

American Water Resources Association
2009 SUMMER SPECIALTY CONFERENCE
Adaptive Management of Water Resources II
June 29 – July 1, 2009
Snowbird, UT

Wednesday, July 1

10:30 AM – 12:00 Noon

SESSION 36: Tools Supporting Adaptive Management

1. Scenario Planning with Multi-Criteria Decision Analysis Linked to a Dynamic Systems Simulation – Linking Science, Policy, and Decision Making in an Adaptive Framework - Kathleen O'Neil, PBS&J, Orlando, FL (co-authors: David Yates, Kris Esterson)

In collaboration with the Stockholm Environment Institute-US, we have integrated a regional water simulation tool with multi-criteria decision analysis and scenario planning techniques – all in a consensus building forum. This system is used to explore the resilience of water management strategies across ranges of uncertainty in key driving variables (e.g., climate, population, and regulatory or policy requirements). The result is a 'living' adaptive management tool designed to update feedbacks and cumulative effects and to re-assess alternatives under changing conditions and across triple bottom line criteria. While aware of cumulative and unanticipated effects, water managers often do not have the tools at hand to incorporate non-linear networks of causation into their decision-making processes. In the past, standard methods assumed that historic hydrologic cycles would repeat themselves and that population and economic sector growth increased year to year on linear basis. Under these assumptions, water management alternatives could be designed to store and move water where it was needed. However, as we have all seen in the past year, there may be considerable uncertainty in demographic demand projections. Further, there is considerable uncertainty in the assumption that past hydrologic patterns can be used to predict the timing and magnitude of future flows. Changes in both demand and supply side variables result in the possibility of a range of future flow volumes and annual time series. How do we develop a sustainable plan in face of this magnitude of uncertainty? Using the SEI-US Water Evaluation and Planning Tool (WEAP) as the central hydrologic simulation tool we have linked it to a multi-criteria decision support system that supports stakeholder input and policy testing. Scenario-based planning methods allow the testing of management strategies across different sets of climate, demand, and supply assumptions. The results show alternatives that rank highest across diverse criteria. Multiple runs highlight alternatives that are resilient across a range of future conditions. Updating as new data become available allows examining the cumulative effects of feedback and response adjustment. The result links science, policy, and decision analysis in an adaptive management framework.

2. Will Simulation of Percolation Lead to Underestimation of Flood Risk? - Zhida Song-James, Michael Baker Jr., Inc., Alexandria, VA (co-authors: Manas Borah, Laura Algeo, Dhananjay Sharma)

Percolation has not been considered as a significant factor in floodplain modeling. However, recent studies have revealed that percolation has played an important role in reducing flood elevations in the floodplains with highly permeable soils and in Karst areas where watersheds are characterized by a wide range of closed depressions and well developed underground drainages. Such areas are seen all over the country, especially in Florida. After FEMA approved the consideration of percolation in the determination of Base Flood Elevations (BFEs) in few of the countywide Flood Insurance Studies in Florida, there have been an increasing number of map revision requests in FEMA Region IV that accounts for percolation in the BFE determinations. While incorporation of percolation is appropriate in some cases, it may not be appropriate or incorrectly incorporated in others leading to underestimation of flood risk. Due to the high risk to life and property associated with underestimation of flood elevations, FEMA Region IV took initiative in developing guidelines for use of percolation in floodplain modeling. This paper will discuss a broad framework for determination of percolation impacts on Flood Risk Estimation. It will describe key requirements including field data collection and assumptions in the simulation of percolation process as a part of floodplain modeling. More detail guidelines will be given in the upcoming revision of Guidelines and Specifications, Appendix C: Guidance for Riverine Flooding Analyses and Mapping. There are a variety of numerical models to calculate infiltration and percolation losses. This

paper will discuss the minimum requirements for such a model to adequately simulate flows entering, moving within, and leaving the system, as well as storage changes within the system. It will present a case study showing the impact of accounting percolation in the determination of BFEs for natural depressions. It will describe ground conditions and discuss type and source of input data used in the simulation. It will also present particular situations such as perched water table, interaction of coastal and ground water, and percolation in Karst terrain. The paper will make a brief comparison of available models that are capable of modeling percolation.

