

PROCEEDINGS

Climate Change: Impacts and Adaptation on the Red and Assiniboine Rivers Basins

A workshop sponsored by:

*Manitoba Eco-Network
Walter & Duncan Gordon Foundation
Manitoba Water Stewardship*

Thursday, June 21, 2007
Crossways in Common, 222 Furby Street
Winnipeg, Manitoba

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Sponsored by:

- Manitoba Eco-Network Water Caucus <http://mbeconetwork.org>
- Walter & Duncan Gordon Foundation <http://www.gordonfn.org>
- Manitoba Water Stewardship <http://www.gov.mb.ca/waterstewardship>

Planning Committee:

Glen Koroluk	Manitoba Eco-Network Water Caucus
Dave Brophy	Manitoba Eco-Network Water Caucus
Hank Venema	International Institute for Sustainable Development
Lance Yohe	Red River Basin Commission

Presenters:

Dr. Henry Venema	Director, International Institute of Sustainable Development
Dr. William Buhay	Assistant Professor, University of Winnipeg
Mr. Alf Warkentin	Manager, Manitoba Water Stewardship
Ms. April Kiers North	Coordinator, Red River Basin Commission
Ms. Andrea Merredew	Manager, Climate and Green Initiatives Branch
Dr. Irene Hanuta	Climate Specialist, Prairie Farm Rehabilitation Administration

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Presentation – Dr. Henry Venema, Director, Sustainable Natural Resources Management International Institute of Sustainable Development

“Climate Change Vulnerability in the Region: Adaptation as Resilience”

The Canadian Prairies are particularly sensitive and vulnerable to changes in climate. The prairies have experienced some of the greatest increases in surface temperatures globally since 1901. The trends also show steady increases in temperature and deficits in precipitation for the prairies. These decreases in precipitation are expected in an already spring/summer moisture-deficit region.

Many of the prairie’s economic activities are directly dependent on weather; agriculture for example. Climate change will greatly amplify the variability of weather in the Prairie Provinces thereby affecting those activities. The extent to which these changes will affect agriculture will be determined by the ability of the sector to successfully adapt.

While it may be possible to identify some emerging problems in advance, changing conditions often render specifically targeted management proposals irrelevant or impossible to implement. Because of this, our research indicates a clear need for frameworks that are “adaptive,” in other words, processes that reflect uncertainties and can respond and adapt as contexts change or unforeseen problems emerge. Specific solutions are less important than the existence of processes and frameworks that enable solutions to be identified and implemented as specific constraints and contexts change.

Climate Change and the Prairies

Globally widespread changes in extreme temperatures have been observed (Intergovernmental Panel on Climate Change, 2007). This includes colder days, and colder nights and less frequent frost. More hot days, and hot nights, and additionally more frequent heat waves have been observed.

Projected for the prairies are changes in precipitation combined with longer and warmer growing seasons. This will alter short and long term water supplies and demands by ecosystems and society, and intensify and extend extreme drought and flood events.

Increased drought frequency will lead to dessication of organic soils and soil cover and lower water storage capability. Under these conditions, runoff becomes almost instantaneous and results in intense flash floods.

During this century the Canadian prairies have experienced two periods of higher than normal temperatures and abnormally low rainfall/precipitation: the 1930s and the drought of 1988. Extreme events such as these have adverse effects on the economy. 2001-2003 may have been the worst ever which saw \$3.6 billion lost in agricultural revenue, \$5.8 billion lost in gross domestic product (GDP), and jobs lost exceeded 41,000.

In recent experience, Manitoba and Alberta are the provinces primarily affected by extreme events.

Vulnerability in the Prairies

Climate change is projected to increase water quality stresses on the prairies. Dilution capacity will decline under climate change as streamflows decrease and lake residence times increase. Prolonged droughts associated with climate change will result in soil erosion from agricultural lands creating sedimentation problems and increasing nutrient loads in local water systems. These problems lead to eutrophication of local water bodies and to increased pathogen loading in streams in summer.

Vulnerability is exacerbated with reduced ecological buffering. Human altered landscapes are dominated by cropland with only narrow segregated strips of forest and few wetlands and marshes. The remaining grassland and forested areas are fragmented by cropping and foraging land uses.

The framework for determining vulnerability includes exposure from historic as well as future climate stress, and adaptive capacity. Adaptation occurs continuously; successfully and unsuccessfully. Ongoing successful adaptation is resilience. The objective is to identify, learn, and replicate the policy environment that creates, and not impedes these successes.

Adaptive Capacity: *Ad-hoc* versus Learned Responses: Drainage and Minimum Tillage

Responses to weather and non-weather shocks and stresses must insure resilience and reduced vulnerability by promoting adaptive capacity and therefore long-term adaptation. Farmer-response to weather-related shocks and stresses is seen to favor short-term practices. The highest ranking response was to employ a standard farm practice such as cultivation (drainage and tillage). A less favorable response was to reduce tillage for example. Legal and illegal drainage maintenance and wetland clearing has dominated prairie water resource management.

Producers in the south study area are more than twice as likely to respond with this ad-hoc measure: compounding downstream impacts to excess moisture. Recourse to a designated institution for an integrated strategy such as the Conservation District is a last resort. Ignoring integrated strategies in preference of other short term coping measures increases future vulnerability. Since climate change projections and observed trends call for increased winter and early spring precipitation, and less precipitation during growing season, we should look at storing the resource.

Minimum tillage is an important learned response combining decades of extension starting with Prairie Farm Rehabilitation Administration (PFRA) in the 1930s. It is observed that farmers in the south are more likely to use minimum till due to their experience historically with more severe soil moisture stress. They have out of necessity, and deliberate extension, learned minimum-till.

Minimum till appears in the north but generally as a response to multiple stresses (labour, energy costs). Farmers in the north study area are more adept at a portfolio approach to farming. The varied topography and landscape heterogeneity of the north region creates fewer drainage problems and induces more diversified agricultural forms.

Adaptive Capacity: Policy Gap

Public policy affects the success of adaptive capacity. The government's policy and legislation also determines how quickly the agricultural sector can adapt. Issues include examples such as taxation and incentives, subsidies and the environment, crop insurance and income support.

Drainage restrictions and weak incentives around wetland maintenance are eliminating the landscape heterogeneity necessary for the ecological buffers that improve resilience. Wetlands now are an Environmental Farm Planning (EFP) Best Management Practice (BMP) in the biodiversity category, and not water conservation.

We need to align multiple objectives such as nutrient management, carbon sequestration, bioenergy, flood peak reduction with policy and instruments. Still policy incoherence exists around taxation. We need incentive structures such as payments for ecosystem services.

