Canadian Climate Impacts and Adaptation Research Network

Managing Climate Change Risks for Natural Resources in Atlantic Canada

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Report prepared by
Ryan Hennessey and Philana Dollin
Canadian Climate Impacts and Adaptation Research Network
Coastal Zone and Atlantic Coordinating Offices

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Introduction

C-CIARN Atlantic, C-CIARN Agriculture, C-CIARN Water Resources and C-CIARN Coastal Zone sponsored the morning session (a roundtable) on March 14, as part of the 2-day Climate, Weather and Risk Forecasting Working Group Meeting IV (Agriculture and Agri-food Canada), March 14-15, 2007 at the Crowne Plaza Hotel, in Moncton, N.B. Over 80 people attended the roundtable which focused on the management of climate change risks to Atlantic Canada's natural resources.

Three primary questions formed the basis for discussion:

- What climate/weather related conditions or changes are impacting Atlantic Canadian natural resource businesses and operations?
- What changes in practices or investments have been undertaken in recent years that might help businesses/operations meet challenges and take advantage of opportunities from climate change or future weather conditions?
- How have those practices helped and what are the costs/benefits of the changes?

The workshop began with opening remarks. Bano Mehdi (C-CIARN Water Resources) welcomed participants and introduced the main theme for the workshop. Two introductory keynote speakers gave presentations on climate and weather in Atlantic Canada and how climate change might affect Atlantic Canada's natural resource based sectors (Forestry, Water Resources, Agriculture and Tourism). Representatives from four resource sectors offered their offered their perspectives on climate change issues and took part in a general discussion on the topic. Summaries of the presentations are presented in the pages that follow.

Impacts Presentations

Weather/climate in Atlantic Canada: Past, Present, and Future

Gary Lines, Climate Change Unit, Meteorological Service of Canada – Atlantic Operations

Summary

Climate change is an ongoing process that is influenced by a number of changing natural variables, such as shifting atmospheric conditions due to volcanic activity, solar variability, and changes in the inclination and orientation of the Earth around the Sun. Such influences can be short-lived, as is the case with volcanoes, or operate on the 40 000 - 100 000 year cycles characteristic of celestial interactions between the Earth and Sun.

Climate change in the 21st century is therefore not a new phenomenon, unless you assess it in terms of rate of change.

Climate is a product of averaged temperature trends over long period, as opposed to daily or hourly temperature events that define weather. The climate record, in turn, has been generated through the examination of trace concentrations of gases in ice cores from Antarctica and through the use of proxy data, such as tree rings used in dendrochronology. Based on these records, the atmospheric gases carbon dioxide and methane are each at unprecedented concentrations; superseding concentrations seen in the last 650 000 years. While these gases are traditionally from natural sources, anthropogenic contributions to carbon levels in the atmosphere have had an increasing influence on global climate due to rising emissions of greenhouse gases since the 19th century.

Recent and rapid shifts in climate are also supported by tree ring analysis. While warming periods are evident throughout the two thousand year record, in particular around 1000AD and 1600-1800AD, a more dramatic warming trend begins around 1850AD. This trend shows a general increase in temperature, with a cooling period from 1960-1980, followed by a sudden, rapid warming occurring after 1980. The warmest years on record dominate the 1990's, and into the 21st century. The year 2005 is the warmest on record. Clearly something has occurred that has not only caused a shift in trends, but has created a warming greater than expected. This warming trend is also characterized by an uneven distribution, with greater rates of warming at higher latitudes and across continents. This pattern is expected to continue into the future.

The distribution of precipitation is also expected to be uneven, with larger increases across central and northern North America. Also evident are large decreases through areas that are already dry such as the Sahara desert, and portions of South America. Europe, Asia, and Australia show mixed results with drying trends in some areas, and wetter trends in others. On average, however, precipitation has been increasing globally.

Canada has experienced a period of relative warming from 1950-2000. Over this period there has been a reduction in the number of cold days and cold nights, with a subsequent move to warmer days and warmer nights. In effect, Canada has not become warmer, only less cold. As a result, the number of frost days has dramatically decreased in certain areas over the past fifty years.

The period of 1948-2003 also saw a shift in precipitation patterns in Canada. In general, the country is getting wetter, with the exception of Saskatchewan and Alberta. Regional differences are evident, with an increase in precipitation in the north, and a decrease in precipitation in the western part of the country.

Regional variation is also evident within Atlantic Canada. In New Brunswick, the average rate of temperature increase from 1895-1998 has been 0.7°C/century, characterized by lots of variability from year to year. This matches the global trend of 0.6°C/century closely, and New Brunswick is likely follow global climate change trends into the future. Newfoundland and Labrador conversely have not experienced any temperature increase and may actually be cooling. Such regional differences will expand the complexities of climate change.

With global warming, the amount of sea ice cover is also expected to decline. The extent of sea ice in 2000 was approximately 9 million km^2. Climate change models indicate that the extent of sea ice in 2100 will be 2-3 million km^2. The impact of reduced sea ice will be significant, as ice mass has a fundamental influence on climate. Therefore, if the global ice mass changes, so too will global climate. In addition, melting sea ice will influence global rates of sea-level rise, which will become a regional concern based on the rate and location of the rise.

When assessing the characteristics of projected shifts in precipitation and temperature climate change models must be used, as the climate cannot be effectively imported into a lab. These models are calibrated by predicting current climate conditions before they are used in projections. Projections are then based on certain variables such as greenhouse gas emissions that are anticipated in the future. For example, a scenario depicting average greenhouse gas emissions usually anticipates a doubling of atmospheric carbon dioxide by 2070.

The subsequent response of temperature is then determined by the model. Models tend to be based on 3 separate emissions scenarios based on a range from a low estimate of greenhouse gas emissions, to a high one, with subsequent responses by the climate. While models typically predict global climate response, there are also models that generate local scale climate responses. One such model for Nova Scotia has predicted a warming of 5°C by 2080, with an increase in precipitation of 12-15% in some areas, and a decrease in others. Seasonal change in precipitation is also predicted across the Atlantic region, with regional variation ranging from a 5% change to a 20% change, primarily evident in a shift from snow to rain. It is always recommended that when assessing climate change projections, more than one model be used.

Extreme weather is very likely to increase in the form of heat waves, tropical cyclone activity and intensity. The incidence of extreme weather will be compounded by a northward shift of extra-tropical storm tracks. This will increase the frequency and intensity of winter storms, with subsequent implications for wind, temperature, and precipitation in Atlantic Canada. Snow cover is expected to diminish. While this will have an impact on Atlantic Canada, it will not be nearly as dramatic as in the Arctic region where widespread thawing of permafrost is already evident. Sea ice is also projected to decrease, and is expected in some cases to disappear entirely by the latter half of the century. The seasonal loss of sea ice will cause the transition from summer to winter ice to be more dramatic.

Anthropogenic induced warming and sea-level rise will actually continue regardless of our efforts to stabilize emissions. The issue of climate change therefore requires immediate attention in the form of both mitigation and adaptation.

Discussion

Can you give a few downscaled examples of how climate change is impacting particular sectors in Atlantic Canada?

Of great concern is the issue of water and water resource availability. Although projections indicate an overall increase in precipitation, the pattern is changing from small events over a long period of time to a number of larger events, with prolonged periods of dryness in between. This will result in more precipitation, but will also increase the potential for drought. Regional drought will subsequently impact water reservoirs, irrigation, and water management.

