



Jul 12th, 10:30 AM - 10:50 AM

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Johnson, Billy E. and Zhang, Zhonglong, "One Dimensional Riverine Water Quality Modeling System (HEC-RAS/NSM)" (2016). *International Congress on Environmental Modelling and Software*. 13.

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# One Dimensional Riverine Water Quality Modeling System (HEC-RAS/NSM)

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**Abstract:** The transport of nutrients from watersheds to aquatic resources (streams and rivers, lakes and reservoirs, and coastal zones) directly influences their environmental quality and ecosystem. While this is a natural process, excessive inputs from anthropogenic sources (e.g., intensive agriculture) can exceed the assimilative capacity and resilience of aquatic ecosystems. The result is accelerated rates of eutrophication and destabilized ecological communities susceptible to the establishment of invasive species or to changes in food web structure, loss of valuable habitat, threats to human health, and reduced economic and societal benefits. As part of the Ecosystem Management and Restoration Research Program (EMRRP), a fully integrated riverine hydraulic, sediment and water quality model that encompasses diagnostic, predictive, and operational applications in conjunction with monitoring data was developed by integrating the Nutrient Simulation Module (NSM) developed by the U.S. Army Engineer Research and Development Center (ERDC) with the Hydrologic Engineer Center River Analysis System (HEC-RAS). HEC-RAS solves the complete one-dimensional Saint-Venant equations of unsteady flow. The model is able to simulate back water flow effects and a variety of hydraulic structures thus allowing one to model tidally influenced streams and rivers. NSM describes changes in the water quality constituent concentrations that are due to biological, chemical, biochemical, and physical processes. Currently the integrated modeling system is being used on multiple projects in support of ecosystem restoration projects by the U.S. Army Corps of Engineers. This presentation will focus on the hydraulic and sediment routing methods found within HEC-RAS, the nutrient fate and transport formulations found within NSM, both simple and advanced methods, a description of the case study done on the Minnesota River located in the vicinity of St. Paul, MN, and the flow, temperature, and nutrient model results from that study.

**Keywords:** Riverine; Water Quality; Nutrients; HEC-RAS; USACE