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Scenario-based Water Resources Management Using the Water Value Concept

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The Saskatchewan River is the key water resource for the 3 prairie provinces of Alberta, Saskatchewan and Manitoba in Western Canada, and thus it is necessary to pursue long-term regional and watershed-based planning for the river basin. The water resources system is complex because it includes multiple components, representing various demand sectors, including the environment, which impose conflicting objectives, and multiple jurisdictions. The biophysical complexity is exacerbated by the socioeconomic dimensions associated for example with impacts of land and water management, value systems including environmental flows, and policy and governance dimensions..

We focus on the South Saskatchewan River Basin (SSRB) in Alberta and Saskatchewan, which is already fully allocated in southern Alberta and is subject to increasing demand due to rapid economic development and a growing population. Multiple sectors and water uses include agricultural, municipal, industrial, mining, hydropower, and environmental flow requirements. The significant spatial variability in the level of development and future needs for water places different values on water across the basin. Water resources planning and decision making must take these complexities into consideration, yet also deal with a new dimension—climate change and its possible future impacts on water resources systems. There is a pressing need to deal with water in terms of its value, rather than a mere commodity subject to traditional quantitative optimization.

In this research, a value-based water resources system (VWRS) model is proposed to couple the hydrological and the societal aspects of water resources in one integrated modeling tool for the SSRB. The objective of this work is to develop the VWRS model as a negotiation, planning, and management tool that allows for the assessment of the availability, as well as the allocation scenarios, of water resources for competing users under varying conditions. The proposed VWRS model will account for the blue water component of the system (water taken from the rivers and reservoirs) as well as the green water (soil water used by agriculture), and track water-dependent products and services (energy, mining, crops, and industrial products). The system dynamics approach is used as a simulation environment for constructing the VWRS model due to its ability to accommodate hydrological and non-hydrological variables in one modeling platform.

A set of scenarios representing various levels of water availability, combined with a set of various priorities of water uses, will be considered and tested. The scenarios will be evaluated with regard to the overall value of water use. The findings will be used to develop water value-based allocation priorities and reservoir operating rules. This novel modeling tool and concept promotes and allows for a paradigm shift from studying traditional water budgets to quantifying virtual and value-based water budgets; i.e. balance of water and water-dependent commodities and services. In this paper, the first and tentative version of the VWRS model is presented and applied to the Saskatchewan portion of the SSRB. Various scenarios of changes of the inflows from Alberta to Saskatchewan will be considered and tested to validate the VWRS model.