Can you comment on the storm track activity in more detail?

There are two elements to storm track activity, the tropical cyclone track and the extra-tropical cyclone track. There is no real consensus on the impact of climate change on the behaviour of the tropical cyclone track and any subsequent variance in the number of tropical cyclones. However, there is no indication that this track will change, leaving Atlantic Canada vulnerable to extreme weather events. Conversely, the tracks of extra-tropical cyclones, which are summer or winter storms that arise in the southwest part of the continent, will likely shift northwards. The implications of this northward shift are that Atlantic Canada will experience more rain, snow, and wind.

In the temperature animation, it is indicated that some areas will remain cooler, longer, why?

The model that was used is an ocean-coupling model. What is being seen is believed to be heat going into the ocean or other changes such as shifts in current or in fresh water outflow. There are other large-scale climate features such as the North Atlantic Oscillation that can dominate the projection depending on how you tweak the model with greenhouse gases. While the exact cause can’t be isolated, it remains an important element of climate change projections to note.

How sensitive is the model to carbon dioxide levels?

The results of the climate change projections are primarily based on what future is chosen. A series of emissions scenarios were developed in the mid-1990’s based on socioeconomic circumstances. Each circumstance considered issues such as 'where are we?', 'what the population is going to be like?', 'what kinds of actions people are going to take with regard to greenhouse gas emissions?' etc.

Subsequently the futures were narrowed down to roughly 5 or 6 predominant scenarios, and three are generally shown to span the range of projected changes. The top scenario is based on a prediction of 500ppm of carbon dioxide by the end of the century, the middle is based on 700ppm, and the bottom is based on 900ppm. While the temperature response is not great between scenarios in the early to middle part of the century, by 2090 the differences become quite dramatic in terms of climate response. The tipping point, which effectively depicts a point of no return, is evident in the mid and bottom scenarios. Climate response will therefore be more severe depending on which scenario becomes reality.

Are we going to see an increase in 10-year and 25-year storms in the region?
There has been a significant amount of work done on possible future storm activity. Recent work done in New Brunswick relating to sea-level rise looks at storm surges, which is directly related to storm intensity and frequency. This work went back into the climatological record to examine historical storm activity, such as a 40-year record of wind intensity across Atlantic Canada. This enabled the construction of trends based on the data, which were then projected outward into the future. It would not be inconceivable to apply that method to storm return periods.

Introduction to Climate Change Issues for Atlantic Natural Resources Management

Norm Catto, Editor, Quaternary International Professor, Department of Geography
Memorial University

Summary

Atlantic Canada is a resource-based economy and industries such as fishing, farming or tourism are vulnerable to climate change impacts. In addition, many other challenges exist for rural communities in relation to economic sustainability. One example is declining rural populations across the region. As a result stresses created by a changing climate will be superimposed on already stressed rural areas.

Impacts from climate change are likely to manifest in longer, hotter and drier summers with precipitation concentrated in high intensity events. Consequently drought may become a prevalent issue. Such drought may not be meteorological in nature but instead related to precipitation at the 'wrong time', or at the 'wrong intensity'. This may lead to a subsequent decline in groundwater recharge due to increased runoff. In addition to an

increased frequency of drought, indirect impacts of climate change may also result in increased thunderstorm activity, increased winter precipitation, stronger winds, a reduction in fog, and more anomalous events.

Agriculture is a particularly vulnerable industry in Atlantic Canada as it is susceptible to weather extremes such as a late frost, hails storms, droughts or floods. Because such extremes are more difficult to assess than long term climate trends, extreme events will drive adaptation. Therefore, due to the increased potential for drier periods, storms, and oscillations in precipitation, temperature, and frost days, a diversification in the species of crops grown in Atlantic Canada may be required. Contingency planning for crop production is also going to be required to respond to natural hazards which will likely become more threatening. As the climate system becomes less predictable, a greater variability in agricultural production will be required to compensate for potential changes and extreme events.

Adaptations will also be required in the care of livestock, where air conditioned buildings are already being incorporated into daily routine to offset the impacts of excessive heat on animals. Care of livestock will also require planning to ensure an adequate supply of forage. Forage may have to be imported from outside sources to ensure an adequate seasonal supply if climate conditions have a significant impact on the growth of species used for forage. Adaptation will also be required to ensure the safe disposal of waste. Monitoring of water consumption by livestock will be another necessity.

Water supply and consumption is extremely vulnerable to climate change impacts. As conditions become drier, an increase in irrigation will add pressure to already stressed groundwater resources. Such stress is caused by the shallow nature of aquifers in the region, which require frequent recharge. As opposed to elsewhere in the country where deeper aquifers may contain water that is thousands of years old. Aquifer recharge will further be affected by reduced snow cover, which will compound water shortages. Future water shortages will require adaptation in the form of: increased monitoring of water consumption patterns; an increase in land use planning; increased water conservation; and, an assessment of groundwater recharge.

Increasing frequencies of extreme weather events will require adaptation of soil management practices as intensively cultivated soils are more vulnerable to climate change.

Tourism is another industry that will be affected by climate change, especially in the summer months. While many industries will have to compensate for negative implications of climate change, longer and warmer summers relating to climate change will extend the tourist season giving rise to many opportunities in the Atlantic region. Adaptation will be required however, to compensate for: increased wave erosion due to winter storms; increased coastal erosion with subsequent narrowing of beaches; increased dune degradation that will be compounded by increasing foot and mechanized traffic; increased trail damage as a result of increasing foot traffic; and, increased issues relating to water quality and quantity. Winter tourism in particular will have to compensate to capture visitation trends as tourists respond to perceived climate conditions. For example, as snow accumulation declines, visitation from regions such as Europe will increase as these regions will have little to no snow cover, while Atlantic Canada will have relatively more snow in spite of the overall decline.

In addition to industry-specific concerns, such as those of tourism and agriculture, there are many impacts of climate change that are common to the resource economy of Atlantic Canada. Increasing temperatures and shifts in precipitation patterns will result in changes to the distribution of pathogens, pests, and predators across the region.

Stresses to renewable resources caused by climate change will increase the vulnerability of the region to competition from sources both within and outside Canada. Changes to climate conditions will also create an increased vulnerability of infrastructure to natural hazards across the region. Such impacts will require shifts in transportation routes, operational changes to compensate for irrigation and water consumption, and changes in communication strategies.

Climate change will bring many challenges and we must be willing to recognize that rapid changes are occurring and adapt accordingly. Impacts from a changing climate will universally affect the socioeconomic conditions of rural communities across Atlantic Canada, compounding existing stresses already present. In addition, while there are many risks associated with changing climate conditions, these are already evident in the historic record of the region. The difference will be the frequency of these events, and consequences of ignoring them now.

A historic perspective and traditional responses to extreme events will prove invaluable. Because of the rapid changes of climate, and ongoing shifts in demographics and socioeconomic conditions already evident in rural communities, the margin for error is going to shrink. However, there are existing best practices and local experiences that can be applied to build on existing resilience. These should be effectively communicated on a broad scale to benefit everyone.

Discussion

What do you think of the lack of local governance and the fact that a significant number of rural communities do not have access to professional planning?

This is definitely an important challenge, as many communities don't have access or time for effective planning, a fact that requires resolution – especially where natural hazards are concerned. This challenge will require individuals and organizations with relevant expertise to disseminate information on planning and adaptation. As well, researchers should be matched with communities based on anticipated risks.

