"Development of Water Quality Modeling in the United States"
National Conference of the Korean Society of Environmental Engineering
November 6, 2008

Robert B, Ambrose, Jr., P.E., et al.

This presentation describes historical trends in water quality model development in the United States, reviews current efforts, and projects promising future directions. Water quality modeling has a relatively long history in the United States. While its origins lie in the work of Streeter and Phelps in the 1920's, the practice began its first modern development phase with the availability of mainframe computers in the 1960s. Successive development phases have been driven by the availability of desktop computers in the late 1980s, improved Windows operating systems in the mid to late 1990s, and the internet in the later 1990s to the present.

Model development has also been driven by the needs of regulation. The primary regulatory driver for water quality modeling in the U.S. has been the 1956 Federal Water Pollution Control Act, including the Clean Water Act and amendments of 1972, 1977, 1981, and 1987. Four US laws address the environmental risks from toxic substances and their effect on watersheds. These regulate industrial chemicals (Toxic Substances Control Act), contaminated sites (Superfund), hazardous waste (Resource Conservation and Recovery Act), and pesticides (Federal Insecticide, Fungicide, and Rodenticide Act).

A variety of institutions in the United States have promoted the development of water quality models. This has been the product of a broad collaboration, both cooperative and adversarial, between government, academia, and private firms (industry and engineering consultants). While the U.S. Environmental Protection Agency has been a leader in the broad development and use of water quality models, other Federal and State agencies have made strong contributions to the field. Chief among these are the U.S. Army Corps of Engineers' Hydrologic Engineering Center and Waterways Experiment Station have been longstanding leaders in hydrologic and water quality modeling.

Most of the conventional water quality variables and processes were coded in modeling frameworks by the late 1970s, and toxicant variables and processes were coded by the mid-1980s. Since then, water quality modeling content has been slowly refined and improved in a variety of applications. Present high-end water quality models feature multiple algal groups and detrital variables, and linkages to sediment diagenesis modules. Faster computers have promoted dynamic, spatially-detailed simulations driven by better transport models. Specialized user interface software has promoted better water quality modeling practice. GIS software and on-line databases are promoting more realistic model parameterization and application. Robust frameworks are facilitating model linkage with databases and other models, which promises more comprehensive analyses of environmental problems. These trends and developments in water quality modeling in the United States will be described, and examples will be reviewed.