USGS

WATER RESOURCES RESEARCH GRANT PROPOSAL

Title: Development of a Prototype System Dynamics Based Decision Support System to Aid in Integrated Watershed Planning for the Lake Tahoe Watershed

Focus Category: Management and Planning

Keywords: Decision Models, Planning, Systems Engineering, Model Studies, Computers, Ecosystems.

Duration: April 1, 1999 through March 31, 2000

Federal Funds: $5,056

Non-Federal Funds: $2,983

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Congressional District: 02

Statement of Critical Regional or State Water Problems

During the last half of the twentieth century the management of the United State's western watersheds has become an increasingly complex task. Initially, the development and operation of the watersheds were dictated by each basin's hydrologic characteristics and the economic benefits produced through hydropower generation, enhanced water availability and flood protection. Thus, the primary method of managing western watersheds was through the development of operating criteria that were based on maximizing the short term economic benefits of water operations within the basin. However, in more recent times, the long term economic and environmental consequences of operating watersheds in this fashion have come to light. Altered stream flows have had significant impacts on the morphology of stream beds, resulting in alterations in channel shapes and the sediment loads entering lakes and reservoirs. These changes have lead to modifications in the ecology of many western watersheds. This in turn has resulted in intangible economic losses, such as endangering the sustainability of some plant and animal species; to more tangible economic losses, such as the degradation of lake clarity or increase in fire risk within the Lake Tahoe Watershed. These effects have demonstrated that the operation of controlled watersheds is an extremely complex issue, and that more advanced modeling and analysis tools are required by personnel charged with the planning and management of water resources within these watersheds. For most larger western watersheds the decision making forum for watershed policies is somewhat centralized in large federal institutions, such as the Bureau of Reclamation, the Army Corps of Engineers, or the U.S. Forest Service. The larger federal agencies typically have the resources to develop decision support systems that employ relatively sophisticated models. For example, the Bureau of Reclamation is currently funding the development of

the Upper Snake River decision support system for use in aiding integrated watershed management approaches for the Upper Snake River Basin. The U.S. Army Corps of Engineers is beginning a collaborative effort with the Bureau of Reclamation to attempt to develop an integrated watershed management plan for the Sacramento River Basin. While at the current time no formal plans for the development of a decision support system have been stated, it is anticipated that a rather sophisticated modeling effort will be undertaken. The U.S. Forest Service is currently funding a project that is performing a watershed assessment for the Lake Tahoe Watershed. There are a variety of products that will be produced from this assessment, with one of the products being models to predict the state of hydrologic, water quality, forest health, biodiversity and socio-economic processes within the watershed. These agencies will receive a significant amount of input from stakeholders in the watershed of interest when water resources plans are being developed. Thus, the stakeholders have some input to the decision making process, but could not presently be considered decision makers in the watershed planning process. However, recently, there has been a movement towards devolving the centralized control of western watersheds. Thus, the decision makers of the near future will change, with many of the current stakeholders within the watersheds becoming these decision makers. This is especially true in the Lake Tahoe watershed where the U.S. Forest Service is just one of a multitude of federal and regional agencies with decision making authority within the watershed. This situation is recognized in the Forest Services Watershed Assessment project, with one of the goals of the project being to develop modeling tools that can be used by all decision making entities within the watershed. However, not all entities will be able to employ large scientific staffs that are required to maintain and operate the process models being developed as part of the Watershed Assessment. Rather, these smaller agencies will have to rely on their intuitive understanding of the watershed and how predictions of watershed behavior will affect their decision making process. Thus, it is likely that simpler models of watershed processes will be preferred by the majority of decision making entities within the watershed.

Project Results

The results of this project will be two-fold. First, the general results of this project will be a prototype methodology for integrating a diverse set of process models into a watershed analysis system. This generic methodology could be used in the future for developing integrated decision support tools for a number of western watersheds. Second, this methodology will be specifically applied to the Upper Truckee Watershed in Lake Tahoe to provide regional decision makers with a prototype decision making tool for the Lake Tahoe Watershed. This tool will then be evaluated by decision making personnel to assess its potential for future use in aiding decision making in the Lake Tahoe Watershed.

Nature, Scope and Objectives of the Research

The use of modeling tools that simply provide information on a limited set of watershed processes are no longer sufficient to allow for the planning and management of large watersheds with diverse economies and socio-political settings. Thus, integrated modeling efforts that attempt to incorporate hydrologic, economic, ecological and social

systems into a cohesive simulation package have been, and are being, developed. One difficulty that was initially encountered in developing and using these models for watershed planning and management is that the user of such a model would not only have to feel comfortable performing the computer simulations, but also have a background in water resources, economics, sociology or political science and some elements of ecology to interpret the numerical output of the models. Obviously, such individuals would be rare, thus making it difficult for the widespread use of the integrated models in an effective manner. This problem has recently been overcome with the advance of personal and workstation computing hardware and software. New computing systems are capable of performing the intensive numerical calculations required by the integrated models. In addition, the integrated models can be implemented on newer computing operating systems with graphical user interfaces that allow model users to manipulate data and interpret model output in a more intuitive graphical format. These interfaces can be constructed to allow decision makers to input data and produce output predictions in formats that are more conducive to making decisions in a planning and management environment. Hence, the term Decision Support System (DSS) platform has been developed that refers to the integrated graphical user interface and model simulation packages.

The overall goal of this project is to develop a prototype DSS platform for guiding the development of integrated simulation models of the hydrology, environment and economy of Tahoe Basin watersheds for use by public policy decision makers within the basin. When constructing a model, or integrating a group of models together, to simulate the behavior of a watershed it can be said in general that more sophisticated models will lead to a lowering of the prediction uncertainty. However, this relationship is only valid if: (a) a sufficient quantity of reliable information is available to describe the system; and (b) the system behavior has a significant impact on the predicted variables that will be used in a decision making forum. If either of these factors is not present, the most sophisticated model may not be the best modeling tool to include in an integrated systems model. Thus, the objectives of this project are to: (1)

develop a procedure that determines the most appropriate modeling components based on the richness of data sets that are available to describe the system, and the level of confidence in the simulations required by the decision maker. (2) Develop a prototype integrated DSS platform geared for management use within the Tahoe Basin; and (2) Demonstrate and assess the prototype DSS platform for a small watershed within the Basin for an integrated economic-hydrologic-water quality example.