Roundtable and Discussion

Summary

The purpose behind the roundtable discussion was to invite individuals of different resource management and professional backgrounds, provinces, and employment situations to give the workshop participants a five minute résumé of their impressions of climate change impacts to, and adaptations of Atlantic Canada's natural resources and sectors. Panellists were also welcome to offer any words of wisdom, after which point the audience was encouraged to engage the panel with questions.

Pam Macintosh, Planner, Municipality of Colchester

Pam Macintosh, Senior Planner for the Municipality of Colchester, began the roundtable by discussing the management of floods along the Salmon River in Nova-Scotia. The river passing through Colchester County is well known for its complicated flood plain in close proximity to the city of Truro. In order to have a better management of the flood risk, the federal government began, at the national level, with the "Flood Damage Reduction Program". The latter requires the involvement of the municipal government to work towards assessing and developing technical solutions for a better flood management for various problematic rivers in Canada. Nova Scotia has been part of this program since the early 1980's and has done work on the Salmon River.

The flood occurrence frequency in the Truro region has remained the same over the past decade; however with a higher development level, the impacts of major climate events have been amplified. The development along the river remains safe and no major flooding occurs, except under exceptional situations, such as ice jamming up stream. Climate change is one of the concerns for the municipality of Colchester since flood occurrence is likely to increase in the future years. With the Flood Damage Reduction Program, different flooding evaluations were conducted, including a hydrotechnical assessment. Among the technical solutions brought by those assessments, the "cut and fill" approach was identified as an effective and viable flood plain management tool for Colchester County. In addition, the pristine area along the river should be protected to enhance water retention time on ground.

For the development of more efficient flood management, federal and provincial buy-in is required. More over, established connections with flood researchers and access to accurate flood models, which include climate change, would be highly valuable for Pam Macintosh and her team. This would allow them to make judicious development planning for the next 20 -50 years to come.

Jonathan Kierstead, Environment Supervisor, Bowater Mersey Paper Company Limited

Following Pam Macintosh, Jonathan Kierstead spoke about the challenges facing Bowater Mersey Paper Company Limited (Bowater). Bowater owns roughly 247 000 ha of freehold land in southwest Nova Scotia, where climate change presents another layer of management challenges faced by operational personnel on a daily basis. Other management issues relate to the management of soil, water and trees in the Acadian forest region, which are then harvested for lumber and for pulp.

Three prevalent challenges relating to climate change and require risk management in the forest industry in Nova Scotia are: wind; rain and flood events; and drought. Severe risks are associated with wind as tree stands are opened up gradually to optimize the growth rate of forest species. Stands are therefore thinned over 2-3 partial harvest periods until the entire canopy is removed and the site is regenerated. As the forest is thinned it becomes increasingly vulnerable to blowdowns during extreme wind events.

This has forced Bowater to make changes to their harvest prescriptions specific to commercial thinning, keeping a minimum density of 900 stems per ha in order to reduce stand vulnerability to wind. Further, Bowater has altered their timing considerations for stands on sandy slopes with northeast or southeast aspects that have proved more vulnerable to wind over time. Bowater has also specified reduced sizes in canopy openings, now favouring openings of less that 10 m.

Rain and flood events primarily affect infrastructure that is vulnerable to flooding. Bowater is currently compensating for potential flooding by constructing higher and wider bridges than necessary over water crossings, rather than culverts. The benefits of these high, wide bridges are reduced erosion and greater stability.

Drought is a future challenge for the forest industry, which is experiencing increasing levels of dryness during seedling planting. Insects pose an associated risk with drought, as shifting hydrology may increase the number of related threats to forest species. Currently there are too many unknown variables relating to drought potential to properly respond with risk management recommendations.

To properly respond the challenges of climate change the forest industry requires more accurate prediction of severe wind events. This would allow foresters to incorporate the locality and severity of wind into long term forest planning and management. Accurate rainfall predictions will also help with forecasting the costs associated with vulnerable infrastructure and allow foresters to incorporate precipitation models into their long term planning process. Predictions relating to future climate conditions will also allow foresters to adapt their regeneration planning. They will be able to compensate for shifts in the natural disturbance regime, temperature, precipitation, and available sunlight; which may include selecting new species for regeneration for a given site.

Hank Kolstee, Supervisor of Land Protection, NS Department of Agriculture

Hank Kolstee's presentation gave brief overview of historical challenges associated with climate conditions and the management of dykelands in Nova Scotia. The Nova Scotia Department of Agriculture currently manages a 240 km long dyke system along the eastern coast of the Bay of Fundy. This dyke system, on average 1-3 m in height, protects approximately 15 000 ha of, primarily, agricultural land. It also encompasses 260 "aboiteaux". Aboiteaux are wooden sluices fitted with swinging doors which open to allow excess fresh water to drain the dykelands during low tide and then shut to prevent re-entry of salt water at high tide.

Three aspects of climate change are of concern for the management of Nova Scotian dykelands: extreme weather, wind, and drought. Extreme weather is of particular concern, as evidenced by past storm surge activity associated with the Saxby Gale (1869) and the Groundhog Day Storm of 1976. In the case of the latter, a storm surge struck the 3 km of dyke in the St. Mary's Bay region, with a water level 3 m higher than the normal high tide. While the impact was moderated by the 18 year tide cycle, damage was still severe. While storm surges present a significant threat, increased rainfall can also lead to flooding as the aboiteaux only function when the tide is out. Consequently, if a heavy rainfall event occurs in conjunction with an incoming tide, water will collect on the marshes for up to eight hours until it is released with subsequent flooding.

Wind severity is an issue of concern as high winds on the Bay of Fundy accelerate wave activity. Increased wave activity contributes greatly to foreshore erosion, exposing the dykes directly to wave activity and subsequently increasing the vulnerability of their structural integrity. While rock is generally used to protect the dykes, strong wave activity can move the rocks, once again exposing the dykes to erosion.

Drought is a concern as it impedes the functionality of the aboiteaux as they tend to silt up during times of low precipitation.

The current 5-8 year cycle for dyke maintenance, based on natural land subsidence in Nova Scotia, already compensates for issues relating to sea level rise. Measurements are taken regularly for height of the dykes relative to sea level. Due to other concerns relating to climate, the dykelands should remain closed to development as they will continue to be vulnerable to extreme events. As long as development is restricted the dykelands should actually increase in value as they are more agriculturally productive during drought conditions than the nearby uplands.

Kevin MacIsaac, Chairman, Prince Edward Island Potato Board

Kevin MacIsaac concluded the panel presentations with a summary of the impacts that climate and weather conditions have for potato production. He described how temperature, precipitation and extreme events influence various aspects of the farming system.

Spring temperatures determine how soon growers can begin spring tillage operations and planting. As well, the average number of frost free days in PEI's growing season affects the number and type of varieties they can grow successfully, as each variety requires a specific number of frost free days to mature. Extended warm temperatures late into the fall can delay harvest, increasing risk of frost at the later end of season. Costs associated with cooling the crop down for long term storage can also increase.

Increases in heat units during the growing season or extended periods of very hot weather can cause heat-related disorders in the tubers. Extended periods of heat may also increase the physiological age of the tubers, thereby shortening their storage life. Additionally, large fluctuations in temperature during the growing season can impact the level of defects in the crop, such as hollow heart and sugar ends. And finally, less severe winters may increase pest pressure on the potato crop as insects and disease organisms may have better survival rates.

