



# Banff International Research Station

for Mathematical Innovation and Discovery

## Mathematical Modeling of Water Resource Allocation Strategies September 7-9, 2007

### MEETING ROOMS

All workshop sessions will be held in Max Bell 150. [Please respect that all other meeting space has been contracted to other Banff Centre guests, including any food and beverage in those areas.]

Dress is casual for all events, and we look forward to your participation throughout. Please contact any one of the organizers with suggestions or requests that could increase the value of this event to you.

### SCHEDULE

#### Friday

- 16:00** Check-in begins (Front Desk – Professional Development Centre, Banff Centre - open 24 hours)
- 19:00-21:00** Hot hors d'oeuvres reception and no-host bar -- 2<sup>nd</sup> floor lounge, Corbett Hall (*included in workshop*). Please come meet and mingle. There will be a significant spread of food available, and so inbound travelers may be able to avoid stopping for dinner en route.

#### Saturday

- 7:00-8:30** Breakfast (*hosted*)
- 8:45** Introduction and Workshop Objectives – Ted Horbulyk (University of Calgary) -- **Max Bell 150**
- 9:00** **Session A:** State of the art approaches to water modeling (Richard Howitt, University of California, Davis)
- 10:30** Health Break, 2<sup>nd</sup> floor lounge, Corbett Hall
- 10:45** **Session B:** Modeling Agricultural Water Use – Chokri Dridi (University of Alberta)
- 11:30** Lunch (*hosted*) (*take some time for a stroll to enjoy the view and the campus*)
- 13:30** **Session C:** Empirical Challenges in Water Valuation – Steven Renzetti and Diane Dupont (Brock University)
- 15:00** Health Break, 2<sup>nd</sup> floor lounge, Corbett Hall
- 15:15-16:45** **Session D:** Collaborative Modeling Exercises – Jay Lund (University of California, Davis)
- 17:00** Hosted reception with beverages (2<sup>nd</sup> floor lounge, Corbett Hall)
- 18:00-20:00** Dinner (*hosted*). Food service ends at 7:30. Available after-dinner venues include the adjoining Three Ravens wine bar in the Dining Centre; the Props Pub, located in Donald Cameron Hall; and the self-serve (cash bar) in the 2<sup>nd</sup> floor lounge, Corbett Hall.

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## Sunday

- 7:00-8:45** Breakfast (*hosted*)
- 9:00** **Session E:** Where to from here? Panel Discussion on Day 1 Lessons (Ayoo, Dridi, Dupont, Horbulyk, Howitt, Lund, Renzetti, Weber)
- 9:45** Roundtable Discussion and linkages to Participants' Modeling Interests
- 10:30** Health break, 2<sup>nd</sup> floor lounge, Corbett Hall
- 10:45** Open Discussion on steps forward
- 11:45** Summary and Steps Forward – Horbulyk, Weber, Ayoo
- 12:00** Lunch (*hosted*). Please check out of rooms by 12 noon.

## MEALS

Breakfasts, lunches and Saturday dinner in *Vistas* Dining Room, Sally Borden Building (*all are included in workshop*). *Vistas* claims to offer “market-style” buffet food service - feel free to pick and choose what you like from any of the serving stations, at any time. Please remember to scan your meal card at the host/hostess station for breakfasts in the dining room.

Health Breaks: As per daily schedule, 2<sup>nd</sup> floor lounge, Corbett Hall (*included in workshop*)

*At other times of the day or night*, beverages and a small assortment of snacks are available in the 2<sup>nd</sup> floor lounge, Corbett Hall on a pay-as-you-go cash honour-system.

\*\* Participants in this workshop are welcome to use the BIRS facilities (2<sup>nd</sup> Floor Lounge, Corbett Hall and Reading Room) until 15:00 on Sunday, although participants are still required to checkout of the guest rooms by 12 noon. There is no Health Break on Sunday afternoon, but self-serve coffee and tea are always available in the 2<sup>nd</sup> floor lounge, Corbett Hall. \*\*

## ACKNOWLEDGEMENT

We are extremely grateful to the following sponsors of this event whose funding and support have made possible the use of the facilities and hospitality and have allowed for the inclusion of invited participants from other jurisdictions to share their experience with us. We thank:

- ✓ the Banff International Research Station for Mathematical Innovation and Discovery
- ✓ Alberta Environment
- ✓ the Alberta Ingenuity Centre for Water Research and
- ✓ the Institute for Sustainable Energy, Environment and Economy at the University of Calgary.