3. Fusion of Remotely Sensed Data for Landcover Classification Using Multiclass Relevance Vector Machine - Bushra Zaman, Utah Water Research Lab, Logan, UT (co-author: Mac Mckee)

A data assimilation technique which fuses remotely sensed data (reflectance, vegetation indices, ground measurements, crop physiological characteristics) to train a multiclass relevance vector machine (RVM) has been introduced for classification of land cover data. Land cover classification plays a significant role in agricultural water management by providing land characteristics and information useful for estimating water balances. Once trained, the machine would help in identifying crop types and estimate acreages. The irrigation water requirements and efficiencies can be calculated on both the farm and irrigation system levels to enhance water management performances. Here, the multiclass RVM routine has been applied on three datasets, two of which come from the same population. The first dataset has four classes and five attributes; the second has seven classes and ten attributes. The multiclass classification accuracy achieved is 96.5% and 86%, respectively. To test the accuracy of the classification routine, the model is applied on the classic IRIS dataset and the accuracy achieved is 97.33%. The reflectance in wavebands 650, 830 and 1640 um were used. The NDVI and NDWI values and the ground measurements of leaf area index were used to enhance class separability. The data comes from the Soil Moisture Experiments conducted in 2003 (SMEX03) in Oklahoma. The supervised classification requires analyst-specified classification data and it is observed that the performance of the model heavily depends on the accuracy of the data and also on the size of testing and training sets. Kernel width, type of kernel, and iterations are the parameters that control the model's performance. The multinomial logit function is used to predict posterior probabilities of class membership. The results show excellent performance by the machine with only one misclassification for the first dataset and two misclassifications for the IRIS flower dataset. The misclassifications generally occur where the posterior probabilities of two classes are very similar. The results indicate that the multiclass RVMs work very well with a reduced computational complexity and more suitable real-time implementation. Predictions show good agreement with actual data as demonstrated by confusion matrices and receiver operating characteristic graphs. The statistics indicate good model generalization capability.

4. Exploring Alternative Controls of Algal Proliferation in Florida's Spring System - Dina Liebowitz, University of Florida, Gainesville, FL (co-authors: Matthew J. Cohen, James B. Heffernan, Thomas K. Frazer, Hollie Hall)

Florida's spring system discharges more than 8 billion gallons of groundwater to the surface each day. This expression of water has created a unique landscape, providing habitat for a diverse array of wildlife, as well as recreation and economic opportunities for human populations. However, the ecosystems are changing dramatically, and the ecological drivers of these changes remain ambiguous. Dense algal overgrowths have been reported in many of Florida's more than 700 springs, exhibiting a shift in ecosystems from states dominated by submerged aquatic vegetation (SAV) to states dominated by benthic periphyton. These changes are causing stakeholder concern, as algal overgrowths can be detrimental for human health, recreation, aesthetics, and wildlife. Without fully understanding the causal factors of ecosystem change, attempts at management may not be effective. Ecosystems theory supports the notion of multi-causal drivers of systems, and regional data remains equivocal regarding the prominent role of nutrients in spring degradation. However, given the information limitations and available tools, current management still focuses on nitrogen enrichment as the cause of algal overgrowth. But as we recognize that impacts to Florida's spring system are complex, management efforts may be facilitated by adopting a more adaptive approach—one which will continue to question and test new hypotheses concerning ecological interactions and the ways to best manage them. In exploration of an alternative hypothesis that "top-down" processes could partially explain the algal proliferation patterns, we conducted a multivariate analysis of data collected on water quality metrics and algal cover in 28 springs. This yielded results that are suggestive of the hypothesis that decreasing DO levels in water issuing from

spring boils leads to grazer exclusion and subsequent release of algal control. We postulate that this recent DO decrease may be due to the prevalence of older aquifer water contributing more to spring flows, due to interactions of climatic variation and consumptive use. The DO-grazer hypothesis is being initially tested through surveys of grazer and algal biomass along chemical and seasonal gradients within springs. We present the multivariate analyses, preliminary survey results, and plans for future in-situ experiments.