Precipitation and adequate soil moisture from precipitation also affect how soon growers can begin spring tillage operations and planting. Adequate moisture is required on a regular basis to maximize plant growth, nutrient uptake and yield. Lack of snow cover will likely increase the potential for soil erosion due to wind and water during the winter months. In addition, torrential rainfall events, between planting and row closure or after harvest, when the ground is bare, can cause soil erosion. Nutrients and pesticides are washed from the soil on intensively managed farms into nearby water courses.

Future climate projections for Atlantic Canada suggest that many of the conditions described above may become more common. It will therefore be important to ensure the potato sector has the capacity to manage the risks and take advantage of opportunities associated with altered weather and climate. Currently, there are many strategies integrated into ongoing farm management and practices to accommodate for climate and weather risk. For instance many producers have adopted Environmental Farm Plans where soil and water conservation are paramount.

The impacts from drought and flooding can be diminished by improving regular farm practices. Through the use of special implements at hilling, water run-off between rows is reduced. Farmers are also using grassed waterways, diversion terraces, strip cropping and buffer zones around watercourses. Other strategies currently in use on farms include: using cover crops on early harvested land and hay mulch on sloped land after late harvest to reduce soil erosion during the late fall\winter\early spring; the diversion of water into ponds and lagoons (recharged from low capacity wells) to make water available for irrigation; and, increasing the use of Integrated Pest Management techniques to help determine the most timely and efficient methods of applying pest control options. Potato producers are also adopting new technology to determine product quality. For example they employ x-ray machines to detect Hollow Heart (a condition that occurs when growing conditions abruptly change during the season).

Also important for the potato industry is research into a number of issues related to climate/weather and production. Trials of different potato varieties, by government and private industry, to determine which ones are most suitable for the growing season and for production in the region, is one such project. Two other important research topics are the promotion of spring tillage to keep winter cover on fields and the feasibility of drip irrigation for potatoes.

There are many future challenges from weather and climate which can be overcome by ensuring that strategies currently employed are maintained and improved. Examples include:

- Further promotion, education and demonstration of the benefits of spring tillage - many growers feel that potato yields are reduced when planted in spring-plowed vs. fall-plowed land. This is not factual.
- Access to earlier maturing varieties suitable for our growing season, with characteristics suitable for our customers (e.g. the current standard for French fry plants is Russet Burbank, a 120-plus day variety). Using plants more suitable to PEI's climate would allow increased use of cover crops following harvest.
- Improved access to water for irrigation and use of irrigation technology that will effectively and efficiently distribute water to crops, as needed.

- Improved technology to apply hay mulch on potato fields after harvest. Currently, machines used are too small and too slow for the limited time window of applying mulch late in the fall.
- New crop protection compounds which are less toxic, more specific and break down quickly.
- Surveillance systems to identify and protect against foreign or invasive species or pests, which may be able to survive in Canada due to changing weather patterns.
- More accurate weather forecasting information. These forecasts would preferably be local so that better planning for crop management can occur (i.e. do not apply insecticide when heavy rain is forecast in 48 hrs).

Discussion

Following the panellists' brief presentations, the workshop participants were encouraged to ask questions and begin a discussion around the issues put forward by the panellists. The questions and discussions which followed ranged widely from technical questions, regarding uncertainty in forecasting, to social issues regarding building awareness of climate change impacts, and enabling stakeholders to respond to climate related risks. Below is a summary of the questions and discussion that ensued:

What are the potential roles of processors to aid in building the capacity of producers to respond to climate change?

Kevin MacIsaac responded that processors have a great deal of concern relating to the quality of crop they receive from growers/producers, and currently require growers to conduct a number of field safety inspections. These field safety inspections identify how the crop has been grown (often the best crops are produced using the most sustainable methods). Because it is in the processors best interest to receive the best crop that can be produced, there is most certainly a role for processors to support both producers and research relating to climate change and agriculture.

Would a measure of uncertainty in weather forecasts be useful to practitioners?

Kevin MacIsaac replied that from an agricultural perspective, the most accurate forecast possible is not simply useful, but necessary. Agriculture on Prince Edward Island is governed by a number of control laws that, for example, prohibit spraying of herbicides if the wind is high. Such control laws require that farmers have an accurate assessment of incumbent weather to avoid inadvertently violating the laws due to sudden changes in weather. Another example of agricultural practice that requires accurate weather prediction is insecticide applications which need to be applied 24-48 hours in advance of heavy precipitation.

John Kierstead replied that the application of herbicides/pesticides is the only incidence in forestry practice where a level of uncertainty in weather forecasts would be useful. Forest practitioners only spray these chemicals a few times each year, sometimes only once in the fall, and at those times, it would be useful to have an estimate of uncertainty relating to wind speed and precipitation that effect application.

With regard to institutional decision making, can you express the challenges that you face in responding to climate change impacts, and the challenges that you experience in bringing those challenges to higher levels of government?
Pam Macintosh stated that municipal planners will need guidance from higher levels of government.

Hank Kolstee expressed concerns stemming from the vulnerability of the dykelands to storm surges; stating that flooding from tidal surges is not nearly as threatening. Such tidal floods occur every 5-10 years and involve limited amounts of freshwater as a result of precipitation. This water often takes 4-8 hours to fill the floodplain. In the case of a severe storm surge, such as the Groundhog Day storm of 1976, both the floodplain and the Town of Truro would be flooded instantly with serious loss of life. Predictions are therefore required to offset this vulnerability.

John Kierstead expressed a need to bring a collective voice through one of the representative forest organizations such as the Forest Products Association of Nova Scotia, the Model Forest Network, or the Nova Forest Alliance. Such organizations could play a pivotal role in information transfer. Such information, he felt, was either not getting to stakeholders in a timely fashion, or not getting to them at all.

Forecast information is not readily available in a high quality format, it should be a goal to make such information available.
Kevin MacIsaac added that weather conditions in eastern Prince Edward Island sometimes resembled the conditions in Western Cape Breton more than those in western Prince Edward Island. He felt that this was indicative of the need to resolve or change the way that prediction is done. He also expressed agreement that high quality weather prediction was needed.

How are stakeholders preparing to face the risks associated with climate change? Especially with regard to common infrastructure such as dykes, which are now not only protecting agricultural land, but towns and highways as well?
Hank Kolstee responded by stating a need for more collaboration between agencies to take preventative measures. These might include adding supplementary height to the dyke system. He felt that such a proactive approach would be far more effective than a retroactive approach – response after a disaster had already occurred.

Kevin MacIsaac expressed the need for continued financial support from Federal agencies. This support will enable producers to undertake expensive soil conservation practices. Many of these expensive practices might otherwise be ignored, given that commodity prices are not always as high as producers would like. He also indicated that producers have taken land out of production based on land laws that prohibit planting on land of a given acreage. Even out of production, these lands are still included in land limits.

Kevin MacIsaac also suggested that producers continue to partner with conservation groups such as Ducks Unlimited, who have access to areas not designated for profit. This land is beneficial for community enjoyment and habitat. Ducks Unlimited has been a great boon to both the environment and to agriculture in Prince Edward Island.

What opportunities does climate change present to your various sectors?
John Kierstead responded that there were few opportunities offered to the forest industry by climate change. He did note that changes in species, depending on the realism of long-term climate change forecasts, might favour the cultivation of a different species of tree that could potentially be better for forest business.