Key Messages: Millennium Ecosystem Assessment (2005)

What is needed is integrated water resource management through local watershed governance, including increased use of economic instruments for ecological goods and services, specifically:

- Make sure the value of all ecosystem services, not just those bought and sold in the market, are taken into account when making decisions
- Remove subsidies to agriculture, fisheries, and energy that cause harm to people and the environment
- Introduce payments to landowners in return for managing their lands in ways that protect ecosystem services, such as water quality and carbon storage, that are of value to society
- Establish market mechanisms to reduce nutrient releases and carbon emissions in the most cost-effective way.

Foremost Water Sector Recommendation: Payments for Ecosystem Services on a Watershed-basis

Adapting Mosaic--In this scenario, regional watershed-scale ecosystems are the focus of political and economic activity. Local institutions are strengthened and local ecosystem management strategies are common; societies develop a strongly proactive approach to the management of ecosystems.

Presentation—Dr. William Buhay, Associate Professor, Geography Department, University of Winnipeg

“Post Glacial Climate and Environmental Change in the Red River Basin”

Drought Reconstructions from Terrestrial and Lacustrine Archives

Past climatic changes can often be approximated from stable isotopic (carbon and oxygen) variations measured in both terrestrial (tree-rings) and lacustrine (lake sediment) organic records. Isotopes are naturally occurring variations (different numbers of neutrons) of the same element (i.e. carbon and oxygen) that result in reaction controlling mass differences between molecules (CO₂ and H₂O) regularly incorporated into both terrestrial and lacustrine plants. These mass dependent reactions can be influenced by climate related parameters such as atmospheric temperature and moisture content. Terrestrial and lacustrine plant archives often represent valuable sources of past climate information.

The work completed in this study includes both Lake Winnipeg (1000-years) and Red River Basin tree-ring (200-years) carbon and oxygen isotope profiles. Past climatic episodes (primarily droughts) have been inferred from the carbon and oxygen isotope profiles. In the case of the Lake Winnipeg core drought or dry period intervals results in isotopic alterations in lake water, the resident aquatic organisms and tree-ring wood. An enrichment of heavy oxygen and carbon in the aquatic organisms and tree-rings signifies a period of drought. There are approximately eight indications of severe drought in southern Manitoba during the last 1000 years corroborated by increases in lake salinity and alterations in regional vegetation. During flood periods however, the inflow of more organic debris results in heavy carbon isotope enrichment in the lake sediment archived organic material.

The record shows that the frequency of flooding has increased over time (in the last 200 years) due to changes in land-use. What remains unknown is the magnitude of these floods.

Climate Change and Red River Water Quality

Several parameters record twentieth century shifts in the quality of Red River water. Several indicators (sediment phosphorous levels, macrofossils and trace nutrients) are attributable to anthropogenic contamination.

There seems to be the potential for significant deterioration in Red River and Lake Winnipeg water quality in the future. Snow entering the river in flood seasons carries nutrients and contaminants into the Red River Basin, otherwise referred to as contaminant loading. Water quality inevitably deteriorates over time.

Red River water quality will directly contribute to changes in climate through the production of increased greenhouse gas emissions. For example, nitrous oxide is 300 times more efficient than carbon dioxide as a greenhouse gas. Similarly methane is twenty times more efficient than carbon dioxide. These are gases formed and released

due to the contaminants from sewage treatment, urban runoff and agriculture present in the water.

**Presentation—A.A. Warkentin, Hydrometeorologist, Manager,
Forecasting and Coordination, Manitoba Water Stewardship**

“Sensitivity of the Canadian Prairie Water Sector to Climate Change: Impacts on Water Supply and Flooding”

The Red River Basin is due to experience the greatest changes in climate. The climate on the prairies is already extreme therefore climate change will increase weather volatility providing greater extremes for both floods and drought.

Global Climate Models (GCMs) can help us determine the kind of climate changes we are facing. Hydrometeorological analysis, which concerns the hydrologic cycle, evapotranspiration, snowpack and soil moisture, will determine how climate change will affect the hydrologic cycle. Hydrological science, which relates to runoff, streamflow, and surface and groundwater levels, will be employed to determine how projected changes in the hydrologic cycle impact runoff, streamflow, and aquifer recharge, for both average and extreme conditions.

Impacts of Climate Change on Snowpacks, Annual Runoff, etc.

Due to changes in climate, a warming of up to seven degrees Celsius is expected as well as a significant increase in precipitation in the spring. Significant increases in evapotranspiration are also expected. However, studies show no particular trend thus far. Increases in vapour pressure changes could be caused by changes in evaporation further altering the climate in this area. Overall, a decrease in soil moisture is expected in the Red River Basin.

We are very dependant on natural spring runoffs to rejuvenate our water supplies on the prairies. A change was witnessed in this pattern in 2005 when the majority of runoff was experienced in July and not in the spring. In the United States, the 29 percent decrease in runoff was due to smaller snow packs. The impact of climate change on snow packs indicate that although winter precipitation is estimated to increase in the future, increases in temperatures will result in large decreases in the April 1 snow pack for the entire Western United States

A comparison of Sturgeon Creek shows the projection of a significant decrease in soil moisture capacity along with less winter precipitation and spring rain. The result is 60 percent of runoff in 2050 (% of 1961 – 1999). This is a significant reduction.

Impacts of Climate Change on Prairie Water Supplies (Lakes and Reservoirs, Groundwater Supplies, etc.)

Climate change will have an effect on summer-fall-winter streamflow resulting in flows that will be lower due to earlier, smaller spring runoffs. Summer rain will be at least 10

percent lower but rainfall intensity will increase. Summer temperatures will increase by 2.5-4.0 degrees Celsius and evapotranspiration will increase significantly. It is assumed that more occurrences of winter melt and rain will occur.

The likely consequences of these assumptions are that the average summer-autumn flows will be significantly lower and winter flows somewhat greater. Greater extremes in river flows will most likely translate to less hydroelectric power generation due to decreases in water. Rivers without significant storage reservoirs could experience critically low flows more often and the implications are decreases in water supply for irrigation, industrial use and domestic use.

Lakes and reservoirs will be affected. The inflow of runoff will generally be reduced in lakes and reservoirs resulting in lower levels. These lower levels will generate less available water to activities downstream such as irrigation or consumptive uses and less hydroelectric power generation. Poorer water quality will ensue and will generally have negative effects on fishing and recreation. In addition, water temperatures within these water bodies could rise up to 5 degrees higher due to their shallowness. An increase of vapour pressure in the atmosphere will occur and the annual net evaporation will increase significantly.

Groundwater and aquifer recharge will be reduced as well. Reduced snow packs and increased evapotranspiration will more than offset the increased spring rainfall. The lower water levels in aquifers may result in the changes in allocation of water. The demands for water for irrigation and consumptive use may not be fully met during dry spells and private wells may run dry more frequently.

