Scenario-Based Planning for a Changing Climate in the Bras d'Or Ecosystem

January 28 and 29, 2010

Cape Breton University

Livia Bizikova, IISD
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Workshop Report

May 2010

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International Institute for Sustainable Development
161 Portage Avenue East, 6th Floor
Winnipeg, Manitoba
Canada R3B 0Y4
Tel: +1 (204) 958–7700
Fax: +1 (204) 958–7710
Email: info@iisd.ca
Website: www.iisd.org

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1.0 Introduction

1.1 Defining scenarios in the context of the workshop

Responding to climate change is becoming a necessity. Communities can no longer afford to rely on policies that are based solely on past and current needs to protect them from impacts of changing climate. On the other hand, developing policies that take into account the potential impacts of future climate without considering local needs, plans and long-term visions could challenge the implementation and effectiveness of such policies. Therefore, to be effective in adapting to climate change, we should try to look at impacts of climate change and needed responses in the context of other challenges and opportunities that regions are facing, and in this way account for synergies and trade-offs between climate change responses and other policies and measures. Current examples show that policies that promote sustainable development and help build capacities also help communities to deal with the impacts of climate change more effectively.

Scenarios provide a great opportunity to explore future possibilities through assumptions made about factors that drive local development. Scenarios in this context are neither predictions of socioeconomic development nor impacts of changing climate; rather, they are plausible descriptions of how the future might develop using current information and assumptions about future trends. They also help to explore the differing outcomes that might result if basic assumptions are changed (UNEP, 2002). Scenarios can be used for multiple purposes (Jaeger et al., 2000), including to:

- aid in recognition of "*weak signals*" of change;
- avoid being caught off guard—"*live the future in advance*";
- challenge assumptions "*mental maps*";
- understand the world better, and make better decisions;
- raise awareness;
- test strategies for robustness using "*what if?*" questions;
- provide a common language; and
- stimulate discussion and creative thinking.

The ultimate aim, in most cases, is to:

- provide better policy or decision support
- stimulate engagement in the process of change

Especially when we are dealing with issues such as long-term development of regions and preferred development pathways, opinions and references of different stakeholders could differ significantly. It is beneficial, therefore, to involve a range of stakeholders in the scenario development. Recently, a number of arguments in favour of participation in scenario development have been developed in the literature; in particular, because participation helps to gather more diverse, extensive and context-specific bodies of knowledge. As such, participation is considered a means to an end rather than an end in itself (Stirling, 2006). Participation helps bridge gaps between scientific communities and governments, businesses, interest groups or citizens. It provides a reality check for research assumptions and methodology, increases the salience and legitimacy of the developed scenarios, and thus their acceptance among end-users (Volkery et al., 2008). Currently, available studies show differing degrees of participation in scenario development, from involving stakeholders as reviewers of the scenarios developed by experts to having stakeholders develop scenarios, called *participatory scenario development*. The latter was our goal in this workshop. In reaching for that goal, we also strived to build local capacity for adaptation to climate change.

1.2 Defining participatory scenario development

Participatory scenario development (PSD) is a process that involves the participation of stakeholders in exploring the future in a creative and policy-relevant way. PSD is used to identify the effects of alternative responses to emerging challenges, to determine how different groups of stakeholders view the range of possible policy and management options available to them, and to identify what public policies or investment support are needed to facilitate effective future actions.

When PSD has been applied in studies focused on community development and future visioning, the following key contributions have been identified (as compiled by Evans, et al., 2008, selected):

- The use of scenarios allows local stakeholders to develop strategies that encourage self-reliance and strengthen intra-community collaboration.
- The process of scenario development educates participants about aspects of the science, economics and governance relevant to adaptation.
- The concrete products of the scenarios—drawn or written visions, prioritized lists of needs, strategies and proposals—served as records of decision-making processes validated by the community.
- This method strengthened group discussions, and broadened participation in decision-making and in the development of practical strategies because the methods provided techniques and practical experience to hold meetings in which all participate.
- Finally, scenarios improve collaborative planning and negotiation between communities and authorities; it helps community leaders to become more vocal and assertive in meetings, and helps marginalized groups within communities make their voices heard.

During this workshop, the primary function of the scenarios was to provide a framework and context within which different groups of stakeholders can better understand potential climate change impacts and consider and discuss a range of possible adaptation options, as well as what forms of policy or investment support are needed to facilitate effective adaptation. PSD approaches also helped in identifying locally relevant pathways of autonomous and planned adaptations in the context of development choices and decisions, and in informing actors of and possible consequences of adaptation actions. It also helped people formalize their impressions and assumptions about change in their communities (e.g., the demographic realities, economic development).

2.0 Workshop Overview

2.1 Workshop objectives

During the workshop, we applied PSD to identify potential future development pathways, assessed the resilience of pathways in the context of future climate change and, finally, identified responses that would be needed to adapt to the impacts of climate change in the context of the particular future scenario.

Objectives of the workshop were to:[1]

- Identify plausible pathway of development for the region
- Identify adaptation options for impacts of climate change that reflect participants' understandings and preferences;
- Uncover relationships, including synergies and trade-offs, between development priorities and adaptation actions so the identified options are relevant for the workshop participants in the context of their future development priorities; and
- Explore what types of sectoral and institutional measures stakeholders feel would be required to facilitate the integration of adaptation actions into policies and practices.

In the workshop, we also combined PSD techniques with specific information about local climate change impacts to help participants to identify the major types and severity of impacts the Bras d'Or ecosystem and its communities that need to be considered when assessing plausible future scenarios.

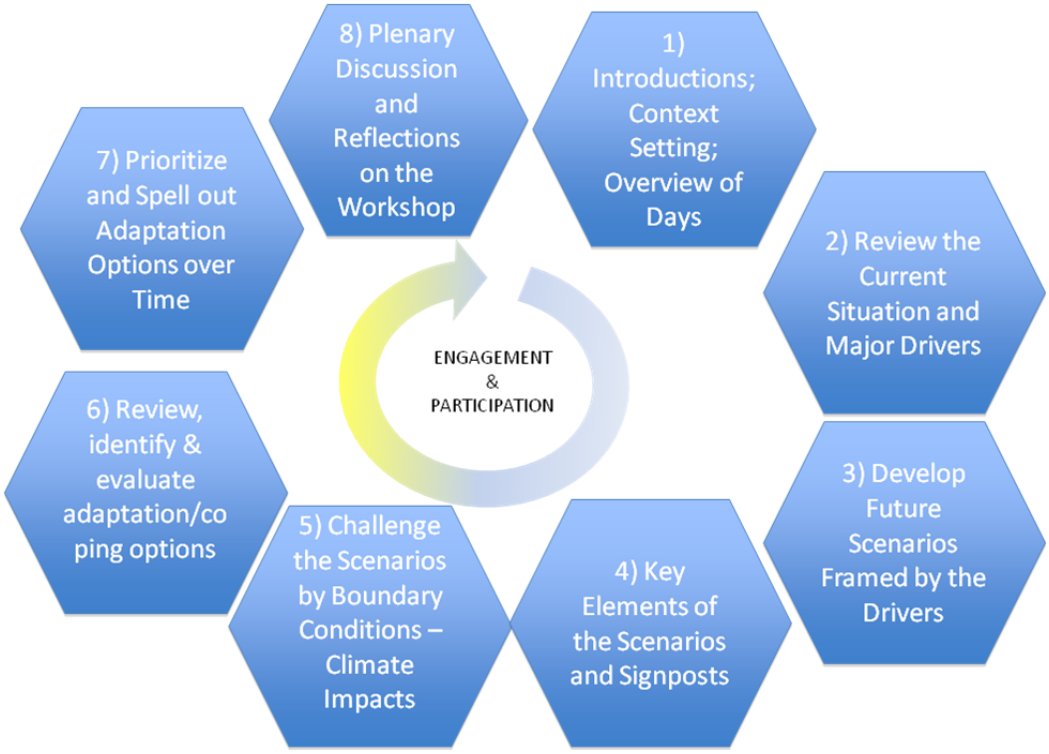
2.2 Overall workshop design

The PSD approach was completed in a two-day workshop. The workshop included eight key steps, moving from identifying development challenges and drivers to future scenarios, impacts of climate change and needed adaptation options. The workshop opened with a welcome from Bruce Hatcher (Cape Breton University), Ruth Waldick (IMAGINE Canada) and Livia Bizikova (IISD). After introductions and setting the stage for the workshop (Figure 1, element 1), in plenary, the participants were asked to review the current situation and identify important future drivers and challenges (Figure 1, element 2). Following this exercise, participants made assumptions about how the drivers could evolve in the future and, from that, developed three potential future scenarios to 2060 (Figure 1, element 3).[2] The participants were then divided into four groups and developed the scenario details by using their knowledge of their communities; they also identified key events and

[1] The PSD approach and workshop methodology is described in Bizikova et al., (2009) and ESSA/IISD (2009)
[2] A similar approach to identifying and making assumptions about key drivers is applied in the corporate context by IISD (in press).

signposts that could signal that the community is on a path resembling the particular scenario (Figure 1, element 4). One scenario was assigned to each group, and one of the scenarios was also assigned to another group of young participants as a comparative contrast.

