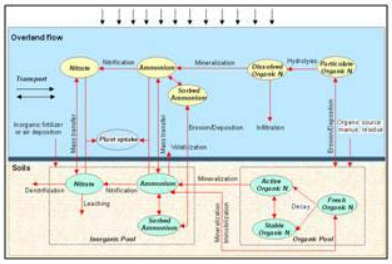
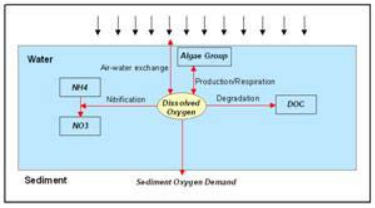
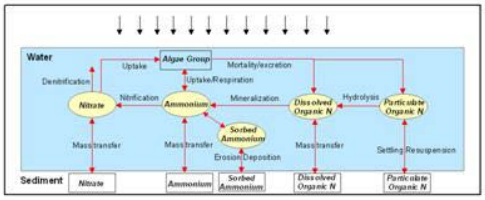
Nutrient Sub-Model

Description: Nutrient Sub-Model (NSM) is a collection of nutrient kinetic libraries developed such that they can be easily integrated with a variety of U. S. Army Corps of Engineers Hydrology and Hydraulics (H&H) modeling systems. NSM relies upon the host program (H&H modeling system) to provide flow and sediment fluxes. Upon receipt of these fluxes, NSM computes the nitrogen and phosphorus kinetics for the upper soil layer, overland, and channel regimes. Some of the kinetics represented include mineralization, nitrification, denitrification, immobilization, and volatilization. NSM will then provide nutrient mass fluxes back to the host program for transport of the nutrient masses through the various hydraulic and hydrologic flow regimes. The nutrient species are allowed to exist in dissolved and adsorbed forms and will be transported as either suspended in the water column or as mass attached to sediment particles of varying gradations. At the water and soil interface, NSM does compute the mass transfer of the dissolved phase of the nutrients based upon the concentration of the nutrient in the water column and the upper soil layer (or channel bed layer). Depending upon the concentrations, NSM will allow nutrient mass to move from the soil layer (bed layer) to the water column or from the water column to the upper soil layer (bed layer).



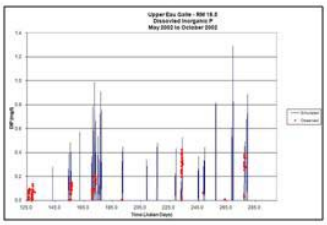


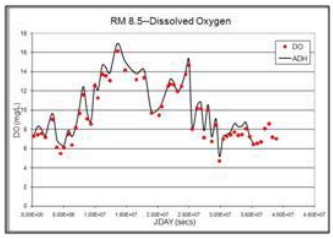


The nutrient species represented within NSM are ammonium (dissolved and particulate), nitrate, particulate organic nitrogen, inorganic phosphorus (dissolved and particulate), and particulate organic phosphorus. Within the channel system, NSM also computes phytoplankton, bottom algae, and dissolved oxygen in addition to the N and P cycles. Finally, NSM does have a terrestrial plant growth and decay module that operates on a heat index day basis. The plant module allows for water and nutrient uptake from multiple soil layers and will provide biomass back to the upper soil layer upon maturation and decay of the plants.

more . . .

Nutrient Sub-Model





Application: NSM is currently being integrated and tested within the Gridded Surface Subsurface Hydrologic Analysis (GSSHA), Adaptive Hydrology/ Hydraulics (ADH), Hydrologic Engineering Center-River Analysis System (HEC-RAS), and Hydrologic Engineering Center-Hydrologic Modeling System (HEC-HMS). There are case studies being conducted using data from the Eau Galle Watershed, WI, and Minnesota River projects. In addition, the Upper Auglaize Watershed, OH, (interagency project team), Luxapalila Watershed, MS, (Mississippi State University), and Fort Shafter Training site, HI, project teams are in the early stages of using the GSSHA model with NSM in order to evaluate the fate and transport of nutrients within their respective watersheds.

Benefits: The benefits to this research and development is in the increased ability of the USACE modeling systems to have a common water quality framework in which they are able to exchange nutrient masses efficiently at varying temporal and spatial time scales. As more research is conducted into the basic water quality process descriptions, all of the USACE H&H modeling systems will be upgraded in a timely and cost-effective manner.

Data Requirements: Besides the basic flow and sediment data needed by the host program, NSM needs to be initialized with soil concentrations (mg/Kg) for the various nutrient species as well as water column concentrations (mg/l) assuming the model is not starting off with dry bed conditions. NSM does have a limited plant database. However, it will be necessary to develop plant growth and decay parameters for specific plant species at each project site.

Future Capabilities: Future capabilities being proposed for inclusion into the NSM are: 1) Development of a carbon cycle module; 2) Integration of NSM with more physically based plant dynamics; 3) Development of a vadose zone module; 4) Development of a groundwater module; 5) Development of a wetlands module; and 6) Development of an aquatic plants module.

Point of Contact: Billy E. Johnson, Environmental Laboratory, U.S. Army Engineer Research and Development Center, Vicksburg, MS. (601) 634-3714. Email: Billy.E.Johnson@usace.army.mil.

System-Wide Water SWWRP Resources Program