The prairies may well witness the worst of both climate change and hydrological change: a greater volatility in weather and greater extremes for both floods and drought. Effects of increased temperatures in the prairie region will outweigh increased precipitable water in the atmosphere. Therefore droughts will likely be more severe in the future. The hope of these, and future studies, is to predict the future occurrences of floods and droughts and to develop integrated watershed planning to deal with the changes in climate.

Socio-Economic Component

Historically, drought tends to occur every 30-50 years due to climatic factors other than global warming. The worst drought in last 500 years was from 1791-1800. There was a severe drought in the 1930's and a significant drought in 1988-1991. There have been many 'single' dry years like those in 1961, 1973, 1977, 1981, 1991, and 2003. These short periods are related to Decadel cycles.

Hydroelectric power is a billion dollar annual industry in Manitoba. Losses due to the 2003-2004 drought were about half a billion. Needless to say, Manitoba Hydro is quite concerned. The resiliency of the system could be threatened if climate change increases the duration and/or the spatial extent of drought.

The impacts of climate change will change the way prairie water supplies are managed. For example, present reservoir capacities may be insufficient to meet multiple water uses during dry spells due to lower inflows. Reservoirs may need to be enlarged or additional reservoirs may need to be built. Probable inflow forecasts for reservoir/lake operations may need to include the likely effects of climate change.

Changes that will have to be dealt with include the decline of rivers to unsuitably low flows more often and the poor water quality which is associated with these decreased levels. Lake levels will be generally lower and will impact fishing, hydroelectric power generation, and recreational activities. Glaciers in the Rocky Mountains could virtually disappear causing lower summer-autumn flows in the Saskatchewan River system. Groundwater levels will decline impacting farming and rural water supplies in general. Dugouts, ponds and shallow wells will dry up much more frequently causing hardship for the rural population. Water management and allocation will need to adapt to minimize the negative impacts of reduced water supply.

For the prairie economy a number of complications may arise from climate change. Agricultural productivity could suffer due to insufficient water for irrigation and domestic use. Similarly, industry could be curtailed or its efficiency reduced due to water quantity and quality concerns. Fishing and recreation could be less productive due to lower water levels. Hydroelectric energy costs could rise due to greater summer demand and decreased supply. An increase in expenditures may occur due to drought proofing, water conservation, improved watershed planning, and flood proofing needs. Winter sports such as skiing and power tobogganing, and consequently their industries, could be seriously affected. And in extreme circumstances there is the possibility of out-migration due to serious water shortages.

The Effects of Climate Change on Red River Floods

There are many variables affecting the volume of spring runoff. The assumptions include a prediction of lower soil moisture at freeze-up. It is projected that there will be little change in winter precipitation, but winter temperatures could increase by 5-6 degrees Celsius. Spring runoff and stream flow would be significantly reduced on average because of the decrease in snow packs. The average snow accumulation period will be effectively reduced by about 6 weeks and sublimation losses of snow will be greatly increased. Spring rain increases of 15-25 percent are predicted which may result in the offset of the decreases in autumn soil moisture and snow pack. However, an unusually harsh winter could be coincident with increased spring rain to produce extreme runoff.

It is likely that major prairie spring floods will be less frequent and rather rain generated floods, such as the record flood of 1993 on the Mississippi and Missouri Rivers, will become a greater possibility. This holds true particularly in areas where the soils are predominantly clay or where there are steep slopes. It is projected that the floods will be smaller and more localized summer flooding will occur due to heavy thunderstorms. Small watersheds will likely experience increased flood peaks.

Concerns and Recommendations

There are concerns on estimating climate change and the effects for the prairie water sector arising from data collection and interpretation. Between models significant differences persist, especially in precipitation projections. There is also a lack of sufficient spatial and temporal resolution in the GCM scenario output. There is not enough information on how ‘natural’ climate variability relates to that of future time horizons. We need more quantitative studies on impacts that use detailed GCM data and hydrologic models. In absence of quantitative info on climate change effects on water, sensitivity analyses are recommended.

Presentation--April Kiers North, Basin Coordinator for Water Quality, Red River Basin Commission

“Red River Basin Drought Preparedness Strategy”

The Red River Basin Commission (RRBC) is a 42 member board of directors representing Manitoba, North Dakota, South Dakota and Minnesota. It consists of government representatives, rural municipalities, cities, First Nations Tribes, and environmental organizations. Our objective is to work together to achieve common goals for water and land management within the Red River Basin.

There are no boundaries where water is concerned; three states, one province and two countries share one river. That is why we need to work together to find solutions to land and water management problems.

The Red River Water Law Study of 2005-2006 was funded by the International Joint Commission (IJC) and Manitoba Water Stewardship. The study’s technical and policy task representatives were from Manitoba, North Dakota, Minnesota and South Dakota. It looked at jurisdictional water laws, policies, and licensing in the context of water scarcity.

The Water Law Study posed a series of questions in which it sought answers for:

- How are priorities established between users in times of drought?
- What legal recourse do users have when supplies are short?
- Is there an ability to ration water to users and among users?
- Do entitlements change with changing water supply conditions?
- What is the ability to allocate water to in-stream flow needs within a jurisdiction?
- What is the role of water quality to in-stream flows?

What the Water Law study highlighted were differences in approach. The Red River is a municipal water source and there are regional as well as local water supply efforts. We need to address long-term shortages of this water supply and effectively look at a basin-wide approach.

RRBC and its partners identified a need for a drought strategy that is basin-wide. The drought strategy will enhance our understanding of existing efforts and will prepare us for the long-term.

The request for proposal issued for a scoping document that is to be completed by September 2007. The scoping document will outline: existing drought plans; water budget and impacts of drought; drought responses: dispute resolution and long-term planning (For example, “soft path” etc.). Whether RRBC carries out the strategy on its own will be determined once costs and timelines are provided.

Presentation—Andrea Merredew, Manager, Climate and Green Initiatives Branch Manitoba Science, Technology, Energy and Mines

“Adaptation Strategies for Manitoba”

The Manitoba government's strategic framework for a green, prosperous, growing province is a guide to how we will continue to approach preserving and protecting our environment, promoting the health and well-being of Manitoba families and stimulating and managing sustainable economic growth. Since 1999, the Manitoba government's strategy has been to focus on the following priorities to reduce emissions and promote adaptation to a changing climate:

Acting on Climate Change and Energy

Our first green priority is to meet and exceed climate change targets, as established in the Kyoto Accord, and create sustainable business practices and opportunities in the process.

We have committed ourselves to a very aggressive goal of developing 1,000 megawatts of wind power in Manitoba over the next decade. This will generate significant levels of clean, renewable electricity and enable greenhouse gas reductions of more than 3.5 million tonnes annually. Pursuing wind energy will stimulate \$2 billion in new investments and create sustainable jobs and income.