Figure 1. Key elements of the PSD workshop in Sydney



Source: Bizikova et al. 2009 and ESSA/IISD 2009, modified

To better understand observed and projected changes in climate, Gary Lines (Environment Canada) provided an overview of the potential impacts of climate change relevant for the region. The impacts of climate change were then further specified in a presentation by Fred Baechler (ADI Limited), which focused on sea-level rise in Bras d'Or Lakes. Following the introduction of regional climate change projections, the participants worked in groups to explore how climate change may affect the future scenarios (Figure 1, element 5). They then identified needed adaptations to climate change based on local experiences in the context of future visions (Figure 1, element 6) and then prioritized and described adaptation actions to create a key list of adaptation options with needed actions over time. They did this from a decision-makers' perspective (Figure 1, element 7). After element 5, each group presented their scenarios, including their levels of resilience in the context of current climate variability and potential impacts of future climate change.

While the previous elements were done in the context of each future scenario, element 7 provided an opportunity for the groups to select and review adaptation options developed by other groups

based on their expertise. Finally, as with any workshop, the workshop concluded with a discussion about the relevance of the outcomes, evaluating the workshop and providing details about the workshop report (Figure 1, element 8).

2.3 Participants' feedback about the workshop process

After the completion of the workshop, we collected 21 completed evaluation forms from the workshop participants. Overall feedback from the workshop in Sydney was positive and informative. Participants expressed considerable support for the engaging facilitation of the workshop, as well as for the participatory and interactive nature of the impacts, adaptations and pathways activities.

Figure 2. Example of a developed future scenario and the identified impacts of climate change and adaptation options

Photo: Livia Bizikova

From the 21 evaluations, the average score indicated a "successful" workshop: half of the participants considered the workshop to be "very successful" and half considered the workshop to be "fairly successful." Participants agreed the activities were challenging yet engaging, and that the information presented in the two presentations on climate change were interesting and highly relevant. Participants also appreciated the links between the scenario development, climate change and adaptations, which, according their responses, were more engaging then just discussing climate change. The highest-rated sessions were the sessions on climate change impacts, developing future

scenarios and adaptation options. Most of the participants considered the workshop successful because of the participatory character of the exercises, opportunities for discussion with their group members and the overall methodological approaches (e.g., Figure 2).

In looking forward, participants suggested improvements to the PSD structure and content for future workshops, including providing more time for participants to complete the exercise; providing clearer guidelines, especially for the scenario development exercise; and having more in-depth discussions when identifying future drivers. They also suggested incorporating these types of activities into planning at the local and community levels so that climate change issues are well integrated with other priorities, and local and regional needs are better reflected in discussions about future responses to climate change.

3.0 Workshop Results

In this section, we will present outcomes of the workshop, focusing on key areas such as: future scenarios, impacts of climate change, adaptation responses and priority actions. Information in this chapter was presented by the workshop participants during their group presentations and plenary discussions or was recorded on the provided sticky notes and flipchart. The reporting of these outputs was augmented by detailed notes taken by two rapporteurs throughout the workshop.

3.1 Current development issues and challenges

Understanding the current situation and current challenges helps in the future scenario development process because participants start exploring issues that will need to be dealt with if they want a different development pathway for their communities. We focused first on identifying the most important issues and challenges to development in the region, and then on the main drivers that are behind these issues and challenges. In terms of identified challenges, the participants listed a number of issues that are summarized as follow:

Environmental and climate challenges:

- Increasing precipitation and storminess (both number of storms and their severity)
- Changes in the patterns of snow and ice deposition and melt
- Changes associated with the above factors, including increased run-off, erosion and landslides
- Changes in surface and ground water levels and potential negative impacts on freshwater resources
- Decreasing productivity and diversity in marine and estuarine ecosystems (declines in fishery yields and increased invasions by new species)

Socioeconomic challenges:

- Changes in population: overall population is declining, but the proportion of elderly and First Nations populations are increasing; there is a potential increase of immigrants, mostly retirees and seasonal residents
- Increasing migration from rural to urban areas, leading to regional disparities
- Policies that do not account for the in-migration and out-migration of the people
- Declining forest heath and wildlife associated with poor forest harvest practices
- Inadequate water treatment infrastructure
- Uncoordinated land-use practices and management

- Recognizing and preserving the cultural significance of the area
- Valuable recreational areas attract tourism, but could be limited by inadequate infrastructure
- Public access to the lake: people are turning large plots of land around the lake into private properties (79 per cent of the foreshore is in private ownership and little public access to the coast remains)
- People can have a good standard of living here, however the First Nations people face challenges of growing population and limited land
- Low level of personal engagement in local matters

Based on the identified challenges, we selected key drivers that formed the basis of the future scenarios. Based on the discussion during the workshop, the major drivers of these changes and the main issues of the community relevant to climate change were identified as follows: land-use policy, changes in precipitation, changes in population and quality of life, economic performance and types of businesses in the region. By specifying and making assumptions about the future development of these drivers and issues, we can form a basis of diverse possible pathways for the community (Table 1).

3.1.1 Assumptions about Key Drivers

In terms of changes in precipitation, we identified two states based on different assumptions—one represents the continuation of current variability in precipitation, and the other assumes increasing precipitation levels with changing character (i.e., shorter and heavier rains with longer drier periods). These assumptions are based on general climate change projections for the region.[3] For land-use change we assumed limited integration of land-use policies, which reflects the current situation. Presently, there are a number of different groups and different levels of governance with limited integration, and while the Collaborative Environmental Planning Initiative (CEPI) acts as integrator of different groups, it does so without decision-making power. On the other end of the spectrum, we assumed that, in the future, land-use policies will be integrated with the goal of increasing ecological and economic resilience in the region. Finally, in terms of socioeconomic development we assumed either the continuation of current, declining population, or an increase in population and economic activities.

[3] For more information see for example: Vasseur & Catto (2007). Atlantic Canada. In: Lemmen et al. (2007), From Impacts to Adaptation: Canada in a Changing Climate. Ottawa: Natural Resources Canada. http://adaptation.nrcan.gc.ca/assess/2007/pdf/ch4_e.pdf and on the Canadian Climate Change Scenario Network: http://www.cccsn.ca/Download_Data/GCM_Introduction-e.html

Table 1. Assumptions about the potential changes of key development drivers of scenarios for climate change in the Bras d'Or ecosystem of Cape Breton Island

Key drivers	Assumptions about key drivers	
Changes in precipitation	Current precipitation variability continues	Increased precipitation in the form of heavy rains
Degree of integration of land-use policies	Limited integration of land-use policies (resembling current land-use policies)	Integrated land-use policies
Designation under the UNESCO MaB Program	Not designated	Designated
Population and economic changes	Static and/or declining economy	Increasing population and economic activities

3.1.2. Scenario Development

In plenary, we reviewed assumptions about the drivers and formulated three future scenarios for the time horizon of 2060 (Table 2). **Scenario 1** (*status quo*) resembles current practices in terms of land-use policies, socioeconomic development, and we made an assumption that the current variability of precipitation will continue in the future. This scenario is useful in identifying the no-regret policies that would need to be introduced to address the challenges of current climate variability if there are no major changes in socioeconomic development and policy-making. Scenarios 2 and 3 take into account projected precipitation in the context of future climate changes. **Scenario 2** (*best case*) assumes that the community will promote integration of land-use policies, become a member of the Man and the Biosphere (MAB) program and enhance economic activities. This scenario is close to a preferred future development for the community in the face of climate change. Finally, **Scenario 3** (*worst case*) describes a future in which the community would succeed in promoting economic development in the context of future climate projections without fundamentally changing how land-use policies are coordinated.

Table 2. Three scenarios created by combing different assumptions of development of the identified key drivers

Scenario 1	Scenario 2	Scenario 3
Current precipitation variability continues Limited integration of land-use policies Not designated as a UNESCO MaBP reserve Static or declining population	Increased precipitation in the form of heavy rains Integrated land-use policies Designated as a UNESCO MaBP reserve Increasing population and economic activity	Increased precipitation in the form of heavy rains Limited integrated land-use policies Not designated as a UNESCO MaBP reserve Increased population and economic activities

In the following sections, we will describe the scenarios in detail, as developed by the workshop participants, and then examine the degree of their resilience in the context of other impacts of climate change beyond precipitation.