Pam Macintosh focused on those opportunities for municipalities that will cause future development to be prohibited in areas prone to flooding. Municipalities should take a more sustainable role and stop encroaching on floodplains by focusing development elsewhere and allowing floodplains to naturally regulate hydrology.

Kevin MacIsaac believes that the opportunities afforded to agriculture were in public education. Climate change and other environmental issues give producers the opportunity to notify the public that Canadian agriculture produces some of the safest food in the world. Producers must document anything that is done to crops as a consequence of past climate-related issues. These rigorous standards are not the same for food producers in other areas, such as California. Canadian producers will try to remain a step ahead of what climate change requires of them.

Hank Kolstee speculated that the opportunities presented by climate change for the dykelands were dependent on what future conditions would exist. For example, drier conditions would present the opportunity for a greater variety of crops to be cultivated in the dykelands.

Peter Duinker, the moderator for the session, added that increased demand for bio-energy based on climate change mitigation would create further opportunities for the agricultural sector as people seek renewable sources of energy.

Is Bowater doing any research to determine which forest species will do well under changing climate conditions?
John Kierstead answered that the current restrictions created by adherence to the forest certification systems prevent the cultivation of exotic species. Therefore Bowater has not and will not focus on shifting species in relation of climate change as a strategy for adaptation in the near future. However, work is being done to maintain and expand the quality of current forest stocks.

A comment from the audience: Dr. Caulder Rock of Sackville University is currently researching forest species response to shifting climate conditions through the use of tree core analysis. He may be able to answer questions relating to forest responses to climate change.

There is a great deal of focus on engineering mitigation rather than challenging land use policy to better respond to changing climate conditions. As floodplain development tends to encompass many types of development within a single floodplain, there is far more risk associated with floodplain development than simply allowing for agriculture. Over the long-term we will need to alter our land-use patterns because climate related events are not going to cease, regardless of funding directed towards engineering solutions designed to reduce vulnerability.
Hank Kolstee mentioned that in Nova Scotia, the Marshland Act was updated in 2000. There are now restrictions on development in the dykelands. He did not foresee future development, but did note that appeals can be approved by a municipal committee to allow for development in spite of such prohibitions. Restricting approval to a provincial level could reduce the likelihood of potential development through the appeal process and restrict the incidence of vulnerable development in the dykelands.

John Kierstead followed by stating that there has been a multitude of changes in the past two decades, and in the past five years especially, that affect land use by the forest industry. Such shifts in land-use practices are widespread and involve many companies and private suppliers of forest products.

Adaptation Presentation

Following the panel discussion Pam Kertland, the Research Program Manager for CCIAD, Natural Resources Canada gave a presentation on adaptation tools for resource management in a changing climate.

Pam Kertland, Climate Change Impacts and Adaptation Research Program
Natural Resources Canada

Developing Adaptation Tools for Resource Management in a Changing Climate

Summary

Climate change will affect everything we do, in a wide variety of ways, incurring a wide range of impacts, from a variety of sources. Not all impacts will occur at the same time, or in the same place.

Consequently, there are great challenges in determining an effective response, and Atlantic Canadian communities will have to be strategic in their adaptation methods. Further, adaptation decisions made by other communities and other countries will affect local markets, production systems, transportation, and other essentials. These in turn will have further local and international impacts.

Over the past eight years, the Climate Change Impacts and Adaptation Directorate (CCIAD) have undertaken approximately 300 projects across Canada. While the scope of these projects seems large, it does not nearly cover all aspects of climate change everywhere in Canada. As a result CCIAD is currently developing a number of tools relating to adaptation and decision making.

A tool, in this case, is defined as a standard methodology or approach to help people work through an assessment of their risks in ways that facilitate future adaptation. While forecasting is a good example of a tool used in natural resource management to assess climate change, other tools are required to assess a community's capacity to adapt, and not just respond, to the challenges presented by climate change impacts. These tools will also be used to examine policy barriers which prohibit decision-makers from making effective decisions in response to climate change, as well as the need to assess climate change impacts across boundaries. These tools are more than just models, but can be as simple as checklists. Many are already in use across Canada.

As a first step in their program, CCIAD has funded seven projects to develop adaptation planning tools for communities. These tools have the added dimension of being scale-dependent as they are directed at a range of communities from large-scale urban areas (i.e. Halifax, NS) to small aboriginal communities in remote areas. The tools also address aspects of planning land-use and/or economic analysis. These projects have been recently completed and formal reports will be available shortly on the CCIAD website (http://adaptation.nrcan.gc.ca/index_e.php).

CCIAD is currently focused on developing broad "cross-cutting" tools that can be utilized by a wide range of professionals working on adaptation and climate change issues. These cross-cutting tools focus on issues such as risk management, expanding their scope beyond the classic approach used by agencies such as the Canadian Standards Association, which has its own series of risk management tools. Specifically, CCIAD is looking at what must be added to existing approaches so they become more robust in a changing climate.

CCIAD is also looking at the types of materials or tools which should be made available to stakeholders and users that are not planners. These tools would enable decision-makers to arrive at sound recommendations without specialized knowledge relating to climate change.

Another project that has recently been undertaken is a method for developing long-term economic analysis. Currently economic analyses often discount future events and consequently begin to fall apart after 30 years. A methodology is therefore required to compensate for future events in order to create more robust economic analyses and to better accommodate future adaptation projects.

A simple tool is also being devised to aid in adaptation planning. This would entail a stepwise process that an individual could go through to ensure that they have explored all the important issues. In this way, they will be prepared for climate change impacts over the longer term.

Future projects will focus on developing sector-specific tools for coastal zone managers, natural resource managers, and others. Mechanisms for creating efficient information transfers are another future project. Such mechanisms would be developed in addition to existing means (e.g. networks such as C-CIARN) and would help disseminate information as well as promote decentralized peer-training on the necessity of climate change assessment and the implementation of adaptation strategies.

In addition to the current work by CCIAD, there are other initiatives in Canada that will aid in the dissemination of climate change adaptation information. The Canadian Council of Professional Engineers (CRP) is currently concluding an assessment of the vulnerability of Canadian infrastructure to climate change. The report focuses on four key areas: storm and waste water; water supply; transportation; and, buildings. This report is the first assessment of its kind, but will also devise an approach that can be used by any community, anywhere to practically evaluate the vulnerability of its infrastructure from an engineering perspective. The Canadian Institute of Planners (CIP) is currently devising in-service modules for the purpose of educating planners on ways to incorporate adaptation into their practices, as well as providing training for future planners. CIP is also exploring methodologies for incorporating climate change and adaptation strategies into planning, where formal planning is not feasible.

