水資源·水質 綜合管理를 위한 ADSS 開發 戰略

Strategy for Advanced Decision Support System Development for Integrated Management of Water Resources and Quality

沈 淳 輔*

ABSTRACT

This study describes the strategy for advanced decision support system (ADSS) development for integrated management of water resources and quality in reservoir systems. The developed ADSS consists of database, modelbase and user interface systems. The ADSS includes seperate databases that contain hydrologic data, observed operational data, and data to support specific reservoir operations simulation, optimization models, and water quality models. The optimization model, mass balance simulation model and water quality models are used in a general prototype ADSS, menu driven controlling framework that assists the user to specify and evaluate the alternative operational scenarios at one time. These alternative scenarios are evaluated by the models and the results are compared through the use of a graphical based display system. This graphical based system uses an icon based schematic representation of the system to organize the presentation of the results. The ADSS includes the ability to use monthly or weekly time periods of analysis for the models and it can use monthly historical or stochastically generated inflows.

INTRODUCTION

The development and application of mathematical models and ADSS to reservoir systems have been proved a powerful tool for water resources and quality management. As a diagnostic

* 韓國 科學財團 指定 忠北大學校 水資源·水質研究센터 所長
忠北大學校 土木工學科 敎授, 技術士

tool, the mathematical models include the abstraction of highly complex phenomena such as physical, chemical and biological reactions, and quantity-quality relationships in a reservoir. As a predictive tool, the mathematical models include

the forecasting and evaluation of the effects of changes on the water quantity and quality of reservoir. As a powerful managing tool, the development and application of ADSS are very important.

ADSS is an integrated computing framework consisting of database, modelbase and user interface that facilitates the development and evaluation of alternative courses of action. Modern ADSS uses advances in computing and information technologies to organize and automate the process of alternative evaluation and selection into a flexible, fully integrated, interactive, user friendly computer environment.

ADSS for INTEGRATED MANAGEMENT of RESERVOIR SYSTEMS

The overall concept of the ADSS for reservoir system is Figure 1. The general database will consist of various "Tables" which are actually separate files that

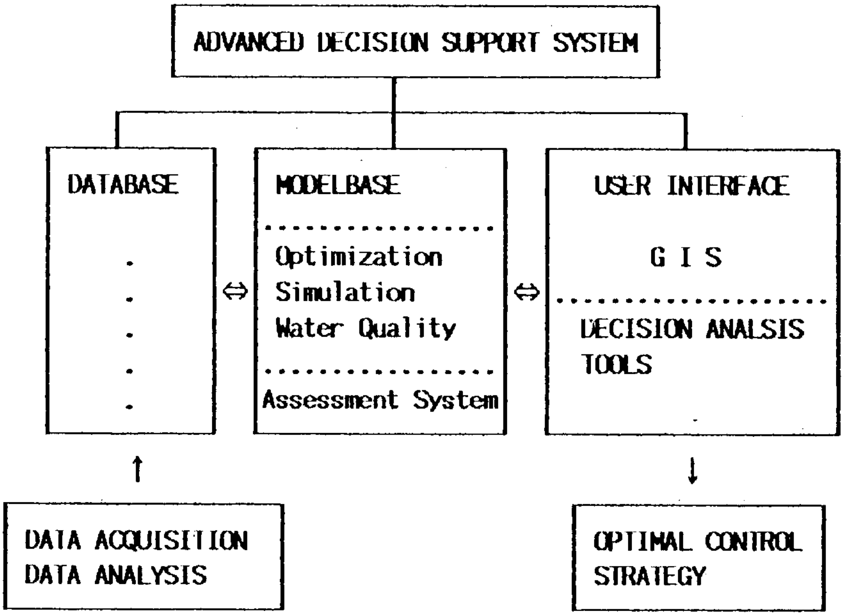

Figure 1. Overall Configuration of the ADSS

contain specific data for a specific purpose. Some of the "Tables" contain relational data and some contain sequential data.