3.2 Overview of the selected scenarios

3.2.1 Scenario 1: Current development, policy and climate variability trends (status quo)

This scenario was selected by the participants, because it resembled current trends in the community, including overall socioeconomic development, policies and precipitation patterns. It provided an opportunity for the participants to think through a scenario in which the current trends will continue for the next fifty years even without adding additional pressures from climate change. (See also Appendix 6.1, Table 6).

Key elements of the Scenario 1
Current precipitation variability continues
Limited integration of land-use policies
Not being part of the MAB program
Static or declining population

Figure 3. Participants develop the future scenarios

Photos: Livia Bizikova

When outlining socioeconomic changes in the context of this scenario, the participants expected to increase property ownership by foreigners, leading to a slight increase in the seasonal or permanent population. The increasing population that is expected to occur in First Nations communities could affect their standard of living, as limited by available land. Uncoordinated policies with changes in seasonal and permanent population will likely to lead to worsening environmental conditions including increasing erosion, limited recharge of ground water and further declining productivity of natural resources by loss of habitat, sedimentation, inadequate management of forestry, fisheries and biodiversity. The community will have opportunities to invest in agriculture and aquaculture, which could be enhanced by nutrient inputs, but challenged by limited policies to comprehensively protect environment when private investors develop businesses.

During the scenario development, participants also discussed possible signposts in the next years that the community is on the path of Scenario 1. Signposts mostly included increasing

environmental deterioration, such as increased numbers of aquatic and terrestrial species at risk, reduced area of marshlands with their natural filtering capacity, and overall reduction in the capacity of the land and water to support agriculture, aquaculture, fisheries and tourism.

Participants indicated that to minimize the impacts on the environment and to increase community resilience, further measures need to be implemented under this scenario. These include:

1. Targeted support for educational, economic and social development to improve the conditions of the First Nations communities;
2. Developing and implementing landowner management policy, especially for new residents;
3. Supporting local stewardships groups (such as the ACAP, BLSS, SRDB, etc.) to overcome policy gaps; and
4. Making the CEPI work as planned.

Priority should be to gradually move away from areas that are under threat of erosion and flooding so that properties and infrastructure are not getting repeatedly damaged.

3.2.2 *Scenario 2: Changing development and policy trajectories (best case)*

Key elements of the Scenario 2
Increased precipitation in the form of heavy rains
Integrated land-use policies
Designated as a UNESCO MaBP reserve
Increasing population and economic activity

Scenario 2 assumed that drivers of community development will move toward integrated and balanced socioeconomic and policy choices, and that the ecosystem and its communities will be designated as a UNESCO MaBP reserve. These elements will exist under climatic constraints based on projected future increases in precipitation in the form of heavy rains. This scenario was developed simultaneously by two groups (one young and one old) and their combined outcomes are discussed below (see also Appendix 6. 1, Table 7).

The major challenge in this scenario for the participants was envisioning what an approach to governance that promotes integrated policies would look like. In general, participants suggested that it would not necessarily require new governance structures and laws. Based on experiences in other provinces, a watershed conservation authority could lead the policy integration. This role could be fulfilled through the CEPI if it were given additional decision-making authority.[4] Effective integration would achieve the goal of the Bras d'Or Lakes Charter.[5] Such an organization would

[4] The CEPI's Management Plan Task Team is tabling a draft management plan for its work in March 2010.
[5] The Bras d'Or Lakes Charter was created at the 2004 CEPI workshop, where the medicine wheel was used to guide participants as they developed a vision of the future of the Bras d'Or. It was signed by the Regional Directors General of Indian and Northern Affairs Canada, Environment Canada and Fisheries and Oceans Canada; the Deputy Ministers of the Nova Scotia Departments of Natural Resources, Aquaculture and Fisheries, Environment and Labour, and Office of

create forums for individuals, different agencies and stewardship groups to discuss and achieve consensus about the key priorities for a healthy ecosystem as climate changes. These venues, supported by education programs, would be needed to increase engagement, a sense of stewardship, awareness, personal accountability and behavioural change (for example, by forming more hunters' associations) to implement measures that enhance ecosystem health. This would require significant and targeted investments in sustainability education, creating an environmentally-conscious generation by 2060. Finally, it also should be recognized that the four Bras d'Or municipalities have different levels of capacity to participate in and to act upon integrated planning. Targeted actions are needed to build capacity in the municipalities and Mi'qmak Band Councils to enable them to engage effectively.

Integration of land-use policies would mean linking land and water research, knowledge and issues to view the Bras d'Or as a whole. Specific governance activities could include designating provincially-owned buffer zones around the shores of the Bras d'Or estuary. This would be particularly useful for adaptation to climate change, as more flooding is expected to affect the region in the future. These buffer zones should be considered in other vulnerable areas besides the shoreline, for example those that have valuable biodiversity where further economic development could impact them negatively. To reduce the frequency of introductions of new marine species, on-board ballast sterilization for ships that enter Bras d'Or needs to be developed. Land for traditionally utilized plants and animals and for Mi'gmaq cultural sites should be protected, and higher environmental standards need to be maintained on the reserves.

Socioeconomic development was identified as essential for effective adaptation to climate change in the Bras d'Or. Promoting local agriculture and small-scale commercial fisheries, increasing employment in new vocations such as IT, the environmental sector, provincial and federal monitoring and ecotourism were amongst those identified by participants. The village of Iona was seen by some as a future hub for commerce, with infrastructure and services. To address the challenge to the First Nations communities, new building regulations should be implemented to improve building design, and foster better environmental and land development practices. These objectives will require increased funding and focused, inter-agency programs.

Participants indicated that signposts of this pathway could include: the introduction of an environmental fee on products (electronics), continuing efforts towards comprehensive land-use planning throughout the region based on research outcomes and improved environmental regulation of those who own property on the region.

Aboriginal Affairs; the Chiefs of Eskasoni, Membertou, Wekoqmaq, Wagmatcook and Potlotek First Nations; the Wardens of Inverness, Richmond, and Victoria counties; and the mayors of the town of Port Hawkesbury and of the Cape Breton Regional Municipality. The final signature was obtained in 2007. Source: http://www.brasdorcepi.ca/charter

3.2.3 *Scenario 3: Economic development in the context of climate change and limited policy integration (worst case)*

This scenario outlined a future in which the region is developing faster than it is currently, climate change is happing as predicted, and people were not successful in integrating land-use policies comprehensively (See also Appendix 6.1, Table 8).

In Scenario 3, participants envisioned significant competition for land to accommodate different development activities, such as mining, forestry and housing (the latter, mostly on the coasts with limited focus on environmental protection). In this scenario, the decisions are based mostly on costs and feasibility, not environmental considerations. Participants expected that environmental degradation and challenges will continue to mount over time, and will include loss of forest land, increased pollution and loss of biodiversity. This could lead to pressure on marine and terrestrial ecosystems, declining water quality and sedimentation, all causing a negative impact on harvestable production and recreation.

Key elements of the Scenario 3
Increased precipitation in the form of heavy rains
Limited integrated land-use policies
Not designated as a UNESCO MaBP reserve
Increased population and economic activities

Projected changes in precipitation will increase the frequency and intensity of localized flooding and run-off with contaminants and sediments exacerbated by land-clearing, paving, etc., which will affect water quality, productivity and species distribution. Those changes would come at high costs to the region in the form of increased insurance rates, especially on the coasts, infrastructure maintenance costs, water treatment fees and expenses associated with enhanced management of erosion and run-off.

Economic development under this scenario will increase demand for external resources (e.g., food and associated transportation), and change the nature of services, demanded by young people, tourists and retirees. This scenario assumes an influx of new residents that could be both seasonal and permanent, which will probably increase the cultural diversity of the region.

Participants considered this scenario generally unsustainable, and as time progresses, they anticipated that more efforts would be needed to address marine and land conversion issues, motivated by the need to maintain revenues and economic activities such as tourism. To increase the resilience of the ecosystem under this scenario, participants suggested that decision-making would need to move towards more integrated land-use strategies. These could involve industry in environmental planning and setting minimal standards for industrial practices and expansions. Furthermore, in this scenario, efforts should be made to increase social cohesion and increase involvement in decision-making beyond powerful stakeholders.

Finally, increases in funding (from property and income taxes, for example), coastal erosion and habitat loss, and insurance premiums for coastal properties as a function of climate change were seen as **indicators and signposts** that the community is on the path leading to the future outlined by Scenario 3.

