FIU | Applied Research Center
FLORIDA INTERNATIONAL UNIVERSITY

U.S. DEPARTMENT OF ENERGY

FIU PROJECT 3 - 2012 FACT SHEET

Modeling of Hydrology, Sediment Transport, and Mercury Fate and Transport in East Fork Poplar Creek, Oak Ridge, TN

FIU's Applied Research Center (ARC) has developed an integrated surface/subsurface numerical model for the hydrology, sediment and mercury (Hg) transport at the Upper East Fork Poplar Creek watershed (UEFPC) as part of the DOE's mercury remediation project at the Oak Ridge Reservation. This model has since been extended to incorporate sedimentation and reactive transport modules, and used to perform numerical simulations that are relevant for NPDES and TMDL regulations.

An integrated surface/subsurface flow and transport model has been developed to analyze the mercury (Hg) cycle in the environment and provide forecasting capabilities for the flow and transport of Hg in UEFPC. Daily fluctuations in stream flow due to scattered rainfall, flooding, and flow augmentation resuspend contaminated streambed sediments, and provide a major source of mercury (>90%) to the creek. Sediment transport and interactions between sediment particles, mercury species and water are key factors responsible for mercury mobilization and transport in the creek. A sedimentation module for the section of EFPC upstream of Station 17 was therefore incorporated into the UEFPC model for better representation of real field conditions, and has since been extended to include the entire EFPC and Bear Creek. This research has provided stochastic modeling of the system and includes analysis of spatial and temporal patterns as a result of stochastic variations of selected properties. The model was constructed and calibrated using an extensive collection of historical records (i.e., hydrological data and mercury concentration measurements in groundwater, soil and sediment) obtained from the Oak Ridge Environmental Information System (OREIS) database.

Project Objectives

- Development of an integrated surface/subsurface model using the numerical software package MIKE by DHI to study multiphase transport of Hg species in the saturated and unsaturated zones of the UEFPC watershed, including physical, biological and chemical transformations under site-specific environmental conditions.
- Extension of the sedimentation module developed for UEFPC to include the entire EFPC down to EFK 6 and Bear Creek. This provides coupling between flow and transport within the creek as well as overland flow used to analyze the significance of floodplain contamination downstream EFPC.
- Assessment of the effectiveness of ongoing and future remedial actions at the site.

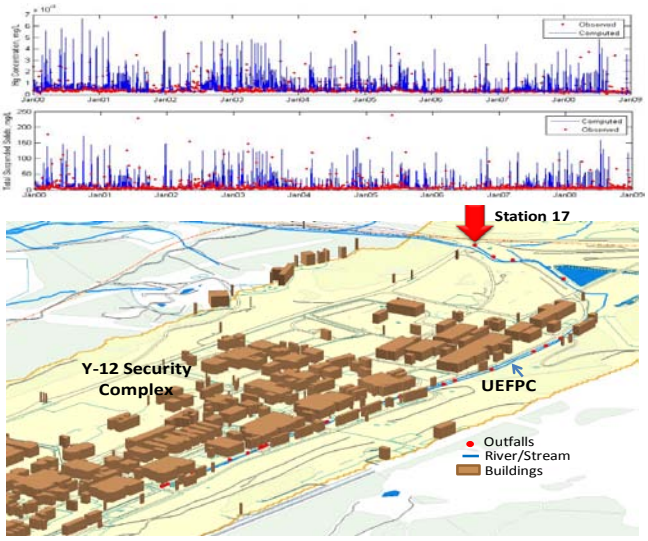

Figure 1 Total suspended solids and Hg concentration compared with historical data at Station 17

Project Benefits

- Simulations provide a better understanding of the flow and transport within the watershed on a regional scale.
- Provides stakeholders with a tool for "what if" analyses in order to achieve lower uncertainty and considerably better spatial and temporal forecasting of the mercury contamination under varying environmental conditions.
- Evaluates the risks associated with D&D operations and potential mobilization of mercury.
- Reduces cleanup costs and accelerates cleanup.

Project Accomplishments

- Developed and calibrated numerical model for hydrology, sediment and Hg transport in UEFPC (1996 to present).
- Reconfigured model to incorporate a sedimentation module and then extended it to include 52 additional outfalls covering the entire EFPC and Bear Creek.
- Performed numerical simulations using a range of Manning's numbers, threshold run-off water depths, and drainage coefficients to calibrate flow from 2000 – 2008. MATLAB scripts were used for statistical analysis of observed and computed data.
- Provided U.S. DOE with assessment reports on the effectiveness of 8 different remedial scenarios.
- Presented poster entitled "Improvements in the Suspended Sediment Interactions Module of an Integrated Flow and Mercury Transport Model for East Fork Poplar Creek Watershed, Oak Ridge, TN (12588)", at Waste Management Symposium 2012, based on project work and modeling results.

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