The task of the data base management systsm(DBMS) can be broken down into two different parts, data acquisition and data analysis. The most important task of the data acquisition is the scheduling, which is divided into three different parts, the error checking, buffering, and stacking. The analysis part of the DBMS is to query, sort, insert, and delete. Thus, in order to have complete DBMS, it must include all of those components.

The modelbase consists of an optimization and a simulation model. The optimization model is used to develop optimal reservoir operating policies for reservoir system considering hydropower prodution, water supply, and downstream minimum flow requirements for water quality management.

The optimal policies abtained from the optimization model can be analyzed to produce reservoir operationg rules. These rules can be incorporated into the simulation model. The simulation model can be used to predict the operation of the system using those rules. Simulation models generally contain much more detail than the optimization model and are more computationally efficient since they only use a single previously determined operation rule rather than having to search over many possibilities for operational policies.

The mathematical models for the integrated management of reservoir water quality should include hydrodynamics model, basic water quality model, ecologic- eutrophication model and toxicant model. The hydrodynamics model solve the multi-dimensional equations descriving the propagation of waves through reservoir water system while conserving both momentum (energy) and volume (mass). The hydrodynamics model based on the conservation of momentum and mass predict water velocities, flows, wind driven currents, density flows, hights (heads) and volumes of reservoir.

The basic water quality models include the mass balance equation, transport of dissolved and particulate matter, and benthos. The mass balance equation for dissolved constituents in a body of reservoir water must account for all the material entering and leaving through direct and diffuse loading; advective and dispersive transport; and physical, chemical, bilolgical transformation. Several physical, chemical and biological processes can affect the transport and interaction among the nutrients, phytoplankton, carbonaceous material and dissolved oxygen in the aquatic environment. The ecologic-eutrophication models include the phytoplankton kinetics, stoichiometry and uptake kinetics, phosphorus cycle, nitrogen cycle, dissolved oxygen balance, sediment-water interactions etc.

The toxicant models include the transport and fate of organic toxic chemicals and metals in all types of aquatic systems. It combines the hydrodynamics and the transport capabilities with the sediment balance and chemical transformation capabilities. This model includes ionization and equilibrium sorption process, kinetic transformation, hydrolysis or reaction of the chemical with water, photolysis due to absorption of light energy, chemical oxidation of organic toxicants, bacterial degradation or biolysis, chemical volatilization and heavy metals.

CONCLUSIONS

The overall research contents and strategy have been introduced for ADSS development for integrated management of water resources and quality in reservoir systems.

To insure maximum flexibility and long term use of the ADSS, it is of primary importance to separate the database, modelbase and user interface. Software technologies are changing rapidly that affect all research areas. Database software is becoming more flexible and able to share data among various hardware platforms. User interfaces software is also becoming more flexible and general. Geographic information system (GIS) software can display almost any kind of spatially-varying data and is becoming more popular in a variety of water resources applications.

At present, Center for Water Resources and Quality Management (CWRQM) is forcusing on the research of the water resources and quality modeling and ADSS. In particular, we are developing a number of software packages for both personal computers and workstations. The intent is to use advanced grapnics displays, artificial intelligence (AI) technologies and geographic information system (GIS) to make modeling more accurate and readily-accessible to various levels of decision makers.

In conclusion, the development of an ADSS framework for the integrated management in reservoir system would be very valuable to the water resources development projects in Korea.

REFERENCES:

1. Anderson, J., Editor. (1991). Proceedings of the 18th Annual Conference and Symposium, Water Resources Planning and Management and Urban Water Resources, ASCE, New Orleans, LA, U.S.A., May 20-22.

2. Slotine, J.E., Weiping Li (1991), "Applied Nonlinear Control", Prentice-Hall International Editions.

3. Labadie, J.W., et al., Editors. (1988). Proceedings of the 3rd Water Resources Operations Management Workshop, Computerized Decision Support Systems for Water Managers, ASCE, Fort Collins, CO, U.S.A., June 27-30.