3.3 Impacts of climate change and identified adaptation options

3.3.1 Identified major impacts of climate change

After describing the scenarios in detail, we focused on assessing how realistic these scenarios are in the context of projected climate change. So far, we had only looked at the changes in precipitation, but in this section we also included other climatic variables such as temperature, sea-level rise, extreme events and impacts on ecosystems (an overview of the impacts is listed in Table 3). Scenario 1, based on the status quo assumptions including conservative estimates of future climate change, could provide a baseline for "no-regret" actions that are necessary even presently to address current climate variability.

Taking into account only current climate variability and conservative estimates of climate change, the major impacts in the region were expected to be sea-level rise with storm surges causing **flooding** and increasing salinity of the estuary and the water table close to the shoreline. The impacts on wells and septic systems and the loss of coastal land have potentially large impacts on infrastructure and arable land. In the future, impacts such as losses of suitable housing areas, increased competition for dry areas, flooded buildings, offices, services, infrastructure (roads) and increased stress on emergency services are expected. Flooding could also challenge future development of tourism and culture due to loss of historically and recreationally significant sites and loss of culturally significant areas (e.g., graveyards and Aboriginal burial sites).

Increasing frequency and intensity of **heavy rain** events and storm wind events will be worsened by inappropriate building sites; flooding, landslides and sedimentation could compromise aquatic productivity. A further impact on terrestrial and marine water quality includes contamination due to washed-out sewage and pollutants. Heavy rains could destroy infrastructure such as roads, culverts and sewage treatment plants. Recurring impacts of heavy rains and flooding on housing and tourist facilities could make insurance companies refuse service or raise premiums in high-risk areas.

Table 3. Overview of identified impacts of climate change and adaptation to it in the Bras d'Or ecosystem of Cape Breton

Climatic variable	Impacts
Sea-level rise	- Increasing estuarine salinity and increasing salt water intrusion to ground water reservoirs - Increased salt water pressure close to the shoreline with impacts on wells and septic systems - Loss of coastal land, including supported infrastructure and arable land), due to floods and erosion - Flooded homes, offices, and other infrastructure (e.g., roads) resulting from inappropriate location and construction - Loss of suitable housing areas and increased competition for building space in the other areas - Decrease in tourism due to loss of historically and recreationally significant sites; also loss of culturally significant areas (e.g., burial sites, medicinal plant gardens) - Increased stress on emergency services - Increased financial risks and maintenance costs - Insurance companies refuse to insure high-risk areas
Increasing temperature	- Changes in the ranges of occurrence of terrestrial and aquatic species - Change in occurrence of pathogens, pests and invasive species affecting terrestrial and aquatic wildlife and cultured species - Extending outdoor recreational activities - Enhanced potential for agricultural and estuarine production - Potential changes in human health outcomes - Decreased frequency of extreme cold weather events that inhibit parasites, pests, fungus, bacteria, etc. - Loss of sensitive breeding areas for birds and other coastal species - Increase in forest fires as trees die from diseases or are weakened because of other impacts and poor management choices
Increased storminess and heavy rainfall	- Destruction of expensive infrastructure, especially on the shoreline due to waves and runoff erosion - Disturbance of ecological communities by wind, forest fires, currents, waves, freshwater run-off and sediment dumping - Power outrages could result in increased human populations - Reductions of terrestrial and marine food production (e.g., crops, finfish, shellfish) - Loss of near-shore marine habitat (e.g., eel grass and algal beds) due to sedimentation - Sedimentation—degraded water quality for aquatic life
Water quality	- Reductions in potable water supplies - Reductions or increases in marine primary productivity - Lowered recreational values of water bodies due to sediment and nutrient loading

Major impacts that concerned the participants considering this scenario are those related to **impacts on terrestrial and aquatic species**, including changes in the range of occurrence of the land and ocean organisms characteristic of the region and potential increase in occurrence of pathogens and invasive species. In the future, further impacts on ecosystems could include reduced harvestable yields from marine food webs, due to increased contamination (e.g., lobsters, oysters and shellfish), loss of habitat due to sedimentation (e.g., eel grass and kelp beds) and loss of sensitive breeding areas for birds (e.g., terns, eagles).

Other potential impacts include those related to **human and ecosystem health**, such as the occurrence of parasites or forest fires as people, fish or trees are weakened by disease or exploitation.

Finally, direct **opportunities** related to climate change impacts were identified, such as the potential to extend outdoor recreational activities and enhanced potential for agricultural production and possibly estuarine production.

3.3.2 *Identified adaptation opportunities*

To respond to the listed impacts of climate change, participants identified a number of potential adaptation options that are focused on: building new infrastructure and changing current development practices; changes in governance and policies; and measures to develop capacities and promote behaviour that increase resilience to impacts of climate change in concert with other economic and cultural challenges (for overview of the options see Tables 4 and 5).

Figure 4. Participants discussing priority adaptation options

Photo: Livia Bizikova

In terms of infrastructure development, key priorities identified by participants include: protecting the shoreline by promoting natural riparian and shoreline ecosystems; establishing vegetated buffer zones along all water courses and drainage lines; and retreating infrastructure from the shoreline. To ensure that the shoreline is protected in future events, participants suggested eliminating building permits in sensitive areas (i.e. those prone to floods, storm surges, erosion and landslides); following the CEPI development guidelines; and strictly implementing permitting procedures in resource development (mining and forestry). This would also require building new recreational infrastructure in safer zones, considering innovative agricultural and aquaculture development with lower impacts on natural resources and habitat, and designing roads adaptive to flooding. In order to prepare for potential future changes, and to measure the effectiveness of management interventions it is essential to invest in monitoring programs that track changes in the region. Measures include: increased funding for Environmental Monitoring Offices to measure water, natural resources and sediment movement; the establishment of more gauges to monitor river discharge; a move towards integrated monitoring of changes in the economy, culture and society.

To increase the resilience of the region in the context of future challenges, including climate change, there is a strong need for an integrated governance model for the Bras d'Or Lake watershed, including improved mapping and planning through adaptive management. Specific attention should be paid to riparian water management and the development of strategies that link economic and human activities with the sensitive environment. This could be supported by creating a series of parks around Bras d'Or connected by trails, beaches and boating. The integrated management plan would need to consider adding land to the First Nation's reserves in order to provide for the growing populations there.

Table 4. Overview of identified adaptation options for the Bras d'Or ecosystem of Cape Breton

Types of measures	Adaptations
Infrastructure and changing practices	- Shoreline retreat and infrastructure - Establishment of natural (vegetated) buffer zones for water courses and shorelines, thereby maintaining riparian and coastal ecosystems - Build new recreational infrastructure in safer zones - Eliminate building permits in sensitive areas (prone to floods, storm surges, erosion and landslides) - Follow permitting procedures in resource development (mining and forestry) - Innovative agricultural and aquaculture development - Design roads adaptive to flooding - Set up more gauges to monitor river discharge, sediment movement - Collect data on issues of environment, economy, culture and society - Invest in research and monitoring of water quality, natural resources and other indicators of ecosystem and human health
Governance and policy changes	- Follow, in principle, the CEPI development guidelines - Prepare an integrated governance model for Bras d'Or Lake watershed, including with mapping and planning - Adopt outcome-based approaches to watershed governance through methods of adaptive management - Closely manage development in the riparian zone - Develop and adopt strategies to minimize anthropogenic introductions of exotic species - Set and enforce limits on human activities and support them by examples of best practices (behavioural change and legislation) - Add additional land to Indian reserves - Create a series of parks around Bras d'Or connected by trails, beaches, and boating to promote sustainable tourism - Enable public access (kayaking, swimming, hiking, sailing) - Create a fund to deal with adaptation needs in the watershed
Capacity building and education	- Invest in education for public and private companies, investors, land speculators, etc. (consider hiring a communication specialists) - Visualize and communicate impacts of climate change (e.g., sea-level rise) to infrastructure planners, land developers, house and cottage builders - Promote a revitalization of watershed community spirit - Assist communities to take responsibility for themselves - Integrate public and private experiences to promote sustainable options - Foster health education and preventive medicine that links human and ecosystem health - Invest in capacity building and across-the-board education on sustainability - Provide education about best management practices and local solutions

Improving awareness and education for public and private companies and investors about shoreline protection, permitting and sustainable practices are crucial for long-term behavioural changes in the region. Strategies should include visualizing and communicating the various impacts of climate change to infrastructure planners, developers, house builders and cottage owners. Customized attention should be devoted to permanent and seasonal residents, and industrial land users in an

effort to revitalize community spirit. This could include integrating public and private experiences to promote sustainable options and educating the public about best practices and local solutions leading to a cross-cutting educational program on sustainability developed by the municipalities and CEPI, with input from provincial and federal agencies.

