APLICABILITY OF RIVERWARE DECISION SUPPORT SYSTEM TO RIVER BASINS IN JAPAN

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River basin management experience indicates a continuing need for increasingly complex computer modeling to assist water resources management organizations in satisfying river users. Reservoirs are the most important element of river basin planning and management. As dam construction in Japan has become considerably difficult, emphasis has shifted to improved management of existing reservoirs. Numerous conflicts now arise in trying to satisfy reservoir system operating objectives. Computer modeling is necessary to efficiently manage the complex interactions between the numerous constraints and objectives over an entire basin. Over the past decades, many site-specific river basin models have been developed and used by water management agencies for the planning and management of their own basins. The site-specific models are considered useful to the agencies, but they have two notable limitations. First, site-specific models are dedicated to particular river basins and have to be maintained and updated individually by the agencies, which is usually difficult and expensive. Secondly, operating rule or policy is imbedded in the code and inaccessible to reservoir operators. Thus, changing the policy in the models either to reflect changes in reality or to conduct policy studies is a large programming task. In addition, imbedding policy in the code makes it more likely that errors would go undetected. In terms of these limitations, RiverWare, a general decision support system for river basin planning and management, has been developed at the Center for Advanced Decision Support for Water and Environmental Systems (CADSWES) at the University of Colorado, sponsored jointly by the Tennessee Valley Authority (TVA) and the U.S. Bureau of Reclamation (USBR).

RiverWare provides a construction kit for complex and detailed site-specific modeling of physical processes and operating policies without the need for difficult and expensive software development.

In this paper, at first, RiverWare's basic structure and solution approaches are described, which includes river basin objects, solvers, expression of policy and runtime utilities. Then, in order to verify its practicality and benefits as a general modeling tool, RiverWare is applied to two Japanese river basins: the Miomote River basin and Koyoshi River Basin to solve three different types of watershed planning and management issues. The two river basins have their own site-specific models for watershed planning and management. The computational results from RiverWare are compared with those from the site-specific models to examine how well RiverWare can work for Japanese river basins. The case studies have shown that RiverWare is applicable and beneficial to Japanese river basins, but the following improvements are required in order for RiverWare to work better for

watershed planning and management issues in Japan.

(1) Adding rainfall-runoff models to RiverWare
Water resources engineers in Japan tend to start with rainfall-runoff model because, for many river basins, long recorded streamflows are difficult to get. RiverWare will be more powerful if rainfall-runoff models are imbedded in RiverWare.

(2) Making more timesteps selectable
River basins in Japan are relatively small and the riverbed slope is steep, which suggests that a small timestep shorter usually than one hour is needed for flood simulation. On the other hand, one sixth of a month is commonly selected as a timestep for simulation of river basin water supply systems. Such timesteps are not available in RiverWare and should be added to it.

(3) Allowing users to use their own models
RiverWare is a general modeling tool that works well for most river basins, but in some special cases where site-specific models and methods are necessary, RiverWare should allow users to easily add their own models to it.

(4) Developing more optimization methods
The Optimization solver in RiverWare is designed to solve multiobjective reservoir systems with hydropower as their main purpose. More optimization methods are required for river basin management issues such as water supply, irrigation and water quality.

Keywords: River basin management; Decision support system; Software; Simulation; Optimization