Modeling the transport of nanoparticles from combined sewer overflows in the Buffalo River
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Introduction
- The sources of nanoparticles (NPs) into the surface water can be agricultural, industrial, consumer products, and medical applications.
- Nanoparticles are widely used in home disinfectants and medical products for its antibacterial property. Up to 10,000 tonne Titanium dioxide nanoparticles (TiO2NPs) per year get produced.
- In the Buffalo River, most of the TiO2NPs are transported through the combined sewer overflows (CSOs) from the Buffalo city.
- The river has three tributaries: Cayuga Creek, Buffalo Creek, and Cazenovia Creek.
- The Buffalo River drains a 447-square-mile (1,158 sq, km) watershed in New York state, emptying into the eastern end of Lake Erie at the City of Buffalo.

Objectives
- Building the three-dimensional Buffalo River hydrodynamic model using the Environmental Fluid Dynamics Code (EFDC).
- Linking the Buffalo city Storm Water Management Model (SWMM) to the hydrodynamic model.
- Developing water quality model of the Buffalo River to analyze where nanoparticles from combined sewer overflows may migrate.

Methodology
- Boundary conditions and initial model setup for the hydrodynamic model.
- Simulation of CSO discharges for the Buffalo city using precipitation data in the SWMM model.
- Collection of the Buffalo River elevation and flow data (time steps vary from 5 minutes to 15 minutes) from the LinnoTech for the period of 5th October 2008 to 15th November 2008.
- Water quality modeling for the TiO2NPs using two scenarios:
  Scenario I- 100 PPB (parts per billion) TiO2NPs in CSOs are considered.
  Scenario II- 200 PPB (parts per billion) TiO2NPs in CSOs are considered.

Mesh used in the modeling

Preliminary Results and Discussions
Model performance
- Model performance is evaluated for water level and the velocity for the Buffalo River.

Hydrodynamic simulation results
- The hydrodynamic simulation results at 10th October 2008, 00:00 and 01:00 AM:
  - Figure 1: Buffalo River connected to the CSO outfalls
  - Figure 2: Buffalo River mesh, 2683 horizontal grids x 8 vertical layers
  - Figure 6: TiO2NPs simulation result for scenario I using EFDC
  - Figure 7: Simulated TiO2NPs concentration for scenario I and scenario II

Future Works
- Measurement of TiO2NPs from Buffalo city CSOs.
- Silver and zinc oxide nanoparticles modeling in the Buffalo River.
- The use of the model to evaluate the effectiveness of different CSO control strategies for reducing the transport of nanoparticles to the river.

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