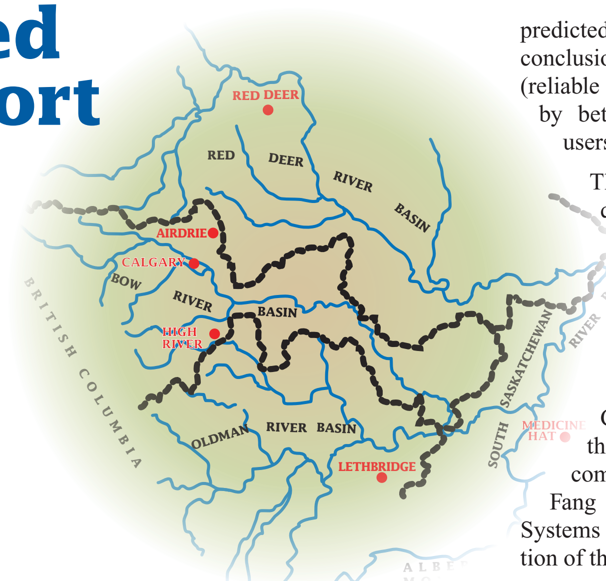
Water Allocation Distinguished Lecture Report

By **Patrick Finnigan**



Professor Liping Fang, Ph.D., P. Eng., FEIC, FCSME, Associate Dean, Undergraduate Programs and Student Affairs, Faculty of Engineering and Architectural Science, Ryerson University (lfang@ryerson.ca) gave an excellent IEEE Canada Distinguished Lecture on the topic of "System-wide Cooperative Water Resources Allocation" last December to an audience of more than a dozen attendees.

After reminding the audience about the importance, scarcity, uneven distribution and quality of the world's water supply, Dr. Fang delved into the general trans-border water allocation principles and its varied uses for navigation, power-generation, industrial, agricultural and essential use for citizens. The real question in all of this is "Whose water is it?" There are various "riparian" and other international (and national) protocols on who can use it, pollute it, pay for it etc.

By building graph models of water supply and distribution, including storage nodes and allowing for "reverse-flows" of water being re-used, and by annotating the nodes and links in the graph with constraints, he has been able to model effective co-operative allocation of the water resource(s) to all users, and meet their goals for availability and cost as well. The models he has developed perform a two-step allocation: 1) a rights allocation using three modeling techniques including maximum net flow, and 2) a re-allocation based on net benefits, which also uses three modeling techniques including Lexicographic Minimax Water Shortage Ratios (Luis, 1999), and the novel "Co-operative Reallocation Game." The Co-operative game lets a group of users in the water network maximize their benefits using it, while at the same time respecting the criteria of individual users up and downstream. It is based on the "Nucleolus" model or "Shapley value" (after the Nobel economist Dr. Lloyd Shapley).

Finally, Dr. Fang ended his talk by showing how his model(s) could be used to better re-allocate water in the South Saskatchewan River Basin (around Calgary). This model graph had 55 nodes, 17 reservoirs and 17 stakeholders. By concentrating on the 4 largest stakeholders, and water data for the full-year period, by month in 1995, Dr. Fang and his graduate students have been able to better predict how to allocate the water resources, especially by 2021, when it is predicted 50% less water will be available. The conclusion was that better allocation efficiency (reliable supply, lower cost) could be achieved by better co-operation among the biggest users.

The audience had several interesting questions for Dr. Fang, including perhaps that the techniques he and his team have developed might well be applied to supply-chain management electric power generation and distribution.

Dr. Alexei Botchkarev, Chair, Systems Chapter, IEEE Toronto Section, hosted the session, introduced the speaker, welcomed the audience, and presented Dr. Fang with a token of the IEEE Toronto Systems Chapter's appreciation for his presentation of this IEEE Canada Distinguished Lecture.

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CONTEXT

Southern Alberta Flood

Spanning 55,000 square kilometres with a clean-up and reconstruction bill expected to reach $5 billion, this past summer's flood in southern Alberta has highlighted the need to have better models for an *excess* of water supply—or at least received over too short a time period.

The need for flood-event modeling will only increase as a result of continued climate change, says Professor Slobodan Simonović of the University of Western Ontario's Department of Civil and Environmental Engineering, and also with the Institute for Catastrophic Loss Reduction (ICLR), affiliated with the University.

"The intensification of the hydrology cycle is becoming visible in the number of floods and the magnitude," Simonović says, referencing studies done at the Institute. "Also, more floods are from summer storm events as compared to the traditional flooding following the spring snow melt. Not only do they cause river overflow, but they overload municipal infrastructure."

Urban flooding is increasingly becoming a problem as municipalities struggle to identify priorities, according to Simonović, who notes this level of government has the fewest resources of any. However, the tools exist for assessing the change in risk to municipal infrastucture for specific locations due to climate change, he says. In particular, he points to recent studies his group conducted concerning the Upper Thames Watershed on behalf of the city of London.

"I'm not saying it's easy or we have all the answers, but we can provide some guidelines to help politicians, and decision- and policy-makers. But policy-makers must be prepared to act on the information."

N.Ed. Readers interested in information about how flood risks are assessed and taken into account may wish to consult *Floods in a Changing Climate: Risk Management*, by Slobodan Simonović, Cambridge University Press, 2013.