Manitoba is the North American leader in earth energy systems also known as geothermal heat pumps. These systems eliminate natural gas bills, reduce greenhouse gas emissions and foster a growing industry in our province. Manitoba now has between 25 percent and 30 percent of all geothermal system installations in the country and 56 percent of Canada's geothermal installers are trained in Manitoba. Manitoba Hydro's Earth Power Loan Program has helped make this renewable energy technology more accessible to Manitoba homeowners with installations tripling in the past four years and predicted to double again in the next two years.

Manitoba was the first province to build an ethanol plant and one of the first to build a biodiesel plant. With new biodiesel plants being built, Manitoba biofuel production will escalate rapidly providing environmental and economic benefits. Ethanol will create a new market for 14 million bushels of wheat and biodiesel will create new markets for off-

grade oil seed crops that will benefit Manitoba producers. Local production will decrease the amount of imported petroleum products and the burning of biofuels over petroleum products will eliminate 150,000 tonnes of greenhouse gasses annually.

New incentives for efficient vehicles such as hybrid cars and buses are being established and promoted to reduce greenhouse gas emissions and maintain Manitoba's reputation as a leader in climate change action.

Protecting Our Water

New legislation has been passed to ensure safe drinking water for all Manitobans. Coupled with this protection is the protection of water right at the source: the Water Protection Act. Established in 2005, the Water Protection Act will put water quality standards under legislation for the first time and establish water quality management zones to better protect sensitive ground and surface water. The act also promotes watershed based planning. In addition, the number of conservation districts has nearly doubled since 1999 and new watershed plans will continue to build on the work of local conservation districts across the province.

The act also contributes to water conservation and we will continue to build on this by establishing regulations for limitations on phosphorus and nutrient loading from agriculture and farm fertilizers, livestock and municipal waste for example.

Many of the measures in The Water Protection Act will also help preserve Manitoba's prairie ocean--Lake Winnipeg. In order to meet the Lake Winnipeg Action Plan targets more work with the federal government to support more research, greater incentives and inter-provincial and international co-operation will be sought.

Protecting Our Natural Areas

The Manitoba government has a long standing commitment to the creation and preservation of parks. Six new provincial parks have been created since 1999 and the government is expanding park and ecological reserves to include the Delta Marsh and Tall Grass Prairie Reserve, and even urban green spaces like Bois des Esprits and Omand's Creek. Our goal is to designate five new and major protected areas by 2010 and to increase both the number of ecological reserves and rivers of special status.

Reducing Waste and Preventing Pollution

Reusing, recycling and other waste reduction strategies are directly related to reductions in greenhouse emissions, water stewardship resource conservation and the creation of community economic development and employment. This green strategic framework combines and coordinates efforts helping to ensure that goals coincide across sectors and that objectives can be met.

Growing a Sustainable, Prosperous Economy

Linking environmental sustainability with economic growth is at the forefront of strategies here in Manitoba and worldwide. Hydroelectric power generation, geothermal energy, wind and biofuel production, all contribute to reductions in greenhouse gas

emissions while simultaneously creating employment and infrastructure for a growing economy.

Fostering a Green and Healthy Society

Manitobans' health and quality of life is directly related to the health of the environment. Beyond the very basics to sustain life, the environment and its various ecosystems support virtually everything that makes up personal and social well-being such as food, livelihood, shelter and access to goods, as well as less tangible factors like personal safety, family and community bonds, respect for others and social order. Our priority is to advance healthy communities and families through ongoing education and the promotion of sustainable work practices.

Greening the Provincial Government

The Manitoba government recognizes that it must lead by example when it comes to being a good steward of our natural resources. The province is committed to pollution prevention and protecting the environment in its daily activities. It does this by operating more sustainably, introducing more energy-efficiency, reducing waste and saving taxpayers money.

Ongoing Initiatives

In its commitment to a growing and green economy, the government has many ongoing initiatives including: the Climate Change Action Plan; Climate Change Legislation; the Manitoba Credit Registry; the Landfill Gas Mitigation and Management Strategy; and a \$53.8 Million Federal Eco Trust.

Beneficial Management Practices (BMPs)

Manitoba emits just over 20 megatonnes of greenhouse gases, which averaged 17.3 tonnes per person in 2005. Manitoba, accounting for 2.7 percent of Canada's overall emissions, is the third lowest emitting province in Canada. The transportation sector accounted for the greatest amount, 37 percent, while agricultural activity was responsible for 30 percent. While contributions from the energy sector have been fairly stable over the long term, agricultural emissions have increased significantly since 1990 due primarily to expansion of Manitoba's hog and cattle industries.

Our department is currently working with Manitoba Agriculture, Food and Rural Initiatives (MAFRI), Water Stewardship and the agriculture sector to identify BMPs that will encourage and enable producers to make their operations more cost efficient and environmentally sustainable.

BMPs can lead to benefits such as economic opportunities and improving environmental health. Producers in Manitoba and across Canada are incorporating practices like soil testing and nutrient management to ensure their own crop-nutrient resources are not being wasted and water quality is maintained. The use of renewable energy such as biofuels allows for diversification and a reduction of farm fuel costs. The preservation of ecological goods and services translates into a direct payment to producers.

Agriculture can play an important role in Manitoba's response to climate change. The adoption of sustainable agricultural practices like reduced tillage leaves more crop residue on the soil reducing wind and water erosion. The reduction or elimination of tillage practices also allows soil carbon to accumulate which protects against carbon dioxide emissions. Land management practices such as reduced summer fallow, improved grazing strategies, and conversion of croplands to annual forages, are able to store and absorb greater amounts of carbon dioxide rather than releasing them into the atmosphere. Wetland restoration, permanent cover, afforestation and riparian area improvement similarly maximize environmental benefit while sequestering carbon.

The alignment of similar objectives across sectors is an attempt to promote a strategy that protects the environment while building a prosperous economy. There are benefits to Manitobans in reducing emissions and more work is being done with MAFRI and Water Stewardship to promote adaptation techniques that will insure the reductions of emissions and the health of the environment. Our next steps include working together on a Climate Change Action Plan, on Climate Change Legislation, and the Manitoba Credit Registry.

Presentation—Dr. Irene Hanuta, Senior Policy Analyst, Climate Specialist, Prairie Farm Rehabilitation Administration

“An Emerging Agriculture and Agri-Food Canada (AAFC) Policy Relating to Climate Change and Water Resources”

The Prairie Farm Rehabilitation Administration (PFRA) has been working with rural prairie people for more than 60 years, helping them meet the challenges presented by a demanding climate and an ever-evolving agricultural industry. We now have a presence across all of Canada. We serve over 30,000 clients annually through ongoing programs and short-term initiatives offered from a network of district and regional offices and several special centres. While we have adjusted our programs over time to remain relevant, our focus has been constant--to ensure the sustainable use of soil and water resources.

