Scenario Analysis of Cooperation Dynamics on the Columbia River under Changing Conditions using Socio-Hydrological Modelling

Charlotte Cherry¹, Felipe Augusto Arguello Souza², Samuel Park³, Ashish Shrestha⁴, Liu Yang⁵, Marlies Barendrecht⁶, Margaret Garcia⁴, David Yu³, Jing Wei⁷, and Fuqiang Tian⁷

¹University of Illinois at Urbana-Champaign, Civil and Environmental Engineering, United States of America
(çcherry2@illinois.edu)
²University of São Paulo, São Paulo, Brazil
³Purdue University, West Lafayette, Indiana
⁴Arizona State University, Tempe, Arizona
⁵Yunnan University, Kunming, China
⁶Vienna University of Technology, Vienna, Austria
⁷Tsinghua University, Beijing, China

The Columbia River Treaty, signed in 1961, solidifies cooperation between the United States and Canada to manage the operation of the Columbia River's extensive dam network jointly to optimize benefits for the whole system. Under the treaty, Canada operates dams to provide flood protection and maximize hydropower potential downstream. In exchange, the U.S. compensates Canada with half of the estimated benefits of the treaty, which provides an economic incentive to cooperate not seen in many other transboundary basins. However, since the treaty was established, this highly-managed system has responded to unanticipated external social and environmental factors. For example, mounting social pressure in the 1990s to protect the aquatic environment resulted in operational changes to U.S. dams to accommodate flows for fish migration, which ultimately resulted in financial losses for hydropower producers. These changes affected the relative benefits each country receives from cooperation. Utilizing a range of hydrological, economic, social, and environmental datasets, a socio-hydrological model was developed that simulates system operations using historical data to mimic operational changes, shifts in flood control and hydropower production, and cooperation dynamics.

Renegotiations of the Columbia River Treaty started in 2018, and the new treaty in 2024 must include provisions for environmental protection that were, originally, not considered. The purpose of this study is to use the established model to envision how changing conditions such as climate change, spring fish flows, and First Nation rights would affect each country's willingness to cooperate. For example, how would changes in snowpack upstream or seasonal changes in precipitation alter the hydrology of the basin and, in turn, the benefits each country receives from cooperation. This scenario analysis provides insight into how a revised treaty that takes future uncertainties into account would affect the balance of benefits to maintain or disrupt cooperation on the Columbia River.