Workshop Organizers: Collins Ayoo, Ted Horbulyk, Marian Weber

*Version: August 31, 2007*



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## Mathematical Modeling of Water Resource Allocation Strategies September 7-9, 2007

### WORKSHOP OBJECTIVES

The purpose of this workshop is to bring together a small group of researchers and government or industry participants who are active in the use or development of water policy models to understand ‘state of the art’ methods in water policy modeling and to explore opportunities to advance water economics research in Alberta. We have organized the workshop into five sessions. The first four sessions will be held on Saturday and will explore various dimensions of water policy modeling. Each session will be led by a presentation or set of presentations followed by questions and discussion by participants. Sunday’s session will review the workshop topics covered on Saturday and the entire group will be invited to discuss opportunities to advance water policy modeling in Alberta.

As a result of participating in the workshop, invited researchers and users of research results should be able:

1. To identify the principal modeling groups and approaches currently active on Alberta water issues and to identify the potential for diverse types of collaboration among these researchers;
2. To understand (somewhat better) the current “state of practice” and the current “state of the art” in quantitative water modeling including alternative applications, techniques and methodologies (e.g., scope and scale – farm-level to basin-scale, model structures, assumptions, calibration, data requirements, software), strengths and weaknesses, and to identify potential areas for improvement in the future work;
3. To identify whether there are relevant approaches and lessons, such as from California and other US jurisdictions, about processes for interdependent quantitative analyses, including collaboration in such areas as data collection and data sharing, model verification and validation, and so on; and
4. To identify the areas of opportunity for broadening or coupling economists’ models of water quantity and quality to models of land use policy and land use change, for example, and/or for introducing or integrating economic analysis to existing physical models of land and water use, such as those involving 2D and 3D hydrology, hydrogeology, contaminant fate and transport, water temperature, food webs, operational and design characteristics of reservoirs and diversions and so on.

By design, the workshop is intended to work from the researcher level—addressing these invited researchers’ interest and capacity in the short- (and longer- ) run to analyze issues and to inform water resource policy and management. Since the largest emphasis is on the “supply side” of the market for water policy research with little involvement from those who are the “demanders” of timely analysis, the principal purpose is not to build a common (“equilibrium”) research agenda that could meet diverse agencies’ current and future needs.

## Mathematical Modeling of Water Resource Allocation Strategies

### Workshop Structure

#### Sessions:

- A – State of the art vs. the state of current practice: Promising future directions**
- B – Choosing the role of economic and behavioral assumptions in quantitative and qualitative water models**
- C – Empirical support for water model calibration**
- D – Opportunities and constraints in interdependent and collaborative modeling exercises**
- E – “Where to” from here?**

The organizers have invited our presenters to make a presentation or to provide remarks that each presenter thinks will best highlight specific emerging issues and opportunities. These topic areas are far too large to survey or canvass comprehensively in one presentation and we hope only to help set the stage for specific discussions on research challenges and how various approaches might apply in the Alberta context. Abundant time in each session will be allowed for discussion among the group.

Although there is considerable potential for overlap across topics, the following lists of topics and issues, sorted by session, are provided here as “invitations” for each participant to raise those of interest in the corresponding discussion period.

#### **Session (A): Water Modeling Approaches**

Emerging research trends and the “state of the art” in economic models of water allocation: what has been most popular, useful or successful in this field and which directions are most promising for the future? What kinds of models are in use here and around the world, and at what kinds of questions are they directed?