Water Risk Management Programs

Both rain-fed and irrigated agriculture are under pressure. But the bottom line is that growing populations with more money to spend on food are, and will, drive the need for more efficient production including conservation & irrigation development. Efficient production is very much a global industry.

With increasing reliance on irrigation for higher value crop production, water will increase in value as an important input to remaining competitive world food production. Presently forty percent of global food production comes from irrigation on eighteen percent of the arable land. The issue is that water related risks of drought and floods are projected to increase with climate change.

A wide-range of public investments is being made by our competitors to improve their competitive position. Some of our strongest competitors are implementing comprehensive drought and flood strategies to reduce risks to agriculture. They include policy reform, monitoring, prediction, targeted programs with triggers, adaptation support, targeted research, and aggressive market opportunity identification. As the resiliency of our competitors increases, our competitive advantage is reduced.

For example, the Australian Government is aggressively working with state governments and producer organizations to develop a policy of “self-reliance” in drought management. Integrated in this strategy is increased investment in adaptation and mitigation research, financial management, and water trading. These efforts appear to be increasing the efficiency of water markets in Australia.

Americans are implementing the National Integrated Drought Information System which includes a \$100 million dollar investment in a national climate monitoring system. It also includes significant investment in physical and biological systems, and social research intended to reduce producer and municipality vulnerabilities while increasing their productivity.

Significant investment in water transfer infrastructure is being made in the United States as well. An example of public investment response is in the Western United States. The crisis and conflicts over water scarcity in the U.S. have caused the U.S. Bureau of Reclamation to make funds available through the Water 2025 Program to rehabilitate irrigation works, complete water planning studies, and encourage water conservation efforts. To date twenty-one million dollars has been committed to support Water 2025 Challenge Grants.

The Canadian Context for Water-Related Policies

We have to ensure our infrastructure is adapting to new realities which will require a proactive approach by government and public investment for public good. Canada’s water resources could give us a competitive edge in the medium to long-term if we become more active in conservation and management.

Pollution Probe water policy workshops held across Canada in 2006 found escalating public concerns about water. They included real scarcity issues and concerns about pollution where agriculture was often implicated. Agriculture is a large consumer of water. Agriculture returns only about 20% of the water withdrawn (i.e. the water is consumed by evapotranspiration of plants and/or is lost to evaporation or seepage), whereas cities and many industries return the most of the water withdrawn to the source.

The impact of a lack of water will affect our competitiveness from both a quality of product, and volume of production perspective. The best evidence is the increasing requirement for supplemental irrigation as a requirement for delivery contracts with potato processors in Manitoba and Atlantic Canada. Processors of higher value crops are increasingly requiring irrigation to ensure the quality of the raw product and to reduce the overall production risk. Interest in this smaller scale “supplemental irrigation” (i.e. the

capacity to add to natural moisture at critical times to crop development with limited irrigation) is becoming more and more common in Canada.

Water Governance in Canada

There is a need to increase the investment of public funds. We need to consider the institutional, infrastructure, and other issues necessary to have and ensure security of water supplies under a changing climate and water market that maintains Canada's agricultural competitiveness, environmental sustainability, and quality of life.

Several provinces are addressing their water management policies and Environment Canada continues to lead federal efforts toward a Canadian Freshwater Strategy in recognition of the importance of the issue.

Water Issues in Canada

The Canadian approach to water governance is complex and uniquely and typically Canadian. It relies on the cooperation between many authorities in federal, provincial and municipal jurisdictions. Environment Canada has the federal lead on water based on the Canadian Environmental Protection Act and the Canada Water Act. There are others with key roles, however, provinces have the main water management role in Canada but are frustrated by a lack of coordination at the federal level.

Agriculture and Agri-Food Canada (AAFC) Role in Water

While agriculture is the major user of water, it can also be the key in improving its use and conservation of the resource. AAFC can offer Canada flexibility in terms of its future domestic and international water marketing policy and structure, provided the investments in market structures, infrastructure, and legal rights are made.

Most provinces in Canada have developed water strategies where protection of quality and security of supplies are critical elements. Protecting ecosystem integrity is an emerging priority across Canada. In agricultural watersheds this translates to BMPs, riparian areas, ecological goods, and services.

Agriculture in every region will have challenges related to water; AAFC will need to be flexible to help address issues as they emerge. In addition, AAFC needs to identify which activities are of sufficiently high value and are provincial priorities in the agriculture sector to justify investment. The objective is to maintain a profitable agriculture and agri-food sector that uses water resources sustainably to benefit all Canadians through economic growth and by minimizing the risk to human health and the environment.

Research and analysis is imperative in expanding our knowledge base related to water and in adjusting current and future agricultural policy accordingly. It is important to facilitate the department's participation in integrated land and water resource management (ILWRM) and in other collaborative work. It is necessary as well to build confidence in the sector through the transfer of knowledge and technologies to stakeholders and to maintain good communications with the Canadian public.

The AAFC Strategic Water Framework will: assist the department in supporting provincial water management initiatives; enable the department to make an effective contribution to broader national and international initiatives for water management; create a platform for further discussion with other stakeholders, including other federal departments, the provinces, and the agricultural sector; and provide the context for an irrigation plan, drought plan, and others (e.g. excess moisture/ flood).

Agriculture needs the right amount of water of appropriate quality in the right place at the right time. The key drivers are climate change, drought, flooding, growth of the agricultural industry, agricultural intensification and diversification, population growth, and competing water uses.

Improved security of supply involves gaining a greater understanding of the water resource, its availability to users, and how actual use by the agricultural sector and other sectors measures up against the supply.

Greater on-farm water efficiency is achieved by improving the efficiency of water use on the farm which has the effect of increasing the supply. Although all agricultural water uses can be improved in their efficiency, irrigation provides the potential for the greatest water savings.

Agriculture contributes contaminants to water from point sources, such as intensive livestock operations, and non-point (diffuse) sources, such as widespread fertilizer application to cropland. Limiting this contribution will improve the quality of receiving waters, protecting the aquatic environment and resident biota and making the water more suitable for human uses.

The agriculture sector is often perceived as a water polluter and inefficient consumer of water. The sector will develop greater confidence in its competitive potential as better performance in water management opens new trade opportunities. The Canadian public will have greater confidence in the industry as it sees BMPs being adopted and water quality targets being achieved.

Agriculture's water needs can be met by: focusing on technical/scientific/research support; planning long-term water supplies and develop adaptation strategies; helping agriculture manage flooding and drought (climate risks); working with industry on increasing water use efficiency/conservation; and synthesizing information on water use and water supplies to support effective water management.

Nutrients, pathogens, pesticides, water consumption, public confidence, information gaps and access are all issues that need to be addressed. We need to understand the sector's contribution relative to all other sectors that impact water quality or quantity. Only then can society start to understand what the marginal benefit is of investing in various programs to effect water quality. Also if we are going to ask the sector to bear costs, it must understand how this effort will translate into meeting societal goals.

