CSREES National Water Quality Program

Title: Development of an Integrated Watershed Information Management for Long-term Facilities Stewardship

Name: Ahmed Said **Email:** asaid@eng.usf.edu

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Theme: Watershed Management

Situation: The problem of information management for integrated watershed assessment has not been addressed comprehensively. A wide variety of recent decision support systems have addressed aspects of watersheds like flow, non-point source pollution, stream/reservoir routing for TMDLs, and combinations of hydrology and water quality. Most are essentially integrated mathematical models packaged as a unit with little data access. Additionally, when mathematical modeling packages are large and complex, logistical problems arise for integrating data among models and populating them with consistent spatial and temporal scales. A strength of the USEPA's BASINs approach is its provision with large data sets focused on control of both point and nonpoint source water pollution. A drawback of such systems is that they use whatever data are available to populate models. In many cases, stakeholders affected by watershed management activities are suspicious of decisions made primarily on the basis of models; they trust data and hearsay more than complex mathematical models. An approach to watershed decision-making that derives decisions from both data and models, and non-quantitative information, including expert and stakeholder opinion is lacking.

Objectives: The overall objective is to provide the U.S. Department of Energy with an Integrated Watershed Information Management Tool (IWIMT) that will integrate and leverage water and environmental management information leading to the improvement of long-term stewardship on the Idaho National Engineering and Environmental Laboratory (INEEL) site and associated watersheds. Specific objectives are: 1) Collect data and develop a regional database on surface and subsurface hydrology, surface water and subsurface soil and water quality, water-land-environmental relationships, and socioeconomic impacts of INEEL site and associated watershed management decisions for use with specific applications within the region; 2) Develop a Bayesian network (BN) to prioritize and fill data gaps with mathematical modeling efforts and future data collection; 3) Use the BN to help design data gathering networks and identify uncertainties in data, environmental and surface/subsurface relationships, and stewardship management options; and 4) Implement tools for communication and ranking of management alternatives for decision making.

Methods: The BN is used to establish hydrologic and water quality monitoring networks, collect further data on management alternative impacts, fill data gaps with the long term goal of supporting and ultimately supplanting models with data which can be used in management decisions. BNs are graphical, probabilistic models that allow the structured representation of a cognitive or decision process. BNs create an efficient language for building models of domains with intrinsic uncertainty and variability. The primary reason for using a Bayesian model for information management is that its purpose is to estimate certainties for events that are not observable. Thus, the initial task in model building is to identify these hypotheses events and to identify the types of (potentially) available information that may reveal something about their state. Once relationships have been identified, prediction of the probability distributions for events in a network contingent on a particular management action is straightforward. Part of the network structure development is the definition of conditional independence among the variables, for example contaminant loading and downstream concentration. It is the conditional independence between the variables that allows us to significantly simplify the evidence propagation, as well as the process of estimating input

Partnerships: This research is collaborative between INEEL scientists and engineers and researchers at Utah State University.

Research: More attention is paid to environmental problems related to watershed management to detect pollution sources and the absence of causal relationships. The simplicity of Big Lost River watershed problems may be so great that it can be determined which actions are likely to improve water quality or quantity. Water quality problems are measurable and tractable with time, hot spots are located, and actions taken when appropriate. In 2000, the average water delivered was about 12,853 ha-m. From this amount, 7,337 ha-m were lost through seepage from irrigation ditches and the Big Lost River. To achieve successful watershed management, managing surface and ground water should be concurrent. Promoting watershed management in the western United States where water rights are the dominant interest may require a greater combination of resources and an explicit strategy for building aspects of social feasibility. Agencies can build social feasibility by promoting civic efforts and developing collaborations. A high degree of cooperation in water management should be developed among the involved parties in the Big Lost River watershed. BNs are an accessible tool for stakeholders and watershed management decision-makers. A user can try different values of a variable, create different combinations of management scenarios, select management options, view resulting probabilities throughout the network, and examine the resulting cost-benefit values. Sufficient motivations are required for effective watershed management especially when water resources are depleted. Although motivational feasibility is closely linked to social feasibility, it must be tested in terms of rational cost-benefit assessments and evaluation of total water values including use and non-use values.

Resources: There are four main elements that involved in this research: 1) data collection and analysis, 2) development and use of mathematical modeling tools for disciplinary processes bearing on water and environmental relationships and management options, 3) development of IWIMTs organized around a BN representation of the Big Lost River water and that integrates data and models into a facilities management decision framework, and 4) use of the BN to aid in current and future data gathering networks and efforts to provide information for long-term management options. To facilitate long-term use of the IWIMT for facility stewardship, training and documentation will be provided for INEEL personnel involved in stewardship activities.

Results: Watershed tools and models developed or utilized in this research are aimed at helping preclusions achieving physical and economic sustainability by utilizing scientific, social, and motivational watershed feasibilities within their watershed.