UNIVERSITY OF ALBERTA
Alberta Land Institute

CONNECTING RESEARCH AND POLICY FOR BETTER LAND MANAGEMENT

IRRIGATION REPORT BACKGROUNDER

Oct. 2017

@AbLandInstitute

WILL THE WATER RUN OUT IF WE EXPAND IRRIGATION?

MODELING SUSTAINABLE LAND AND WATER POLICY IN ALBERTA'S IRRIGATION SECTOR

IRRIGATION IS IMPORTANT

What is irrigation? Simply defined, it's the controlled application of water to land through human-made systems, to support agriculture when rainfall alone isn't sufficient. More than any other province in Canada, Alberta relies on irrigation.

How much water can irrigation use? Irrigation licenses in Alberta total 3.5 billion cubic meters per year – up to 60-65% of the province's water usage.

What difference does it make? Irrigation dramatically improves productivity. Only 4% of the cultivated land in Alberta is irrigated, but it yields 18.4% of the province's agricultural production. Many of the province's most valuable crops are grown on irrigated land.

IRRIGATION IS GROWING

Can we irrigate more land? The river basins that supply Alberta's 13 irrigation districts are fully allocated, so if we irrigate more land, it will be with the same amount of water. To stretch the existing supply to cover more land, Alberta Agriculture and Forestry first has to confirm that enough water is available, then irrigators must vote in favour of expansion during a plebiscite. This process is expected to expand irrigated land by 10% over the next 20 years.

IRRIGATION IS POLICY

Who else needs water? Crops obviously aren't the only consumers of water in southern Alberta; cities, towns, and industries rely on the same basins, and if they face shortages of water or dips in water quality, it can be difficult for them to grow and prosper. Balancing this wide array of needs can have serious implications for the development of water management policy.

Who has the answers? No single study can address all water management issues. However, by building a numerical model to predict water demand under a wide variety of social, political, economic, and environmental scenarios, we'll give policymakers a tool that can help them understand the potential consequences of different solutions, and provide a starting point for further in-depth research.

OUR RESEARCH QUESTIONS

This project assembled a ten-person interdisciplinary team to explore the interactions of a variety of subsystems within Alberta's irrigated districts.

Below are some of the primary research questions that were investigated:

1. What economic, environmental, social, and policy linkages and trade-offs exist related to agriculture, and how do these factors interact within Alberta's irrigation districts?

2. What is the future outlook for irrigation, given changes in irrigated areas, crop types, infrastructure and climate, as well as regional development?

3. What are the current policies related to irrigation in Alberta, and what policies from similar jurisdictions might be applicable in Alberta?

4. What are the potential costs and benefits of existing and potential irrigation and water management policies in Alberta?

5. What outcomes related to water demand might develop under different economic, environmental, social, and policy scenarios?

HOW THIRSTY ARE MY CROPS?

WATER ISN'T ABUNDANT, SO WE NEED TO FIND THE BEST WAY TO SHARE

FOOD REQUIRES WATER

If you pour a glass of water to go with your meal, will you be drinking more water than the food on your plate consumed while it was growing? That depends on the food, and the size of the glass, but it raises an important point that is easy to overlook: food requires water. Farmers across the world grapple with this 'water footprint' reality as they choose what to plant in their local environments, and in some regions, humans go to extra efforts to get water to their fields.

Alberta is home to some 8,000 km of conveyance works, more than 50 reservoirs, and some 35,000 jobs tied to irrigation. The province's 13 irrigation districts currently cover the same area as the entire province of Prince Edward Island. Directly and indirectly, it's estimated that irrigation adds $940 million to the province's economy. No other province has so much experience with irrigation, and no other province grapples with the particular policy challenges that result.

What happens if, because of a dry season and the demands of irrigation, you can't wash your car, water your lawn, or even take a shower? What if the only way to get clean water is to reuse treated wastewater? Planning and policy must balance the needs of individuals, businesses, agriculture, and the environment. However, to do that, we need to able to predict how different scenarios could affect our water supply and our demands.

A COMPLEX SYSTEM

Farmers often have to make decisions about what to plant based on the demands of an international marketplace, or on incentives from other industries – water requirements are rarely the leading consideration. For instance, the crops necessary for manufacturing of biofuels might be profitable to plant, but their water requirements could be very different than traditional cereals.

What might happen if economics demanded farmers shift to growing specialty crops for biofuels, while a change in the climate led to reduced rainfall, and a new water conservation policy was implemented? Could existing crops fail? Could towns face water shortages? Could economic considerations push farmers to plant different crops? Could the ongoing adoption of new, more efficient irrigation technologies compensate for these factors?

Projecting the possible outcomes of the interaction of such diverse factors is what our systems model is being designed to do.

MANAGING THE POLICIES

Our team identified 22 water management policies, to see how they might interact with economic, social, and environmental factors to influence water supply if applied in southern Alberta:

- Alternative water supplies
- Incentives for water conservation
- Integration of water and land-use policies
- Improvement of on-farm water efficiency
- Irrigation management practices
- Joint management of surface and groundwater
- Maintenance of an agricultural land base
- Optimization of crop mixes
- Prioritization of basic human needs
- Private individuals and groups to hold water for environmental purposes
- Proportional water sharing
- Public awareness and involvement in policy and management planning
- Restraint of increase of irrigated acres
- Return flow management
- Water conservation for the environment
- Water conveyance system enhancement
- Water pricing
- Water reuse and recycling
- Water storage
- Water trading
- Water use monitoring and measurement, data collection

WHAT HAPPENS TO THAT WATER?