National Drought Strategy

AAFC Strategic Water Framework and the proposed Drought Strategy will help agriculture policy and decision-makers, and all stakeholders to make timely and informed decisions to prepare for, mitigate, respond to, and adapt to drought.

With the risk posed by increasing variability under climate change, a coordinated National Drought Strategy will be beneficial for AAFC to lead because: issues and gaps in knowledge, monitoring, and in dealing with current drought (and other climate risks) can be identified; roles and structures can be established to deal with issues and gaps; agricultural areas and practices which are most at risk can be identified; and AAFC can work with provinces/territories/producer groups to improve future preparedness, increase resilience to drought, and continue to be sustainable.

From a Canadian perspective drought can have significant negative impacts to society, the economy, and the environment. An AAFC drought strategy is needed because Canada lacks a national drought strategy or policy. We need to ensure our environment and economy continues to function. Our agriculture competitors are also facing and will continue to face drought (Australia has developed a national strategy; the U.S. is in the process of developing one). To maintain competitiveness and not be at a disadvantage, Canada also needs to ‘drought-proof.’

Drought is a business risk that can see management improvements by both governments and producers (producers should accept responsibility for managing reasonable levels of risk; and, ‘abnormal’ situations which go beyond reasonable expectations and outside the coping range will still require support). We can be proactive and be prepared for future longer-term climate changes (Intergovernmental Panel on Climate Change predict a 66-90 percent increase of drying and drought in mid-latitude continental areas). We can also become better prepared if more variability occurs. A strategy development process will identify current activities that work and help move forward development and implementation of new activities.

Conclusion

Sustainability is still a key factor in the development of the industry. Water policy, markets and climate are changing and we need to be in step with agricultural opportunities. As adaptation takes place within a global context, Canada needs to be aware of competitive opportunities and the link to water supply and development.

Presentation—Dr. David B. Brooks, Director of Research, Friends of the Earth Canada

“Water Soft Paths: Fresh Water and Ecological Security for Canadians”

Explaining the Concept: Thinking Globally

The concept of soft water paths embodies the vision that the future lies in restricting demand, and not in increasing supply. Four principles distinguish water soft path (WSP) analysis from conventional approaches:

1. Treat water as a service to be achieved, not an end in itself.
2. Make ecological security an absolute criterion, not something that is checked as an afterthought.
3. Match the quality of water delivered to that required by end use, so as to conserve quality of water as well as quantity of water.
4. Plan backward, from future to present, to ensure that you have a firm vision of where you want to end up before starting to get there.

Soft paths differ from hard paths in their attempts to scale down our impact on natural resources. For example, hard paths depend on large, centralized sources of water supply and they assume that demand for water is fixed function of growth. Waste is moved to central plant and treated chemically. Soft paths, in contrast, focus on small, distributed sources of supply and demand for water is built-up from specific end-uses. Waste is kept nearby or on-site and treated with bio-mimicry.

There are lots of reasons for choosing ‘soft paths’ over hard paths. Most obviously, they use a lot less natural resources, particularly less steel and concrete. However, the more important reason is that they are intensely human. Soft paths seek to solve natural resource problems through ingenuity and innovation, and by working with nature, rather than by overcoming nature.

Water soft paths can also be compared with demand management, which also tries to cut water use. However, demand management seeks only to ensure that water is used efficiently and it restricts conservation approaches to measures that are cost effective in a narrow sense. Soft paths in contrast try to change the task being accomplished, and even to eliminate the use of water if a good alternative is available. A short hand way of expressing the difference is that demand management asks the question “How?” – How can I use water more efficiently, whereas water soft paths ask “Why?”—Why are we using water for this job in the first place. Early results from comparative analyses suggest that soft paths double the water savings that can be achieved by demand management alone.

Typical soft path policies begin with demand management, which can typically cut water use by a third or more, by doing the same tasks in more efficient ways, as with low-flow toilets or modern forms of irrigation. However, they do not stop there. Soft path policies go on to think about ways to remove waste (which is the real task, not flushing a toilet) without water, or with minimal water. They go on to ask about how well modern adaptations of older rain-fed cropping could do in the area, perhaps supported by rainwater harvesting or only supplementary irrigation. As well, there are macro questions to ask, including whether some area is really suited to agriculture, or whether economic development should move in different directions. In addition, with education and information, soft paths seek to change values and habits toward more water conserving

approaches. And ultimately the questions of population growth and, especially, economic growth (at least as it has been pursued in most nations) have to be raised. Water is not fixed in any specific relationship to population and to income, but they do play some role.

Current Study

The Water Soft Path Policy study is coordinated by Friends of the Earth Canada and it focuses on three scales of analysis, each carried out with a collaborating institution:

- Provincial scale for the Province of Ontario at the University of Waterloo.
- Watershed scale for the Annapolis Valley of Nova Scotia at Acadia University.
- Municipal scale at the POLIS Project for Ecological Governance at the University of Victoria.

In addition, special studies to fill in gaps in the information were undertaken, as with a study of the pulp and paper industry, or recycling and reuse systems for buildings, and of the effects of different eating patterns on water use.

I can only give a very brief indication of the results from the study. Without pushing the analysis very hard, we showed that:

- Ontario could cut delivered water use by 20 percent, even if vigorous industrial growth continued.
- Nova Scotia could cut water use in the Annapolis Valley by more than 50 percent, and almost eliminate the risk of aquifer depletion.
- Urban water use can drop by at least 45 percent despite a doubling of population.
- Fully recycling pulp and paper mills in Ontario can cut water use by 95%, though with a trade-off of somewhat higher energy use.
- Dietary changes toward lower meat consumption can cut water use to grow food by a third to a half.

The Canadian study of water soft paths is the first time the analysis has been fully demonstrated. It can be seen as an experimental study, and of course there are numerous gaps and limitations. For example, we had to conduct the study without the ability to consider anything other than existing forecasts of population and economic growth, or any changes in industrial structure. Had those variables been included, our results would likely have been even stronger. We also had to work with many data problems. With the exception of municipal water use, we have had no national data on water use in Canada since 1996. Finally, though our study does include the agricultural sector, it did not look at any of the Prairie Provinces, which means that it does not have results for large-scale grain and pulse producing provinces.

Perhaps the two most important conclusions of the study are:

- Soft path analysis is feasible; despite data gaps that were evident from the start, useful results can be produced.

- Soft path results are distinct from and much greater than those that can be achieved with demand management analysis.

Admittedly, all of our results are indicative, not definitive. However, that is not bad for a world first!

Getting Started: Acting Locally

There are a number of things that we can do right now. The implementation of demand management strategies would determine the actual worth of water. Water can be priced by volume and, similarly, wastewater can be priced by volume and quality. In addition, re-using grey water around buildings is easy and would make a significant difference in water consumption. We should also invest in water-use reporting and plan for climate change impacts. All of these are win-win measures that will save us money and help protect the environment in the short term as well as the long.

