Potomac watershed (a Chesapeake Bay mainstem) and the Neuse watershed (a Pamlico Sound mainstem) - were performed to support the U.S. EPA's Final Risk and Exposure Assessment for the Secondary National Ambient Air Quality Standard Review for nitrogen oxides (NOx) and sulfur oxides (SOx). The role of atmospherically deposited nitrogen in eutrophication was assessed using a combination of watershed modeling and Pressure-State-Response evaluation. Nitrogen loads to watersheds, including atmospheric deposition, were assessed with USGS's SPAtially Referenced Regressions on Watershed attributes (SPARROW) model. Linked to SPARROW, through developed response curves, was NOAA's Assessment of Estuarine Trophic Status Eutrophication Index (ASSETS EI), a comprehensive categorical estuarine evaluation. Assessment of ecological impacts under current ambient conditions (2002) resulted in a SPARROW-modeled total nitrogen loading to the Potomac estuary of 36,660,000 kg N/yr (deposition equaled 20% of the total loading) with an ASSETS EI of Bad. The 2002 SPARROW load estimated for the Neuse river basin was 4,380,000 kg N/yr (deposition was 26% of the total load) with an ASSETS EI of Bad. Alternative deposition levels were assessed for the Potomac and Neuse watersheds by applying percent decreases in atmospheric nitrogen deposition and back-calculating the decrease in atmospheric deposition needed to improve the ASSETS EI by one category. Results indicated that there is a slim chance that a decrease >78% in the 2002 nitrogen deposition load to the Potomac watershed would improve the ASSETS EI score from Bad to Poor. The Neuse watershed's ASSETS EI score could not be improved from Bad to Poor with a 100% decrease in 2002 deposition because the total nitrogen loadings to the Neuse watershed are highly dependent on other non-atmospheric nitrogen sources. Future applications of this combined SPARROW-ASSETS method should be performed on watersheds where atmospheric deposition comprises a significant portion of nitrogen loading and is therefore more influential on the assessed ecological impacts.

Bayesian SPARROW for Understanding the Dynamic Changes in Nutrient Loadings - Song Qian, Duke University, Durham, NC (co-authors: Jonathon Goodall)

This presentation intends to discuss two issues related to SPARROW. First, the nutrient loading data used for fitting a SPARROW model is based on a long-term average flow-nutrient concentration relationship. This relationship is often affected by the relative contributions of nutrient between point and non-point sources. When water quality management practices are implemented, the relative contributions of the two sources may change. Consequently, long-term average flow-concentration relationship is often inadequate. Second, the SPARROW model is static fitted to historical data. The land-use - nutrient loading relationship may have changed because of management practices. As a result of these two problems, SPARROW can often provide biased estimates of nutrient loading. To overcome these two issues, a Bayesian SPARROW was proposed by Qian et al. (2005), where alternative model formulations were discussed and applied. But the Bayesian SPARROW did not explicitly resolve these two issues. In this presentation, we discuss a framework of using the Bayesian SPARROW (Qian et al. 2005) and the Hydrological Information System (HIS) sequentially updating the fitted SPARROW model to understand the effect of changes in watershed on nutrient loading. The combined HIS-Bayesian SPARROW technology is applied to the SPARROW model developed for the Neuse River Basin in central and eastern North Carolina.