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Governance and decision making in complex socio-hydrological systems

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The transboundary Saskatchewan River, originating in the Canadian Rockies in Alberta, flows through Saskatchewan and Manitoba and discharges its water into Lake Winnipeg. It supports irrigated agriculture, hydropower generation, flood protection, municipal water supplies, mining, recreation, and environmental services across a large area and in multiple administrative jurisdictions. Managing the region's water-based economic activities and environmental services, requires decisions at a variety of scales to incorporate competing values and priorities about water use. Current inter-provincial allocations are based on the 1969 Master Agreement of Water Apportionment whereby upstream Alberta must release one-half of the annual natural flows of the Saskatchewan River to Saskatchewan, which in turn must pass one-half of the residual natural flow to the Province of Manitoba. This analysis uses a hydro-economic simulation model, SWAMP, to examine risk-based tradeoffs in Saskatchewan for various types of water use including, agriculture, energy, and flood protection under various scenarios of water availability. The eco-hydrological effects of the scenarios on the largest inland delta in North America – the Saskatchewan River Delta – are also shown. Results enable decision makers to weigh the costs and benefits of implementing particular sector-based future development strategies.

Assuming net provincial benefit as a single monetary indicator of economic value, the effects of various scenarios of environmental and policy changes are quantified Results show that improving irrigation technology and expanding irrigated lands in Alberta will positively affect the province's economic development and have compound effects downstream on hydropower generation, environmental flows and the economies of Saskatchewan and Manitoba. The implementation of similar policies in Saskatchewan will have different downstream impacts because of the large hydro-power capacity downstream in Manitoba. The model highlights the spatial tradeoffs across the three provinces and sectoral trade-offs among the differing water uses. These trade-offs represent challenging dilemmas for water management decisions in a complex system. The study reveals the need for a holistic framework of water resources analysis that can dynamically capture the feedback loops among hydrological, social, and administrative/political analysis units to support public discussion of critical water tradeoffs and a consensual water value framework to guide future development decisions.