Soft path policies must, however, go further. The focus of analysis must shift from money saved in the short term to the avoidance of future costs, and to alleviating problems at their source rather than merely dealing with the aftermath and outcomes. New thinking would include the idea that ecosystems and their services are valuable and that a land-use decision inevitably equals a water-use decision. Implementation of a “No New Water” policy for establishments and communities would force a lot more soft path thinking, and that would stimulate experimentation with WSP analysis.

What would this mean for Manitoba? You are better placed than I to answer this question, but I would certainly start with a look at re-using grey water for local irrigation and urban recreation such as golf courses. Large buildings would gradually redesign their infrastructure to accommodate internal circulation and re-use of water on site, as would new residential and industrial areas. In agriculture the focus would be on crop selection and water harvesting, for example, to find ways to maintain a healthy farm economy but one that is turning back from today’s emphasis on irrigation.

To sum up, sustainable development, which is what we are seeking, depends not only on sustainable production, but also on sustainable consumption. A water soft path is the water component of sustainable development, and it applies to both production and consumption.

APPENDICES

Appendix I

	Last Name	First Name
Organisation		
Assembly of Manitoba Chiefs	Hotain	Melissa
Assiniboine Community College	Rabe	Nicole
Brandon & Area Environment Council	Paton	Bill
Canadian Council of Ministers of the Environment	Petkau	Sandy
Canadian Environmental Assessment Agency	McNaughton	Dan
City of Winnipeg Climate Change Education Coordinator	Walsh	Katy
Climate Change Connection	Hull	Curt
Climate Change Connection	Lindsay	Susan
Concerned Citizens of the RM of Piney and Buffalo Pt.	Ould	Phil
Concerned Residents of Winnipeg	Robinson	Shayne
Council of Women of Winnipeg	Garlich	Carolyn
Crocus	Taylor	Harold
Ducks Unlimited	Bruce	Greg
Farm Stewardship Association of Manitoba	Whitaker	John
Fort Whyte Nature Centre	Watson	Jody
Freshwater Institute	Shearer	John
Friends of the Earth Canada	Brooks	David
Friends of the Earth Canada	Price	Lawrence
Great Plains Region Bureau of Reclamation	Davis	Gary
Green Manitoba	Storey	Marie
International Institute for Sustainable Development	Cunningham	Dennis
International Institute for Sustainable Development	Venema	Hank
Invasive Species Council of Manitoba	Parks	Candace
Lake Manitoba Stewardship Board	Goldsborough	Gord
Lake Winnipeg Foundation	Maclean	Joy
Lake Winnipeg Implementation Committee	Stephens	Richard
Manitoba Agriculture, Food, and Rural Initiatives	Szumigalski	Tony
Manitoba Agriculture, Food, and Rural Initiatives	Wilson	Brian
Manitoba Conservation Districts Association	Foster	Harold
Manitoba Eco-Network	Hunter	Kristina
Manitoba Eco-Network	Lindsey	Anne
Manitoba Métis Federation	Carriere	Lesley
Manitoba Métis Federation	Gaudry	Alan
Manitoba Round Table for Sustainable Development	Peters	Karen
Manitoba Rural Adaptation Council	Marak	Helena
Manitoba Science, Technology, Energy and Mines	Merredew	Andrea
Manitoba Water Council	Friesen	Jean
Manitoba Water Stewardship	Angus	Jeremy
Manitoba Water Stewardship	Fox	Elaine
Manitoba Water Stewardship	Harrison	Bob
Manitoba Water Stewardship	Kelln	Duane
Manitoba Water Stewardship	Matthews	Rob
Manitoba Water Stewardship	Raines	Teresa
Manitoba Water Stewardship	Smithson	Jim
Manitoba Water Stewardship	Warkentin	Alf

Mixedwood Forest Society	Clubb	Lindy
National Farmers Union	Tait	Fred
Pembina Valley CD	Alexander	Don
Pembina Valley Water Coop	Martel	Gord
Prairie Farm Rehabilitation Administration	Hanuta	Irene
Provincial Council of Women	Fleming	Elizabeth
Provincial Council of Women	Scott	Mary
Red River Basin Commission	Kiers North	April
Red River Basin Commission	Smith	Muriel
Resource Conservation Manitoba	McQuaker	Randall
Seine/Rat River Conservation District	Carr	Kristy-Layne
Seine/Rat River Conservation District	Goertzen	Cornie
Spirit of the Red	Kennedy-Courcelles	Cheryl
The Manitoba Habitat Management Corp	Sopuck	Tim
U of M Natural Resources Institute	Sinclair	John
U of W Env. Studies	Diduck	Alan
U of W Geography	Rannie	Bill
University of Winnipeg Geography	Buhay	Bill

Appendix II

Dr. Henry David Venema directs IISD's Sustainable Natural Resources Management Program, which has a thematic focus on water and agricultural issues in Western Canada. Dr. Venema is a professional engineer and natural resource management consultant with extensive experience in rural development, environmental economics, water resources planning, and energy sector planning in North America, Africa, and Asia. Dr. Venema leads IISD's current research on the Valuation of Natural Capital in Prairie Canada, Institutional Linkages between Payments for Ecosystem Services and Integrated Water Resources Management in Prairie Watersheds, and Governance Models for Lake Winnipeg Stewardship. Dr. Venema is also the principal investigator of the NRC-funded project, Adaptation as Resilience Building: A policy study of climate change vulnerability and adaptation on the Canadian Prairies and co-directs the IDRC-funded project, Adaptive Policy-making for Agriculture and Water Resources in the Face of Climate Change.

Climate Change is expected to bring more frequent and widespread drought to the Prairies, which is home to 5.5 million Canadians and 50% of the country's farms. Dr. Venema's presentation will outline how existing agriculture and water management practices promote or reduce resilience to climate stress, and how adaptive capacity can be strengthened through targeted policy intervention. It will also identify prairie regions that may be highly vulnerable to climate change and which policies may be most important in these regions.

William Mark Buhay has a BSc from McMaster University, MSc McMaster University and PhD from University of Waterloo. He has had post-doctoral positions at the Limnological Research Centre, University of Minnesota, Research Associate, Freshwater Institute, Winnipeg Manitoba and Assistant Professor, Department of Geology, Brandon University. He is currently an Assistant Professor, Department of Geography, University of Winnipeg and Director of the University of Winnipeg Isotope Laboratory (2000 to present).