Presenter: Professor Richard Howitt, Department of Agricultural and Resource Economics, University of California, Davis

Target issues for consideration / discussion in this session

Regional water modeling approaches

o Challenges of economic-engineering simulation approaches

- Representing user economic decisions
- Stochastic dynamic programming approaches (compare static, deterministic ones)
- Spatial optimization approaches
- Platforms available, solvers, software
- Integrating water quality and quantity

o Linking micro water management decisions to regional and system water management decisions

o Incorporating institutional constraints and incentives – water rights, water laws, water markets

o Specification of alternative objective functions (e.g. optimization of social welfare in distorted markets vs. the optimization of private profit )

Applications of water models

o Supply or demand management

o Testing economic policy options – e.g., smart water markets

o Assessing variability of outcomes and risk management with short- and long-run models

## **Session (B): Modeling Agricultural Water Use**

Choosing the role of economic and behavioral assumptions in quantitative and qualitative water models—alternative objectives, assumptions: integration of water use, land use and other resource use decisions across time and space

Presenter: Professor Chokri Dridi, Department of Rural Economy, University of Alberta

Target issues for consideration / discussion in this session

- Selecting the appropriate individual unit for modeling
- Intertemporal adjustment options and implications for spatial and conjunctive water management
  - switching between multiple water sources
  - land use change
  - investment in efficient irrigation and storage
- Representation of spatial interactions among agents (e.g., endogenous or exogenous return flow, conjunctive management)
- Representation of individual agent risk
- Risk-based basin management objectives (e.g., chance constrained programming)
- Incorporating environmental services and pure public good objectives
- Are there unexploited or under-exploited opportunities for broadening or coupling economists' models of water quantity and quality to (new or existing) models of land use policy and land use change, for example? Should economists be introducing or integrating economic analysis to existing physical models of land and water use, such as those involving 2D and 3D hydrology, hydrogeology, contaminant fate and transport, water temperature, food webs, operational and design characteristics of reservoirs and diversions and so on?

## **Session (C): Empirical Issues in Water Value Estimation and/or Model Calibration**

This session will explore empirical support for water model calibration including potential uses of market and non-market data to estimate model parameters, as well as private and social water values at the margin.

Presenters: Professor Diane Dupont and Professor Steven Renzetti, Department of Economics, Brock University

Target issues for consideration / discussion in this session

- Characterizing crop response to irrigation water and soil moisture: reconciling agronomic and engineering data, sometimes in the presence of changing varieties and irrigation efficiencies
- Disaggregated approaches for estimating economic behavior from aggregate data
- Methods for approximating water demand attributes in the absence of individual use and price data
- The promise and limitations of “benefits transfer” approaches in the major water using sectors
- Challenges in estimating use and non-use water values
- Sensitivity analysis and influence analysis in a long-term research strategy—detecting which data and estimates have the greatest effect on solution values and what this implies for new data collection and non-market valuation

## **Session (D) Collaborative Modeling Exercises**

Opportunities and constraints in interdependent and collaborative modeling exercises will be explored building on key experiences from the California water system. Potential areas for discussion include: How to capture economies of scale and scope in large-scale or multi-team research environments; retention of independent research agendas within team environments.

Presenter: Professor Jay Lund, Department of Civil and Environmental Engineering, University of California, Davis

Target issues for consideration / discussion in this session

Characterization of experiences from California and elsewhere with multi-agency or multi-team research using computational models

- o What does this type of collaboration look like? How much does it “cost,” what does it achieve, and is it worth it?
- o What protocols, practices and agreements allow the sharing and verification of primary and secondary data?
- o Are common definitions of hydrological, agricultural or spatial parameters necessary for effective collaboration or comparison, and if so, how are these established?
- o What protocols, practices and agreements allow the sharing, verification and / or validation of new equations, code, modules or entire models across teams or agencies?
- o What modeling practices or strategies could streamline external peer reviews (i.e., from beyond the set of collaborating agencies)?
- o The ABC’s of model documentation and “version control” when many users might have access to “your” code and data.

## **Session (E): Where to From Here?**

This session will review opportunities and constraints related to each of the four workshop topics covered on Day 1. The presenters from Sessions (A) through (D), aided by the workshop organizers, will be given an opportunity to provide any opening observations about the directions and suggestions that follow from the full set of sessions held previously. Then the entire group will be invited to discuss opportunities to advance water policy modeling in Alberta.

- I. Where are there opportunities for collaborative research to advance water policy modeling in Alberta?
- II. How can one best move forward with collaborative research?
  - a. Where there are constraints, which of them can be side-stepped or overcome?
  - b. Which follow-up actions have been suggested from the previous sessions that can best be promoted collaboratively or collectively, and what would be the next steps for each?

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