According to participants' opinions, many of these adaptive options may require raising new revenues (e.g., taxes) for monitoring and for capacity-building activities. They also suggested that a special fund could be created and that some of the new funding would be used to finance measures that deal with the impact of climate change.

3.4 Prioritizing adaptation responses and promoting resilience

Once all relevant and significant adaptation options were identified for each of the scenarios, participants were asked to select the three adaptation options that they identified as the most critical, given limited resources. It was interesting to see that all groups considered it necessary to promote integration of land-use policies, moving away from reactive measures to proactive policies and finally investing in capacity-development and engagement of the public including local communities of residents, industry and other stakeholders.

When focusing on integration of land-use policies, participants emphasized a need for community-wide consultations to gather the views of different stakeholders before policies are implemented. Specifically, the participants outlined the following key steps towards better integration of land-use policies:

- Aggregate completed stakeholder consultations; identify gaps (e.g., missing communities, issues, groups of stakeholders). Allocate resources to address these gaps and bring communities together to identify short, medium and long-term tasks through a climate and impact lens. In general, the participants suggested that the work of the CEPI is a good basis from which to address these issues.
- Identify existing knowledge and future research that is needed to deal with climate impacts, including vulnerability assessments and specific studies that, for example, focus on the impacts of climate change on marine and terrestrial species. Many studies and assessments are available in the region, but some key aspects are missing. For example, measures of socioeconomic vulnerability that complement those of physical vulnerability, assessments of available capacities, etc. These gaps will have to be addressed gradually due to limited resources.
- Develop management objectives (short-, medium- and long-term) and identify gaps in delivery, authority and mandate; consider defining new mandates and responsibilities if the current governance is unable to provide the required actions.

- Define indicators and monitor actions and changes (short, medium and long-term) in the region; improve current monitoring systems with a focus on water and environment, but gradually include socioeconomic indicators that could capture the changes in the society.
- Engage with the Provincial Climate Change office and other federal agencies to explore the information available, including experiences with adaptive measures and legislative information.
- Create new opportunities for transfer of information to potential users, and promote the connection between environmental and natural resources departments at all levels of government with links to communities and community development. This process provides potential to integrate regional and local decision-making.

Accomplishing these steps would require significant collaboration and the involvement of diverse stakeholders. The region has the opportunity to leverage the UNESCO Man and the Biosphere Reserve designation process in order to facilitate engagement at the local level, and exchange information between managers and governments. It provides an opportunity for testing, delivering management actions, monitoring, feedback, outreach and education and revisions. Other specific actions were suggested, including:

- Promoting existing government information by using information technologies
- Creating easily accessible information for specific target groups: schools, town halls, cottage owners, summer residents and groups with low capacity to access such information
- Collecting and disseminating best practices from the region and distant areas in similar circumstances that improve adaptive capacity and reduce vulnerability. Selected, desirable practices should then be supported by incentives and regulation (if necessary). These practices should include those focused on land-use planning and integrated land-ocean management
- Fostering citizen science (i.e., citizens involved in environmental research and monitoring)
- Promoting awareness about culture in the region through branding and fostering a sense of the Bras d'Or community (e.g., through road sings, social networking, building on examples of sustainable development and adaptation)

Moving towards integrated land-use policies and increasing public engagement is a long-term process, the benefits of which may not be available immediately. However, current climate variability is having impacts that should to be addressed soon. Decisions that are made now will reduce potential losses and costs in the future. Therefore, during the workshop, participants also identified a list of short-term actions that include:

- Eliminating the issuance of building permits in sensitive areas prone to floods, storm surges, erosion and landslides

- Following permitting procedures in resource development (mining and forestry)
- Cooperating with the province to create road designs that are adaptive to flooding
- Cooperating with INAC, particularly on the possibility of adding land to reserves
- Increasing monitoring, especially by setting up more "stream gauges" to monitor discharge and sediment movement.
- Following, in principle, the CEPI development guidelines

Finally, the three future scenarios developed during this exercise clearly demonstrate different levels of resilience in the face of climate change. Scenario 2—which assumed better integration of land-use policies, shoreline protection and designation of the Bras d'Or ecosystem under the UNESCO Man and the Biosphere Program—appears to have the greatest potential for truly adaptive responses to predicted climate change in the Bras d'Or ecosystem over the next 50 years. The other two scenarios did not include policy integration, although they did suggest specific measures to promote the integration of policies that were relevant for the context of each scenario. Scenario 1 focused on current practice, recommending the introduction of a landowner management policy to deal with an increasing number of newcomers wanting to build near the Bras d'Or estuary. Setting standards for industry and involving industry in managing environment were strongly recommended in a scenario focused on economic development (Scenario 3).

All scenarios strongly emphasized the need for policy integration, vulnerability assessments, continuing capacity development, focused engagement in communities of low capacity, and overall improvement in the involvement of different stakeholder groups in planning and decision-making.

4.0 Conclusions

In this workshop, we identified potential future trajectories for the Bras d'Or ecosystem and its human communities. The work on these scenarios constitutes a preliminary assessment of the resilience of the ecosystem and its people based on current climate variability and potential future climate change. Because adaptation options depend not only on the impact of climate change and available technologies, but also on current and future local, regional and national priorities identified through the participatory process, we used the created future scenarios to envision outcomes of these potential priorities.

In order to simulate various development pathways for the region, we applied the PSD approach to generate and explore three future scenarios in collaboration with the workshop participants. Using different assumptions about key drivers, the three scenarios assumed current practices under current climate variability (Scenario 1 – status quo); changing development and policy trajectories (Scenario 2 – best case); and economic development based on future climate change projections and limited policy integration (Scenario 3 – worst case). The scenarios were then examined for the capacities to adapt to climate change; if the capacities were lacking, adaptation actions were identified.

Taking into account only current climate variability and conservative estimates of climate change, the major impacts in the region were expected to be sea-level rise with storms causing flooding, increasing salinity and increasing salt water intrusion, elevated water table close to the shoreline and loss of coastal land with impacts on infrastructure and arable land. The effects of increasing frequency or intensity of storms and heavy rain events were anticipated to be worsened by inappropriate land uses that increase runoff from the land to the estuary. These included erosion, landslides and sedimentation causing water quality degradation and challenges to aquatic habitats and organisms. Recurring impacts of flooding and shoreline erosion on housing and tourist facilities could make insurance companies refuse to insure developments in high-risk areas. Participants were also concerned about the impact of climate change on sensitive marine and terrestrial ecosystems, including changes in the ranges of occurrence of the terrestrial and aquatic species, and potential increases of invasive species.

All of the suggestions for adaptive response to climate change predicted in the various scenarios emphasized the importance of integrated land-use planning and ecosystem-based policy development that increases society's resilience in the face of rapidly changing climate and severe weather. All scenarios emphasized that, in order to promote economic activities, including tourism, better integration of development decisions, especially on vulnerable coasts that would be most severely affected by climate change, need to be coordinated. Without integration of land-use policies, it is challenging to account for the cumulative effects of diverse sectoral needs and decisions; the integration of land-use policies is crucial in enabling effective coordination of diverse

activities, including the effective implementation of adaptation action.

However, achieving effective integration of land-use policies is a long-term goal and it is perhaps equally important to ensure that current decisions are helping to reduce vulnerabilities and improve capacities to enhance the prospects of actual adaptation and also the ability to explore opportunities discussed in the three scenarios. In general, we can identify four specific groups of actions and measures aiming to address current sensitivities, increase capacities, develop specific adaptation options and, finally, promote research and communication. Specifically in the context of the created three scenarios for Bras d'Or ecosystem, we can summarize the key measures as follows:

- Reducing sensitivity of the local systems: providing greater focus on areas that struggle to cope with current socioeconomic challenges and current weather patterns and variability as outlined in Scenario 1. This includes eliminating building permits in already sensitive areas (prone to floods, storm surges, erosion and landslides), following permitting procedures in resource development (mining and forestry), allocating protected land for traditional plants and animals and for Mi'qmaq cultural sites and supporting higher environmental standards on the reserves.
- Enhancing capacities of local systems and communities to respond to challenges including climate change: It is generally accepted that improving capacities to respond to climate change often act in synergy with other areas of needed capacities to deal with other stresses. Such actions include, for example, augmenting available vulnerability assessments focused on physical and environmental issues to add socioeconomic aspects; identifying groups and regions at risk, and people that lack capacities to respond effectively to the impacts of climate change and other challenges; reviewing emergency preparedness practices in the context of identified vulnerabilities; reviewing insurance schemes and economic incentives that work together with measures outlined above aiming to reduce sensitivities of the local system.
- Reducing and managing risks related to climate variability and climate change by promoting the implementation of specific adaptation options: cooperating with the province to create road designs that are adaptive to flooding, increasing monitoring, especially by setting up more gauges to monitor river discharge and sediment movement, planning transitions especially in coastal areas to move away from current development patterns (in collaboration with home developers); evaluating plans for aquaculture and other economic activities that could require specific adaptation actions.
- Promoting research, communication, institutional development and extension agencies to assist in changing management practices—for example, through the use of climate projections, identifying linkages between impacts and adaptation, and drawing on lessons learned from other countries and regions with similar conditions and impacts. On the local level, it is necessary to actively seek and create new opportunities for transfer of information

from these sources to the potential users and promote connections between environmental and natural resources departments with links to communities and community development. The region has the opportunity to leverage the UNESCO Man and the Biosphere Reserve designation process to facilitate engagement at the local level, enhance the exchange of information between managers and governments, and provide opportunities for testing and delivering management actions, monitoring indicators of environmental and human health, collecting feedback, and revising outreach and education activities.