CCIAD is working toward tools that would allow stakeholders to have access to:

- Training
- Communication material
- Partnerships to tackle climate change issues
- Timely data for decision making
- Management tools, especially for cross-boundary issues such as water
- Information pertaining to the scale and the accuracy of climate predictions
- Information pertaining to the uncertainty surrounding climate change predictions
- User ease of use of the material is important

Recommendations

Based on the presentations, roundtable and discussions that took place during the workshop, the following recommendations are proposed:

- Work towards improving communication between resource managers and climate and weather forecasters
- Short training sessions for stakeholders, given by the climate and weather forecasters would help to become familiar with what is available and how to interpret the data, graphs, etc.
- Work towards improving short- and long-term predictions for weather, especially extreme weather events, in Atlantic Canada
- Work towards reducing the uncertainty surrounding weather events
- Work towards providing timely data to users, especially for extreme weather events
- Work towards dissemination of current best practices that are working for reducing vulnerability of managed natural resources in Atlantic Canada
- Provide water management tools (e.g. for storage and supply, design criteria, etc.)
- Work towards increasing the adaptive capacity of rural communities, in particular those dependent on decentralized natural resource economies such as agricultural communities
- Work towards increasing the availability of professional planners and planning tools for rural communities vulnerable to climate change impacts

Appendix 1: Short Biographies of Speakers

Norm Catto

Editor, Quaternary International
Professor, Department of Geography
Memorial University
St. John's, NL A1B 3X9
ph 1-709-737-8413
FAX 1-709-737-3119
ncatto@mun.ca

Norm Catto is a Professor of Geography, Memorial University, St. John's, Newfoundland, Canada. His research interests include coastal landforms, natural hazards, sea level change, and the impacts of climate change in coastal environments; response of river systems to climate and weather events, and flood risk assessment; mass movements and slope failures; geomorphic processes in permafrost, arctic, and northern boreal environments; the impacts of climate and weather events to transportation, fisheries, and communities; and the history of climate change. Professor Catto's research has included projects and investigations in environments in Scandinavia, Estonia, Russia, the Dominican Republic, Argentina, and throughout Canada. He is currently co-authoring the Atlantic Canada chapter of the Natural Resources Canada study on Impacts and Adaptations of Climate Change. Professor Catto is a member of several nodes of the Canadian Climate Change Impacts and Adaptations Research Network (C-CIARN).

Pam Kertland

Climate Change Impacts and Adaptation Research Program
Natural Resources Canada
601 Booth Street, Room 113
Ottawa, Ontario K1A 0E8
(613) 943-0650
pkertlan@nrcan.gc.ca

Pam Kertland is a geographer who has been working in the field of climate change for the past 18 years. She started as a science advisor on climate change at Environment Canada. Nine years ago Ms. Kertland moved to Natural Resources Canada to manage the climate change impacts and adaptation research program and has recently taken on the new topic of developing tools for adaptation decision making – the focus of her presentation today.

Jonathan Kierstead

Environment Supervisor
Mersey Woodlands Operations
Bowater Mersey Paper Company Limited
Box 1150, Liverpool, NS, B0T 1K0
(902) 354-3445, ext. 2170
kiersteadjm@bowater.com

Jonathan Kierstead is a graduate forester from the University of New Brunswick with an MScF in wildlife ecology (1999) and a Registered Professional Forester in Nova Scotia. He worked with the Nova Scotia Department of Natural Resources, Canadian Wildlife Service in Sackville, New Brunswick, and Alpine Land Information Services in California, U.S., before joining Bowater in 2002. Mr Kierstead's responsibilities include the maintenance of Mersey's environmental management system, delivery of woodlands public communication documents, and coordination of Bowater's recreation areas. He is a member of both the Blanding's Turtle and Mainland Moose Provincial Recovery Teams, and sits on the Nova Forest Alliance Research Coordination Committee. Jonathan is married to Gail MacFarlane and they have a daughter named Tessa.

Hank Kolstee

Supervisor Land Protection
Nova Scotia Department of Agriculture
P.O. Box 550, Truro NS B2N 5E3
Kolstehw@gov.ns.ca

Hank Kolstee graduated from the Nova Scotia Agricultural College and the Nova Scotia Technical College (now known as Dal Tech), with a degree in Agricultural Engineering.

He began work with the Nova Scotia Department of Agriculture in 1973 and has worked in all aspects of soil and water. Between 1973 and 1976, Mr. Kolstee worked primarily on river engineering and stream bank protection. In 1976, he started part-time work on dykelands, mainly drainage, and provided extension work related to ponds, drainage, etc. In 1983, Mr. Kolstee became the Supervisor of Soil and Water Engineering for the Department. After the restructuring of the Department in 1998, his position switched to become Supervisor of Land Protection.

Mr. Kolstee has spent a great deal of time dealing with environmental issues related to many of the larger projects that the department has carried out. Now a majority of his time is spent with dykelands, as the Administrator of the Agricultural Marshland Conservation Act.

Gary Lines

Climate Change Section, Meteorological Service of Canada
Environment Canada, Atlantic Operations
45 Alderney Drive, Dartmouth, N.S., B2Y 2N6
Phone: (902) 426-5739, Fax: 902-426-2248
gary.lines@ec.gc.ca

Gary Lines is with the Climate Change Unit, Meteorological Service of Canada - Atlantic Operations. He brings over 25 years of meteorology experience to the topic of climate and climate change. In the past several years, Mr. Lines, as part of his role in CCD, has helped deliver more than 100 presentations on climate change to a varied audience. He also manages research projects and participates in several networks aimed at expanding climate change knowledge. Mr. Lines has become a regional science authority on climate change and is the regional resource for the Seasonal Forecast.

Pam Macintosh

County of Colchester
1 Church Street
P.O. Box 697
Truro, Nova Scotia
B2N 5E7
(902) 897-3160

Pam Macintosh is a member of the Canadian Institute of Planners and has a Masters Degree in Planning from Dalhousie University. She has worked for the Municipality of Colchester in the Community Development office for 8 years and prior to that, worked for the Town of Truro Planning Department.

Kevin MacIsaac

PEI Potato Board
90 Hillstrom Ave
West Royality Business Park
Charlottetown, PEI C1E2C6
902-892-6551
potato@peipotato.org

Kevin MacIsaac is the current Chairman of the Prince Edward Island Potato Board. He is an agri-science graduate of the University of Guelph, and a past president of the PEI Soil and Crop Improvement Association. Kevin and his brother, Blair, operate Lily Pond Farms in Bear River, PEI, where they produce potatoes and a small acreage of soybeans and canola. Lily Pond Farms received the 2007 Soil Conservationist of the Year Award or Prince Edward Island.

Appendix 2

Rollin Andrew
Agriculture and Agri-Food Canada – PFRA
440 University Ave
Charlottetown, PEI, C1A 4N6
(t) 902-566-7315
andrewr@agr.gc.ca

René Audet
Agriculture and Agri-Food Canada
Gare maritime Champlain, 901 rue du Cap-Diamant
Quebec, QC, G1K 4K1
(t) 418-648-3649
audetr@agr.gc.ca

Jim Baillie
Nova Scotia Federation of Agriculture
8395 Hwy 311 Balfron
Tatamagouche, NS, B0K 1V0
(t) 902-657-2256
hill.tree@ns.sympatico.ca

Jeffrey Betts
New Brunswick Dept. Natural Resources
PO Box 6000
Fredericton, NB, E3B 5H1
(t) 506-453-2804
Jeffrey.Betts@gnb.ca

Gaeton Bourgeois
Agriculture Agroalimentaire Canada
430 Boul. Gouin
Saint-Jean-sur-Richelieu, QC, J3B 3E6
(t) 450-346-4494
bougeoisg@agr.gc.ca

David Carmichael
PEI Dept. Environment, Energy and Forestry
PO Box 2000
Charlottetown, PEI, C0A 1T0
(t) 902-368-4700
ddcarmichael@gov.pe.ca

Norm Catto
Department of Geography, Memorial University
St. John's, NL, A1B 3X9
(t) 709-737-8413
ncatto@mun.ca

