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## Integrated Watershed Management to Save the UNESCO Biosphere Reserve Lake Urmia, Iran

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**American Water Resources Association**  
**2012 ANNUAL WATER RESOURCES CONFERENCE**  
**Nov. 12-15, 2012**  
**Jacksonville, FL**

**Thursday, Nov. 15**  
**10:30 AM – 12:00 Noon**  
**SESSION 51: Water Quality 5 - Salinity Resources**

**Sacramento-San Joaquin Delta Simulation Model for Simulation of Various Cations and Anions - Gomathishankar Parvathinathan, MWH Americas, Sacramento, CA**

The Delta Simulation Model II (DSM2) is a one-dimensional mathematical model for simulating Sacramento-San Joaquin Delta hydrodynamics, water quality, and particle tracking. Historically, simulated Delta hydrodynamics and water quality conditions were validated through comparison with available hydrodynamics and electrical conductivity (EC) data in the Delta. There are concerns about DSM2's ability to simulate other salinity constituents using the existing model. DSM2 was calibrated using EC as the target salinity. Concerns have been raised about using EC for calibrating dispersion factors due to its failure to behave as a truly conservative indicator of salinity. As salinity and ionic concentration increase, EC increases. At higher salinity concentrations, ion mobility is depressed and ability to transmit electrical current is impaired. As a result, EC increasingly underestimates true salinity at higher concentrations, a trend manifest in a nonlinear relationship between EC and any conservative constituent (Suits, 2002). This study evaluated the ability of the DSM2 model to simulate the transport of seven cations (Calcium, Magnesium and Sodium) and anions (Chloride, Sulfate, Bromide and Bicarbonate Alkalinity) based on observed data at six different Delta locations. The validation effort was based on limited available monitoring data on cations and anions in the Delta, which do not adequately cover the range of seasonal flow and salinity conditions. Boundary water quality conditions for the DSM2 model were generated from available EC data using regression equations relating EC and various ions that were validated using cation-anion charge balance analysis. Four different statistical metrics, including RMSE (the root mean square error), NRMSE (normalized root mean square error), and bias were applied to evaluate the performance of the model in simulating various ions. The results of this study showed that the DSM2 model performs equally well in simulating cation and anion concentrations in the Delta. The range and magnitude of errors in the simulation of cations and anions are comparable to EC simulation results at the six Delta locations. Overall, DSM2 is shown to be capable of simulating various cations and anions in the Delta adequately well.

**Development and Application of an AdH Hydrodynamic Model for Biscayne Bay - Shabbir Ahmed, U. S. Army Corps of Engineers, Jacksonville, FL (co-author: G. L. Brown)**

An effort to restore the freshwater flows to the Southern Coastal Systems (SCS) in South Florida is underway as one component of the Comprehensive Everglades Restoration Plan (CERP). An integral part of the SCS is Biscayne Bay, a large coastal estuary located along the Atlantic coast of South Florida. It is one of several major South Florida Estuaries that receives freshwater discharge from the Everglades. Currently, freshwater flows enter Biscayne Bay primarily through sixteen man-made canals, each of which is regulated by a coastal salinity control structure. In addition, freshwater input to the Bay includes rainfall and groundwater inflows. The spatial and temporal variations of these freshwater flows directly affect the salinity regimes of the Bay. To facilitate the planning and management of the restoration activities impacting Biscayne Bay, the Restoration Coordination & Verification (RECOVER) group of CERP has constructed a hydrodynamic and salinity transport model using Adaptive Hydraulics (AdH) code developed at the Engineer Research and Development Center Coastal and Hydraulics Laboratory of the U. S. Army Corps of Engineers. AdH is a physically based finite element model for simulating hydrodynamics and transport, including salinity transport. The ADH model domain for Biscayne Bay has been represented using a network of triangular finite elements. The conceptual model data for Biscayne Bay has been translated into a numerical model, and the calibration has been accomplished by comparing model results with the measured data for the water levels, flows, and salinity. The validation has been performed by demonstrating the ability of the model to produce results that compare well to a different set of observed data. After successful calibration and validation of the model, various planning scenarios will be simulated to determine a salinity restoration target for Biscayne Bay. This restoration target will be the basis for a salinity performance measure used to determine the success of the restoration effort and/or implement adaptive management measures to ensure success. Future plans are to integrate the results from the AdH model with ecological models developed for the Bay for use in setting ecologic restoration targets and subsequent refinement of existing ecological performance measures.

**Integrated Watershed Management to Save the UNESCO Biosphere Reserve Lake Urmia, Iran - Sina Khatami M.**, Lund University, Lund, Sweden (co-author: R. Berndtsson)

Lake Urmia is a hypersaline lake in northwest Iran. Due to its unique aquatic ecosystem it is designated as a Biosphere Reserve by UNESCO and a National Park under the 1971 Ramsar Convention. The biodiversity of the lake is determined by its salinity and *Artemia urmiana* is the key element of the lake's food chain. The lake is relatively shallow and satellite data indicate that the water level has plummeted during the last 17 years due to a dramatic decline in surface water inflow and consequent increase in salinity of the lake (from 166 g/L in 1995 to about 340 g/L in 2008). Thus, the entire lake's ecology is threatened. The lake represents about 7% of the total surface water in Iran. About 20 permanent and periodic rivers together with other episodic streams are flowing into the lake. These rivers along with precipitation are the major sources of inflow and evaporation is the main outflow from this endorheic lake. In view of the above, the main objective of this paper was to review the state of art of knowledge for the threatened lake and to suggest possible solutions to improve the lake's ecology. Hydrological and hydraulic data for the area are quite limited with short records. Many previous studies, using the same data records, have arrived at quite different management options to restore the lake. The fundamental reason for the threatened lake appears to be the lack of sustainable management. The paper evaluates different management options and their environmental impact. Through an integrated multidisciplinary approach, possible short-term and long-term solutions are presented to manage the lake's ecology and reach a sustainable watershed management through a restoration project. Suggested integrated watershed management includes consideration of population growth and water demand, cloud seeding and rainwater harvesting, freshwater inflow to the lake and improved irrigation methods, efficient salt industry, establishing a wastewater treatment plant and developing tourism industry as a source of income. Further hydrological modeling is needed to study the combined effect of climate change and dam construction. The paper is closed by discussing practical implications of the study and scaling-up possibilities.