Finally, this workshop demonstrated by example the procedures and benefits of scenario-based planning to a large group of committed individuals from all of the main communities of interest in the Bras d'Or ecosystem. Applying scenario-development techniques, especially in this context, provides opportunities for the participants to learn about impacts of changing climate on the local ecosystem and on planning priorities, and to identify adaptation options that are relevant and preferred by the communities. Based on the feedback from the participants, the scenario elements, including those focused on policy integration, confirmed their current efforts in the community. It is anticipated that the people of the Bras d'Or ecosystem are now better equipped to engage more fully in detailed planning for climate change in the near future. That really was the key accomplishment of the exercise, and it remains to be seen where this strong beginning will lead.

5.0 References

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6.0 Appendix

6.1 Overview of the developed scenarios

Table 5. Overview of Scenario 1: Current development, policy and climate variability trends in the Bras d'Or ecosystem of Cape Breton Island, Nova Scotia

Description of the Scenario 1	Signposts	Actions to increase resilience
Socioeconomic development - Foreigners will continue to buy properties and land in the region (seasonal population and retirees will likely increase) - Increasing First Nations population, but with limited available land, could lead to low standards of living - Agriculture and aquaculture opportunities enhanced by fresh water supply run-off, land and ocean interactions, but challenged by private investors and lack of policy coordination **Environmental change** - Water quality and potable water will be under stress, especially if the population is growing and because of deteriorating environment and limited recharge of ground water - Declining productivity of natural resources—loss of habitat, reduced biodiversity, sedimentation, inadequate forestry, fisheries and biodiversity management	Increased aquatic and terrestrial species at risk Greatly reduced area of marshlands and their natural filtering capacity Overall reduction in land and water capability to support agriculture, aquaculture and tourism	Targeted support for education and economic and social development to improve the conditions of the First Nations communities Landowner management policy Support real local stewardships groups Consider monitoring key indicators species Make the CEPI work Become a member of the MAB program

Table 6. Overview of Scenario 2: Changing development and policy trajectories in the Bras d'Or ecosystem of Cape Breton Island, Nova Scotia

Overview of the vision in 2060 under Scenario 2	Signposts of being on the pathway to this scenario	Actions to increase resilience
Socioeconomic development and environment - Iona emerges as a commercial hub (food and services) - Food security and local food production is high - Increase in jobs in the IT sector, environmental field, provincial and federal monitoring access and ecotourism **Environmental change** - Protected land for traditional plants and animals and for Mi'qmaq cultural sites - Region will be advertised as best swimming on the West Coast due to the buffer zones, streams and water management within the watershed - Healthy small-scale commercial fisheries (maybe there will be new species) **Infrastructure** - First Nations communities designed for higher density housing (unless more usable land is available) - Better environmental and land-development practices throughout the watershed - Increased road size to accommodate bike lanes **Governance, policies** - Different approach to governance, including increased participation, engagement, sense of stewardship through education, awareness and enforcement (e.g., more hunters' associations) - Citizens will be very environmentally conscious, aware and personally accountable - Higher degree of self-governance and environmental stewardship on the First Nation's Reserves	Introduce environmental fee on products (electronics) Research on how to prepare for 2060 (new technology, fisheries, industries and planning for stewardship, weather changes) Comprehensive land-use planning throughout the region integrating biology, biodiversity, geography Improved environmental regulations for watershed property owners	Integrated land and water management view Bras d'Or as a whole Provincially-owned buffer zones around shores of Bras d'Or On-site ballast sterilization for every ship that enters Bras d'Or Increasing allocations of tax revenue to integrated planning and adaptation

Table 7. Overview of Scenario 3: Economic development in the context of climate change and limited policy integration in the Bras d'Or ecosystem of Cape Breton Island, Nova Scotia

Overview of the vision in 2060 under Scenario 3	Signposts of being on the pathway to this scenario	Actions to increase resilience
Socioeconomic development and environment - Land development is shaped by mining, forestry and housing development - Non-sustainable development—focus on individual goals - Increased residential development especially on the coasts - Demand for external resources is increasing (e.g., food and associated transportation) - Changes in nature of services—more demand for services for young people—information and decreasing demand for "Boomer" services - Increasing health disparity - Loss of social cohesion - Increased cultural diversity - Increased pollution with potential impacts on human health **Environmental change and governance** - Environmental protection is limited - Decisions are based mostly on costs and feasibility of industrial activities not environmental issues, potentially leading to pressure on marine ecosystems, declining water quality, sedimentation and limited access to the water; ultimately it will have a negative impact on recreation - Environment is degrading—less opportunity for recreation (land and lakes) - Decreasing natural areas—loss of forest land - Increasing pressures for land conversion - Loss of natural systems, increased invasive species - Negative impacts on lakes from land base including run-off with contaminants, sediments from deforestation and paving, etc. (water quality, siltation, run-off, changes in species distribution) **Infrastructure** - Increasing precipitation will lead to increased insurance costs, infrastructure repairs, water treatment and the need for better erosion and run-off management	Property and income tax increases Increasing social welfare demands, maybe even negative impacts on health Increased coastal degradation and erosion Increased insurance costs for mostly coastal properties	Moving towards more integration in decision-making on land-use Setting standards for industry Involvement of industry in managing environment Promoting more inclusive government Increasing social cohesion

6.2 Workshop Agenda

Scenario-Based Planning for a Changing Climate in the Bras d'Or Ecosystem

January 28 and 29, 2010

Cape Breton University
Multi Purpose Room

Workshop Agenda

Thursday, January 28, 2010

9:00–9:30	Welcome and objectives for the workshop
	Bruce Hatcher (Cape Breton University)
	Ruth Waldick (ILM Secretariat, Environment Canada)
	Livia Bizikova (International Institute for Sustainable Development)
9:30–10:15	Identifying key questions and issues of interest in the region
10:15–12:30	Selecting elements of the alternative futures
	Plenary discussion
12:30–13:30	Lunch
13:30–14:30	Local alternative futures: Developing alternative futures and a flow of actions leading to the future
	Group activity
14:30–15:15	Impacts of climate change in the Bras d'Or ecosystem
	Gary Lines (Environment Canada)
	Fred Baechler and Bill Jones (ADI Limited)
15:15–17:30	Assessing alternative futures in the context of changing climate
18:00	Dinner

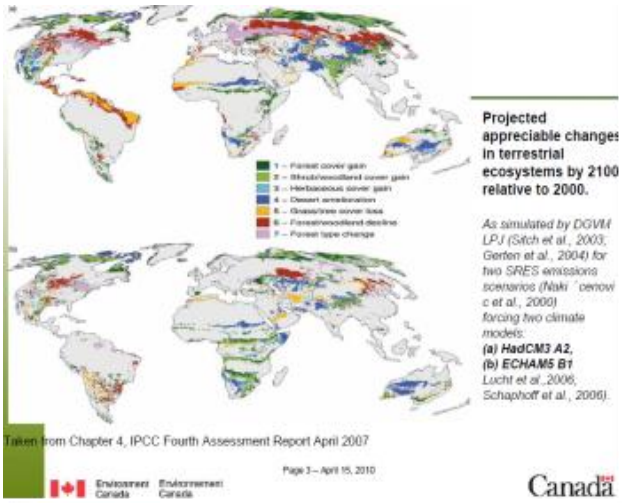
Friday, January 29, 2010

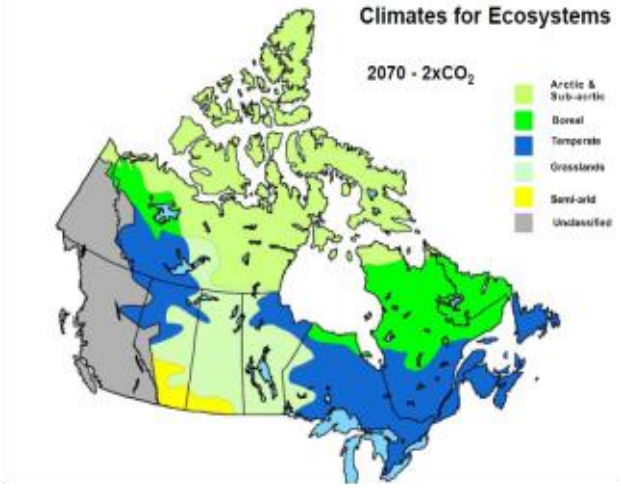
8: 00–8:30	Breakfast
8:30–11:00	Prioritizing adaptation actions to respond to climate change *Group activity and plenary*
11:00–12:00	Introducing the prioritized adaptation options to decision-makers *Presentation of the workshop outcomes*
12:00–13:00	Lunch
13:00–14:00	Planning options for adaptation to climate change *Group discussions and plenary*
14:00–15:00	Identifying capacity gaps needed for successful implementation *Group discussions and plenary*
By 15.30	Next steps and closing