Aston Chipanshi
Agriculture and Agri-Food Canada – PFRA
408-1800 Hamilton St.
Regina, SK, S4P 4L2
(t) 306-780-7680
chipanshia@agr.gc.ca

Dwayne Chobanik
Agriculture and Agri-Food Canada – PFRA
1800 Hamilton St
Regina, SK, S4P 4L2
(t) 306-780-5156
chobanikd@agr.gc.ca

Omer Chouinard
Universite de Moncton
Moncton, NB, E1A 3E9
(t) 506-858-4761
chouino@umoncton.ca

Claude Cote
Environment Canada
260-77 Westmorland St
Fredericton, NB, E3B 6Z3
(t) 506-452-4166
claude.cote@ec.gc.ca

David Colville
NSCC Applied Geomatics Research Group
50 Elliott Road
Lawrencetown, NS, B0S 1M0
(t) 902-825-5476
david.colville@nscc.ca

Nicole Comeau
Faculté des Sciences de l'éducation,
Université de Moncton
Moncton, NB, E1A 3E9
(t) 506-855-4408
nicole.comeau@umoncton.ca

Gwen Corrigan-Vessey
PEI Department of Agriculture, Fisheries & Aquaculture
PO Box 1600
Charlottetown, PEI, C1A 7N3
(t) 902-368-5650
gtvessey@gov.pe.ca

Jean-Louis Daigle
Eastern Canada Soil and Water Conservation Center
1010 Ch de l'Église
DSL Saint-André, NB, E3Y 2X9
(t) 506-475-4040
jdaigle@umce.ca

Andrew Davidson
Agriculture and Agri-Food Canada
960 Carling Avenue, 4th Floor
Ottawa, ON, K1A 0C6
(t) 613-715-5293
davidsona@agr.gc.ca

Kenel Delusca
Université de Montréal
2985 rue Goyer, apt. #6
Montreal, QC, H3S 1H7
(t) 514-574-2968
kenel.delusca@umontreal.ca

Philana Dollin
C-CIARN Atlantic
6100 University Ave, Suite 5010
Halifax, NS, B3H 3J5
(t) 902-494-6355
pdollin@dal.ca

Peter Duinker
Dalhousie University
6100 University Ave., Suite 5010
Halifax, NS, B3H 3J5
(t) 902-494-7100
peter.duinker@dal.ca

Dan Ferguson
Nova Scotia Federation of Agriculture
RR #1
Wallace, NS, B0K 1Y0
(t) 902-257-2639
dan.ferguson@ns.sympatico.ca

Guillaume Fortin
Université de Moncton
165, avenue Massey
Moncton, NB, E1A 3E9
(t) 506-858-4364
forting@umoncton.ca

Ronald Frenette
Environment Canada
8500, 57e avenue
Laval, QC, H7R 4G1
(t) 514-283-8988
ronald.frenette@ec.gc.ca

Daniel Germain
Campus Shippagan, Universite de Moncton
218 Boul. J.-D. Gauthier
Shippagan, NB, E8S 1P6
(t) 506-336-3471
daniel.germain@umcs.ca

William (Bill) Glen
Forest and Woodland Consultant
131 Green Road
Bonshaw, PEI, C0A 1C0
(t) 902-675-4315
wglen@auracom.com

Mike Green
NB Agriculture and Aquaculture
381 Killam Dr.
Moncton, NB, E1C 3T1
(t) 506-856-2777
michael.green@gnb.ca

Eric Hache
293 Church St Apt. 308
Moncton, NB, E1C 9P6
(t) 506-389-2805
hache.eric@gmail.com

Monica Hadarits
C-CIARN
90 Adam St.
Cambridge, ON, N3C 2K6
(t) 519-824-4120
mhadarit@uoguelph.ca

Trevor Hadwen
Agriculture and Agri-Food Canada - PFRA
1800 Hamilton St
Regina, SK, S4P 4L2
(t) 306-780-8405
hadwent@agr.gc.ca

Richard Hardin
Agriculture and Agri-Food Canada - PFRA
850 Lincoln Road
Fredericton, NB, E3B 4Z7
(t) 506-452-4243
hardinr@agr.gc.ca

Nairn Hay
Fundy Model Forest
701 Main St.
Sussex, NB, E4E 7H7
(t) 506-432-7563
nairn@fundymodelforest.net

Peter Hayes
Inter-Cultural Development Innovations
37 Roslyn Dr
Dartmouth, NS, B2W 2M2
(t) 902-462-7940
idihayes@ns.sympatico.ca

Ryan Hennessey
C-CIARN Coastal Zone
1 Challenger Drive
Dartmouth, NS, B2Y 4A2
(t) 902-426-8988
rhenness@gsca.nrcan.gc.ca

Winston Jones
Farmer, Petitcodiac Watershed Alliance
1225 Coverdale Rd.
Riverview, NB, E1B 5G4
(t) 506-387-5808

Paul Jordan
New Brunswick Department of Environment
PO Box 6000
Fredericton, NB, E3B 5H1
(t) 506-444-3611
paul.jordan@gnb.ca

Charles Karemangingo
NB Agriculture and Aquaculture
PO Box 6000
Fredericton, NB, E3B 5H1
(t) 506-453-8311
charles.karemangingo@rogers.com

Pam Kertland
Natural Resources Canada
601 Booth St
Ottawa, ON, K1A 0E8
(t) 613-943-0650
pkertlan@nrcan.gc.ca

Kevin Keys
Nova Scotia Department of Natural Resources
PO Box 68
Truro, NS, B2N 5T2
(t) 902-893-5713
kkeys@gov.ns.ca

Jonathon Kierstead
Bowater Mersey Paper Company Limited
Box 1150
Liverpool, NS, B0T 1K0
(t) 902-354-3445
kiersteadjm@bowater.com

Lacia Kinner
Dalhousie University
1187 Queen St, Apt. 3
Halifax, NS, B3K 2S5
(t) 902-802-6935
lkinnear@dal.ca

Hank Kolstee
Nova Scotia Department of Agriculture
PO Box 550
Truro, NS, B2N 5E3
(t) 902-893-6569
kolstehw@gov.ns.ca

Ken Kwok
Environment Canada
1800 Hamilton St
Regina, SK, S4P 4L2
(t) 604-773-9000
ken.kwok@ec.gc.ca

Jean Lambert
Secrétariat rural
1600 Main, Piéce 210
Moncton, NB, E1E 1G5
(t) 506-851-3523
lambertj@agr.gc.ca

Nadine LaPlante
Université de Moncton
293 Church St Apt. 308
Moncton, NB, E1C 9P6
(t) 506-389-2805
nlp246_@hotmail.com

Anita Leblanc
Agriculture and Agri-Food Canada
PO Box 2069
Bouctouche, NB, E4S 2J2
(t) 506-743-1146
leblanca@agr.gc.ca

Serge LeBlanc
Agriculture and Agri-Food Canada
1045 St-Joseph Rd, Box 2069
Bouctouche, NB, E4S 2J2
(t) 506-743-1147
leblancs@agr.gc.ca

Robin LeBlanc
Littoral et vie
41 1/2 Hillside Drive
Moncton, NB, E1A 3S2
(t) 506-548-9452
jazzrl@hotmail.com

Louis Lefaivre
Meterological Service of Canada
2121 Trans-Canada Highway
Dorval, QC, H9P 1J3
(t) 514-421-4654
louis.lefaivre@ec.gc.ca