A short sediment core (1.62 m), covering the period between A.D. 920 to 1999, was sampled from the south basin of Lake Winnipeg for a suite of multi-proxy analyses leading towards a detailed characterization of the recent millennial lake environment and hydroclimate of southern Manitoba. The record indicates eight major dry periods and 10 to 14 flood occurrences between A.D. 1100 and 1800. Of particular interest here is information on the frequency and duration of major dry (drought) and wet (flood) periods in southern Manitoba in light of the effects that ensuing climate change may have on water quality.

Therefore, a recently initiated objective will use water isotope tracers in Red River and tributary waters, in conjunction with water quality and discharge data currently collected by Manitoba Water Stewardship, Environment Canada and the City of Winnipeg to quantify water balance parameters. This will provide a baseline of modern hydrological processes, and identify variations in hydrology that result in changes in ambient water

quality. Simultaneous measurements of water isotope tracers and geochemical tracers and organic contaminants in these rivers will be used to identify the contributions of snowmelt, precipitation, soil water and groundwater to discharge. In addition to providing a better understanding of the modern hydrology of the basin, this modern baseline assessment of the isotopic water balance will provide a framework to aid in the interpretations of changes in hydroclimate in the region.

Alf Warkentin is currently the manager of the Forecasting and Coordination Branch of the Regulatory and Operational Services Section of Manitoba Water Stewardship. His areas of expertise include flood and water forecasting, design floods, hydrometeorology and climate change impact scenarios on the water sector. Mr. Warkentin received his BSc from the University of Manitoba and was formerly a Professional Meteorologist with Environment Canada.

Considerable controversy remains with respect to the impacts of climate change on water resources. It is often assumed that climate change will bring generally drier weather and that water supplies will decline. This will undoubtedly be true for some parts of the world but other areas will be wetter. The difficulty is knowing which areas will be affected in which way. Global circulation models give an indication of changes in temperature, precipitation, humidity, snow accumulations and many other parameters but significant differences in model output remain. Runoff, streamflow and aquifer recharge are very sensitive to the magnitude and timing of the meteorological conditions. This is particularly true for hydrologic extremes. A study by the author in the Red River watershed using daily model output from a Canadian GCM suggest that potentially serious problems remain in the simulation of the factors determining runoff and streamflow. The effect of climate change on water resources therefore remains unclear. The recommended approach for water managers and planners in the interim is to do sensitivity analyses of hydrologic conditions based on assumed deviations from past climatic conditions.

An aquatic ecologist by training, **April Kiers North** has worked for the Red River Basin Commission since 2003 as Director of Plan Development and most recently, Basin Coordinator for Water Quality. Prior to settling down into her career, she enjoyed three summers of mucking around Delta Marsh on the southern shore of Lake Manitoba. She received her BSc (with distinction) and MSc degrees from the University of Manitoba.

The Red River of the North begins at Lake Traverse in South Dakota and flows north across the international boundary into Lake Winnipeg and from there into Hudson Bay. The states of Minnesota, North Dakota, and South Dakota and the Provinces of Manitoba and Saskatchewan make up the Red River drainage basin.

The problems that affect this basin vary from: water supply, flooding, competing use of land, economic development, restoration, multi-jurisdictional political boundaries and the lack of basin wide data to guide decision makers. For example, in recent years the basin has experienced both drought and flooding at various times and has even experienced both during the same time at different places in the basin. RRBC has recently initiated an

effort to begin a basin drought preparedness strategy that will provide an outline, along with costs and timelines, for how the basin jurisdictions could begin to work cooperatively on all or some of the areas that will likely emerge during an extended period of drought.

This effort will also identify current and planned local, jurisdictional, and regional activities related to drought planning and water supply efforts so that these efforts can be woven into the basin approach. In addition there will be a component that explores options to drought preparedness that assume there is no additional or new water sources in an extended drought period.

Andrea Merredew is a Manager with the Climate and Green Initiatives Branch in the Department of Science, Technology, Energy and Mines of the Manitoba government. Andrea is responsible for coordinating the development of climate change legislation for the province and the development of a landfill gas mitigation and management strategy. She also works closely with MAFRI to identify and promote Beneficial Management Practices in the Agricultural sector. Andrea has a master's degree in environmental studies from York University and has worked as a senior policy and program planner for Alberta Parks and Protected Areas and coordinated climate change programs for EcoSuperior Environmental Programs and the Sierra Club of Canada.

Ms. Merredew will provide a broad overview of Manitoba's emissions profile actions to date and a discussion on climate and agriculture to address emissions in our second largest emitting sector and potentially hardest hit sector. The presentation will focus on collaborative work done with MAFRI and Water Stewardship to identify the multiple benefits and activities that both reduce emissions and promote adaptation.

Dr. Irene Hanuta is currently a Senior Policy Analyst, and Climate Specialist with the Prairie Farm Rehabilitation Administration of Agriculture and Agri-Food Canada. Before joining PFRA, Irene worked for about 3 years as a Policy Analyst - Climate Change Specialist with the Government of Manitoba, Department of Energy, Science and Technology in the Climate Change Branch. Irene's current activities include:

- Leading development of a National Drought Strategy for Agriculture, in partnership with provincial governments, researchers and stakeholders;
- Leading a multi-disciplinary National Climate-Related Production Risks Committee that regularly reports agri-climate conditions for the Agriculture and Agri-Food Canada Minister;
- A variety of collaborative multi-disciplinary projects on climate change adaptation research, education and awareness-raising

Agriculture is a major water user in Canada, dependent on the availability of sufficient water of appropriate quality for all aspects of crop and livestock production. One of PFRA's key roles involves maintaining the health of agricultural land and water resources to keep our sector competitive and sustainable, and contribute to health and quality of life of every Canadian. When developing policies or programs, PFRA works with producers, private sector agriculture industries, provincial governments and agencies

responsible for water, and non-government organizations committed to natural resource conservation and management. This presentation summarizes a selection of emerging policies in the agriculture sector related to water resources and a changing climate, including activities that help producers become more resilient to climate risks.

Dr. David B. Brooks, who was educated in geology and economics, retired several years ago after 14 years with the International Development Research Centre. He is now Director of Research for Friends of the Earth - Canada. His main research interests lie in the linkages between environmental protection, on the one hand, and the use of minerals, energy and water, on the other. Among his publications are: Zero Energy Growth for Canada; Watershed: The Role of Fresh Water in the Israeli-Palestinian Conflict; and Water: Local-Level Management. Dr. Brooks has been elected to The International Water Academy, based in Oslo, Norway.

In the simplest sense, water soft paths say that the appropriate way to deal with gaps in supply and demand is not to look for more supply but to find ways of cutting demand. Though water soft paths incorporate a vision of an alternative, more sustainable, future, they also offer an analytical methodology that permits calculation of savings and impacts from changing the way we deal with water. Finally, they are a planning tool that allows citizens, planners and decision makers to compare alternatives and to make choices among them. This overview presentation will include results from a recently completed water soft path study in Canada, the first such study anywhere in the world.