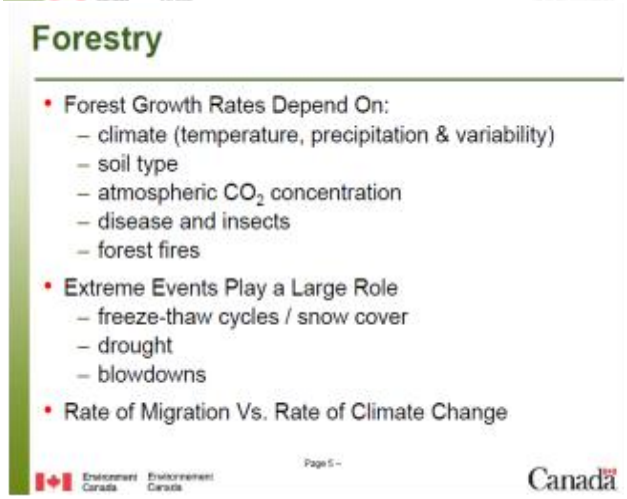
6.3 List of participants

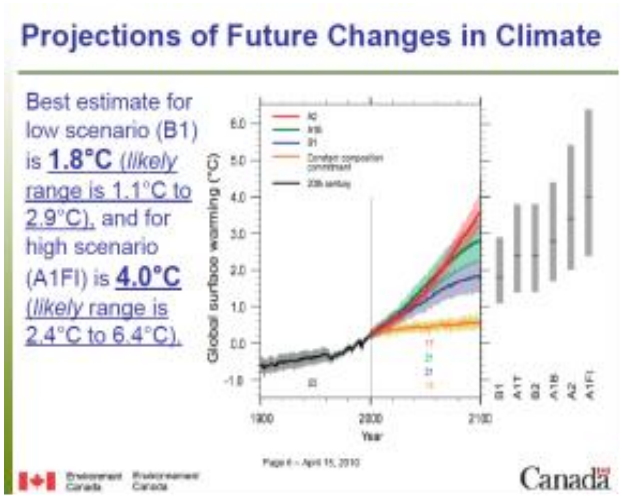
Name	Organization
Bruce Hatcher	Cape Breton University
Elizabeth MacCormick	Cape Breton University
Emily Mizier-Barre	Cape Breton University
Shelley Porter	Collaborative Environmental Planning Initiative
Lorena Patino	Policy Research Initiative
Guy Rochon	Environment Canada
Jim Foulds	Bras d'Or Lakes Biosphere Researve Association
Elizabeth Beaton	Cape Breton University-- Community Studies
Brian MacSween	NS Depart. Natural Resources-- Forestry
Fred Baechler	ADI Limited
Lynn Baechler	Bras d'Or Lakes Stewardship Society
Phil Drinnan	WFNR
Doug Foster	Cape Breton Regional Municipality-- Planning
Lorne Penny	Fisheries and Oceans Canada
Jerry Wolchuck	INAC
Jim Richard	NS Community College -- Environmental Engineering
Kyle MacKenzie	NS Environment
Amanda Karst	Center for Indigenous Environmental Resources
Dan Lane	University of Ottawa
David Michell	NS Fisheries
Gary Lines	Environment Canada
Bernard Cantin	Policy Research Initiative
Kirsten Campbell	NS Community College -- Environmental Engineering
Paul Boudreau	CoinAtlantic
Shelley Denny	Unama'ki Institute of Natural Resources
Tyson Paul	Unama'ki Institute of Natural Resources
Tom Johnson	Eskasoni
Paul Gentile	Fisheries and Oceans Canada
Mae Rowe	Councilor- CBRM
Livia Bizikova	IISD
Ruth Waldick	Environment Canada