Hong Li
Nova Scotia Agriculture College
Dept. of Plant and Animal Science
Truro, NS, B2N 5E3
(t) 902-893-7859
hli@nsac.ca

Hai Lin
Environment Canada: Meteorological Research
2121 Trans-Canada Highway
Dorval, QC, H9P 1J3
(t) 514-421-7276
hai.lin@ec.gc.ca

Gary Lines
Environment Canada
45 Alderney Drive
Dartmouth, NS, B2Y 2N6
(t) 902-426-5739
gary.lines@ec.gc.ca

Pam Macintosh
Municipality of the County of Colchester
PO Box 697
Truro, NS, B2N 5E7
(t) 902-897-3170
pmacintosh@colchester.ca

Dan MacKinnon
Nova Scotia Department of Natural Resources
PO Box 130
Shubenacadie, NS, B0N 1C0
(t) 902-758-7234
mackindg@gov.ns.ca

John MacLellan
Forest Safety Society of Nova Scotia
PO Box 696
Truro, NS, B2N 5E5
(t) 902-895-1107
jmaclellan@fss.ns.ca

Malcom (Mac) MacLeod
Scotia Weather Services Inc.
192 Wyse Rd, Suite 8
Dartmouth, NS, B3A 1M9
(t) 902-468-3866
mmacleod@scotiaweather.com

Maurice Maillet
Agriculture and Agri-Food Canada
1600 Main St, Suite 210
Moncton, NB, E1E 1G5
(t) 506-851-2062
mailletm@agr.gc.ca

Gilles Martin
Université de Moncton
Moncton, NB, E1A 3E9
(t) 506-858-4661
marting@umoncton.ca

Philip McCabe
Parks Canada
2 Palmers Lane
Charlottetown, PEI, C1A 5V6
(t) 902-672-6367
phil.mccabe@pc.gc.ca

Dale McIsaac
Maple Producers' Association of Nova Scotia
PO Box 217
Amherst, NS, B4H 3Z2
(t) 902-667-7810
dalemcisaac@eastlink.ca

Janelle Mclaughlin
Université de Moncton
139 Av. Morton, App. #9
Moncton, NB, E1A 3H7
(t) 506-204-0874
jungle74@hotmail.com

Bano Mehdi
C-CIARN Water Resources,
McGill University
21-111 Lakeshore Rd.
Ste. Anne de Bellevue, QC, H9X 3V9
(t) 514-398-7836
bano.mehdi@mcgill.ca

Monique Mills
New Brunswick Agricultural Council
850 Lincoln Road, suite 113
Fredericton, NB, E3B 9H8
(t) 506-450-3891
acaafpascaa@nb.aibn.com

Peter Murphy
Agriculture and Agri-Food Canada - PFRA
1 Regent Square
Corner Brook, NL, A2H 7K6
(t) 709-637-4960
murphy@agr.gc.ca

Mary Myers
PEI Dept. Environment, Energy and Forestry
PO Box 2000
Charlottetown, PEI, C1A 7N8
(t) 902-368-4700
mnmyers@gov.pe.ca

Brent Newton
Dept. of Environment PNB
20 McGloin St, Box 6000
Frederiction, NB, E3B 5H1
(t) 506-444-4108
brent.newton@gnb.ca

Jean-Luc Pilote
55 avenue Garden Hill
Moncton, NB, E1C 3E5
(t) 506-548-4045
jeanlucpilote@yahoo.fr

Wendy Pratt
Agriculture and Agri-Food Canada - PFRA
90 Research Dr
Truro, NS, B2N 6Z4
(t) 902-896-0336
prattw@agr.gc.ca

Dianne Pruneau
Groupe Littoral et vie
Université de Moncton
Moncton, NB, E1A 3E9
(t) 506-858-4264
prunead@umoncton.ca

Jacqueline Richard
C-CIARN Ontario
935 Ramsey Lake Road
Sudbury, ON, P3E 2C6
(t) 705-675-1151
jrichard@mirarco.org

Claude Robichaud
NB Agriculture and Aquaculture
PO box 5001 381 Killam Drive
Moncton, NB, E1C 8R3
(t) 506-856-2277
claude.d.robichaud@gnb.ca

Michel Rocheleau
Agriculture and Agri-Food Canada
3410 route 475
Sainte-Anne de Kent, NB, E4S 1J4
(t) 506-743-8436
rocheleaum@agr.gc.ca

John Ross
Nova Scotia Department of Natural Resources
23 Creighton Rd. Box 130
Shubenacadie, NS, B0N 2H0
(t) 902-758-7216
rossjc@gov.ns.ca

Dave Schellenberg
New Brunswick Department of Environment
20 McGloin St, 3rd Floor
Fredericton, NB, E3A 5T8
(t) 506-453-3925
dave.schellenberg@gnb.ca

Raymond Scovil
Retired Agricultural Consultant
135 Edinburgh Street
Fredericton, NB, E3B 2C8
(t) 506-454-3128
scovil@nbnet.nb.ca

Inuk Simard
Conservation Council of New Brunswick
180 St.John Street
Fredericton, NB, E3B 4A9
(t) 506-458-8747
inuk@conservationcouncil.ca

Erin Swansburg
PEI Environment, Energy and Forestry
11 Kent St
Charlottetown, PEI, C1A 7N1
(t) 902-368-6111
eoswansburg@gov.pe.ca

Etienne Theriault
Ministère de l'agriculture et aquaculture du NB
C.P 3058, succ.bureau-chef
Tracadie-Sheila, NB, E1X 1G5
(t) 506-394-4128
etienne.j.theriault@gnb.ca

Stephen Tulle
New Brunswick Dept. Natural Resources
80 Pleasant St.
Miramichi, NB, E1V 1X7
(t) 506-627-4056
stephen.tulle@gnb.ca

Marie-France Turcotte
Centre Météorologique Canadien
2121 route Transcanadienne
Dorval, QC, H9P 1J3
(t) 514-421-7226
marie-france.turcotte@ec.gc.ca

Rob Uttaro
Nova Scotia Department of Natural Resources
PO Box 130
Shubenacadie, NS, B0N 1C0
(t) 902-758-7229
uttarorf@gov.ns.ca

David Walker
NB Agriculture and Aquaculture
PO Box 6000
Fredericton, NB, E3B 5H1
(t) 506-453-3467
David.Walker@gnb.ca

Ellen Wall
C-CIARN Agriculture
University of Guelph
Guelph, ON, N1G 2W1
(t) 519-824-4120
ewall@uoguelph.ca

Dave Wattie
NB Agriculture and Aquaculture
39 Barker Lane
Wicklow, NB, E7L 3S4
(t) 506-392-5139
david.wattie@gnb.ca

Greg Webster
Webster Farms Limited
Box 84
Cambridge, NS, B0P 1G0
(t) 902-538-9492
webfarm@ca.inter.net

Renee Wissink
Fundy National Park
PO Box 1001
Moncton, NB, E4H 1B4
(t) 506-887-6098
renee.wissink@pc.gc.ca

Jack Williams
Agriculture and Agri-Food Canada
PO Box 2069
Bouctouche, NB, E4S 2J2
(t) 506-743-2464
jackwilly89@hotmail.com

Suzanne Young
NB Agriculture and Aquaculture
39 Barker Lane
Wicklow, NB, E7L 3S4
(t) 506-392-5142
suzanne.young@gnb.ca