SYSTEM DYNAMICS FITS PERFECTLY WITH SOUTHERN ALBERTA IRRIGATION

THE RIGHT SIZE FOR STUDY

System dynamics is a methodology that uses "casual-descriptive" mathematical models to simulate real-world scenarios. By examining the interaction of a wide variety of factors, this approach allows for the inexpensive exploration of policy options, by generating impartial projections in response to "what-if" questions.

Irrigation in southern Alberta is just the right size for this type of systems modeling to provide practical, policy-related insights. Working with good data and clearly-defined, relevant questions on a variety of economic, social, and environmental factors within a discrete area, we sought to have our model offer specific guidance about the possible water- and land-related consequences of various scenarios.

By incorporating numerous 'levers' into our model, we worked to create the flexibility to use it for policy discussions beyond those we're already investigating. Modelling these levers is complex – we tested how best to incorporate modifiable key factors (for example: population growth, water availability, and crop mixes) without having any one of them inadvertently distort the results. We sought to complete this work to be used as a policy tool used across southern Alberta.

THE MODEL ISN'T AN ANSWER

Sophisticated though they are, it's essential to remember that systems models are not the *answers* to policy questions. Our model won't predict what *will* be, but what *could* be. Even the most sophisticated systems model cannot incorporate every variable of human choice into its framework.

We're not in the business of making judgments. Our model does not decide whether policies are 'good' or 'bad', but instead offers snapshots of how they might play out when they interact with numerous other factors. These snapshots can inform policymakers' decision-making processes, aid in conversations with stakeholders, and point researchers towards region-specific questions that warrant closer study.

At the Alberta Land Institute, we connect research with policy for better land (and water) management. By developing this data-driven systems model to examine major 'what if' questions, we're putting a new tool on the table for policymakers and researchers working on vital irrigation issues in southern Alberta.

OUR RESEARCH TEAM

DR. EVAN DAVIES (PRINCIPAL INVESTIGATOR) Associate Professor of Civil and Environmental Engineering.

DR. MILES DYCK (CO-PRINCIPAL INVESTIGATOR) Associate Professor of Renewable Resources.

DR. SCOTT JEFFREY (COLLABORATOR) Professor of Resource Economics and Environmental Sociology.

DR. JIM UNTERSCHULTZ (COLLABORATOR, DECEASED) Associate Professor of Resource Economics and Environmental Sociology.

DR. FENG QIU (COLLABORATOR) Assistant Professor of Resource Economics and Environmental Sociology.

MOHAMED AMMAR PhD student in Civil and Environmental Engineering.

BIJON BROWN PhD graduate in Resource Economics and Environmental Sociology.

XIAOFENG RUAN PhD student in Renewable Resources.

KAI WANG Post-doctoral fellow with Dr. Junguo Liu at Southern China University of Science and Technology

DARESKEDAR AMSALU Masters student in Resource Economics and Environmental Sociology.

MARIE-ÈVE JEAN MPhD student in Civil and Environmental Engineering at INRS, Quebec City.

DAWN TRAUTMAN Research Associate at Livestock Gentec, University of Alberta

WHAT WERE THE FINDINGS?

REPORT PAVES WAY FOR STRENGTHENED POLICY AND SUSTAINABLE GROWTH

NEW SYSTEMS MODEL FOR IRRIGATION

Through our work, we were able to create a new system model to study sustainable land and water policy in Alberta's irrigation sector. The new systems model to study sustainable land and water policy in Alberta's irrigation sector, called CropSD, is one of the most detailed model of its kind for river basins in Canada.

CropSD simulates crop biomass and yield for six crop types, calculates irrigation water demand for each crop based on on-farm irrigation technologies, gross irrigation water demands based on the conveyance network, and reservoir releases to satisfy irrigation demands. Further, it can predict the changes in these factors until 2040.

With irrigation in Alberta generating nearly $3.2 billion to the national GDP in 2011, these type of modelling systems are critical to develop public policy when it comes to water management for municipal and agricultural activities.

The hope was that the agricultural models could be coupled with municipal components when it comes to demands on water use, but due to constraints, this work was not completed under this study.

At the Alberta Land Institute, we connect research with policy for better land (and water) management. By developing this data-driven systems model to examine major 'what if' questions, we're putting a new tool on the table for policymakers and researchers working on vital irrigation issues in southern Alberta.

BENEFIT OF SUBSIDIES FOR EXPANSION

The study also found that the expansion of current public investment from both the provincial government (75 per cent) and irrigation districts (25 per cent) would be significantly beneficial for producers, with a net-profit value of $78 million or $1,324 per hectare at the baseline discount rate of 10 per cent.

Without this subsidy, expansion would be unattractive for producers, because the net benefits obtained from convertying dry land crops into irrigated crops are insufficient to cover the full investment costs.