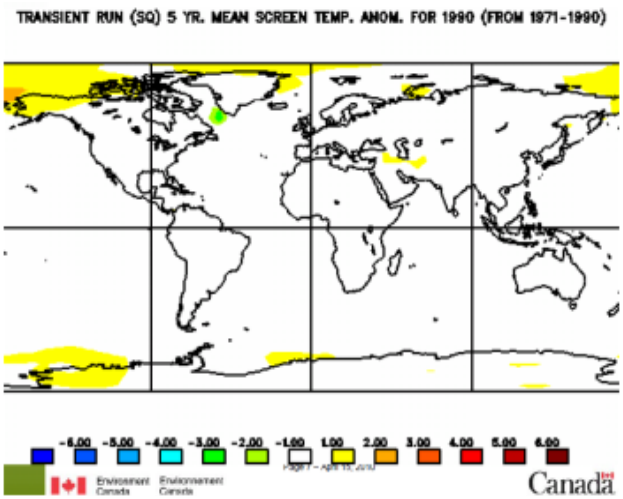
6.4 Presentation by Gary Lines










TRANSIENT RUN (SQ) 5 YR. MEAN SCREEN TEMP. ANOM. FOR 1990 (FROM 1971-1990)
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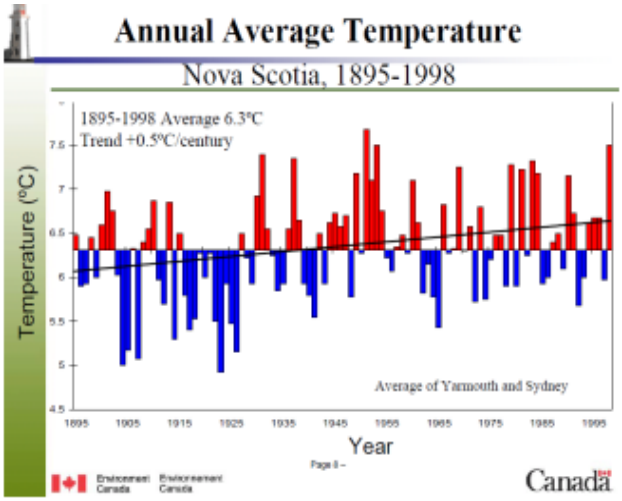
Annual Average Temperature
Nova Scotia, 1895-1998
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Trend +0.5°C/century
Temperature (°C)
Average of Yarmouth and Sydney
Year
Environment Canada
Environnement Canada
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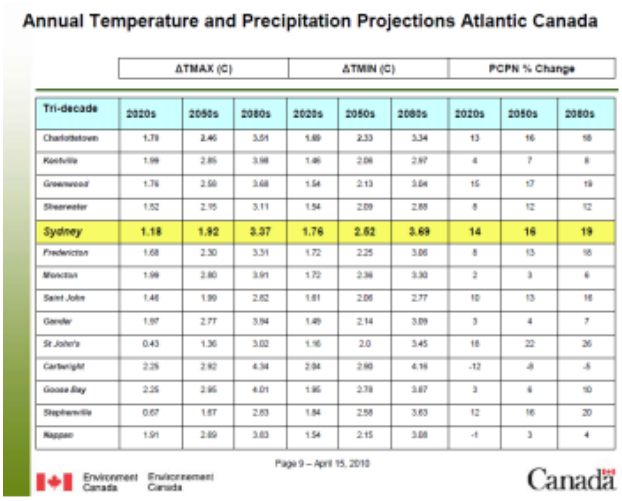
Annual Temperature and Precipitation Projections Atlantic Canada
ΔTMAX (C)
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PCPN % Change
Tri-decade
2020s 2050s 2080s 2020s 2050s 2080s 2020s 2050s 2080s
Charlottetown 1.78 2.46 3.51 1.69 2.33 3.34 13 16 18
Kentville 1.99 2.85 3.98 1.46 2.06 2.97 4 7 8
Greenwood 1.76 2.50 3.68 1.54 2.13 3.04 15 17 19
Shearwater 1.52 2.15 3.11 1.54 2.09 2.88 8 12 12
Sydney 1.18 1.92 3.37 1.76 2.52 3.69 14 16 19
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Moncton 1.99 2.80 3.91 1.72 2.38 3.30 2 3 6
Saint John 1.46 1.99 2.82 1.61 2.06 2.77 10 13 16
Gander 1.97 2.77 3.94 1.49 2.14 3.09 3 4 7
St John's 0.43 1.36 3.02 1.16 2.0 3.45 16 22 26
Cartwright 2.25 2.92 4.34 2.04 2.90 4.16 -12 -8 -5
Goose Bay 2.25 2.95 4.01 1.95 2.78 3.87 3 6 10
Stephenville 0.67 1.67 2.83 1.84 2.58 3.63 12 16 20
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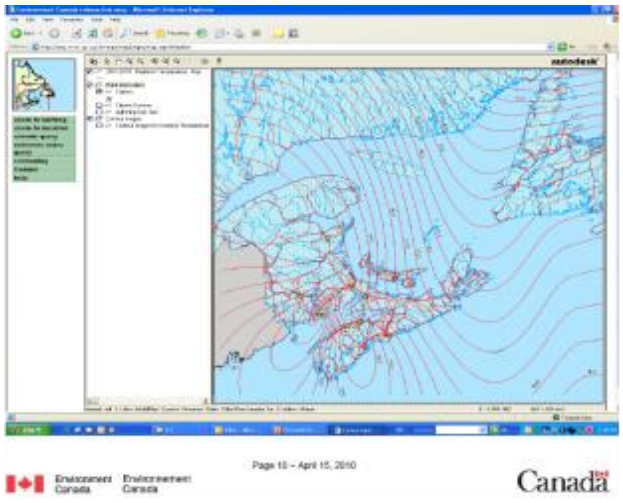
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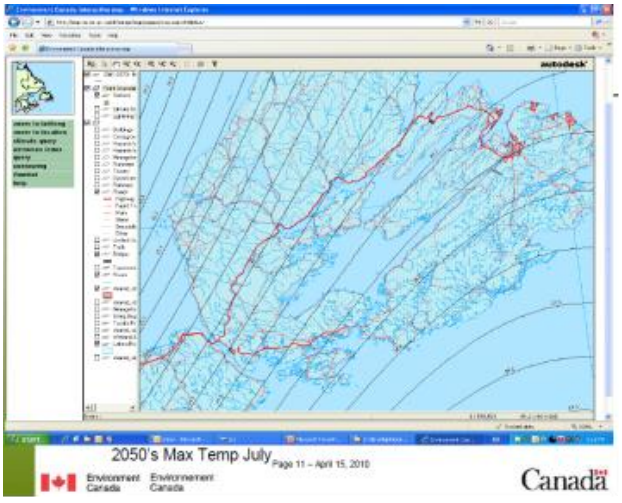
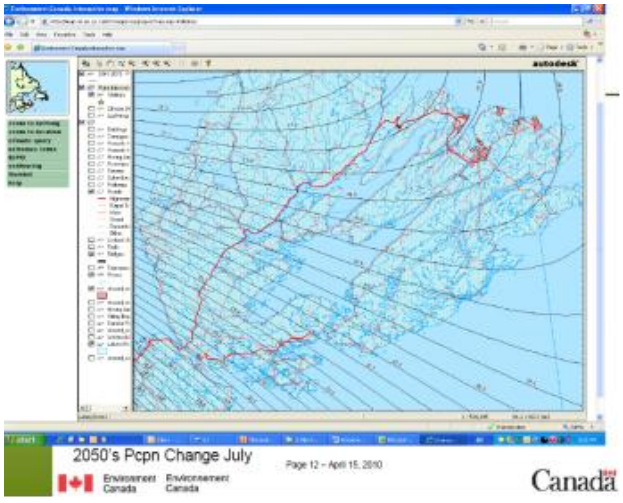

2050's Max Temp July
Environment Canada
Environnement Canada
Canada


2050's Pcpn Change July
Environment Canada
Environnement Canada
Canada

Percent Increase in Precipitation Over Bras D'Or Lakes

Season	2020's	2050's	2080's
Winter	3	2	2.5
Spring	17	10	9.8
Summer	14	13	2
Autumn	26	34.5	41
Annual	15	15	13.5

Percent Change (%) in Seasonal and Annual Precipitation from Historical (1961-90) Value

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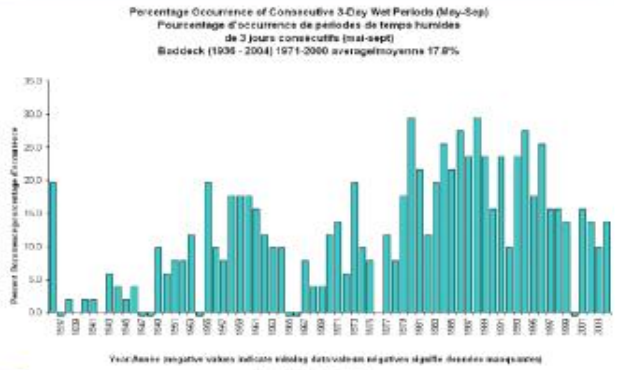
Precipitation Occurrence (3-day Wet)



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PROJECTIONS OF FUTURE CHANGES IN CLIMATE

- *Very likely* that hot extremes, heat waves, and heavy precipitation events will continue to become more frequent
- *Likely* that future tropical cyclones will become more intense, with larger peak wind speeds and more heavy precipitation
  - **less confidence in total numbers**
- Extra-tropical storm tracks projected to move poleward with consequent changes in wind, precipitation, and temperature patterns

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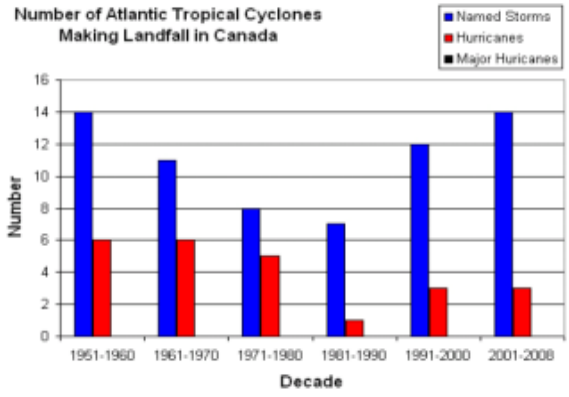
Tropical Cyclone Climatology



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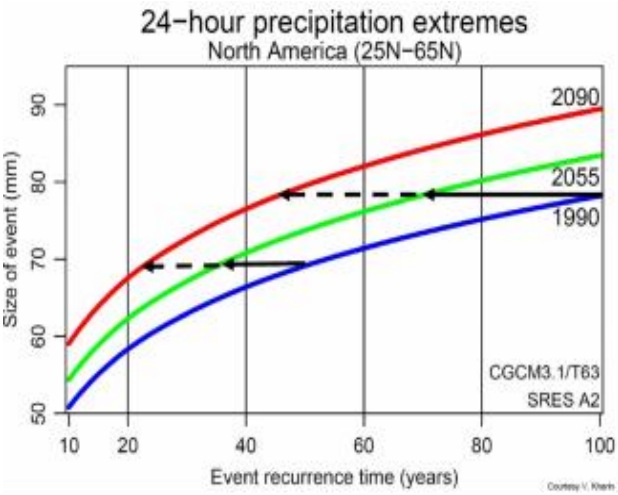

Courtesy V. Kharin

Return Period Projections for Extreme 24-hour Precipitation Amounts (mm)

Return Period	10 Years				50 Years				100 Years			
	Hist	2020s	2050s	2080s	Hist	2020s	2050s	2080s	Hist	2020s	2050s	2080s
Greenwood	78.7	122.3	105.1	89.9	100.8	166.6	140	129.7	**110**	185.3	164.7	**142**
Shearwater	102.1	148.9	130.1	132.6	135.1	202.6	166.8	175.6	**149**	225.4	180.6	**194**
Sydney	93.6	135.1	137.6	129.2	117.1	186.5	160.8	1105.3	**127**	1206.2	186.6	**180.5**
Moncton	86.8	99.3	103.1	132.6	113.7	122.6	135.1	175.6	**125**	134.9	146.7	**194**
Saint John	100	119.7	107.4	118.6	143.4	153	133.2	149.6	**157**	167.1	144.1	**163**

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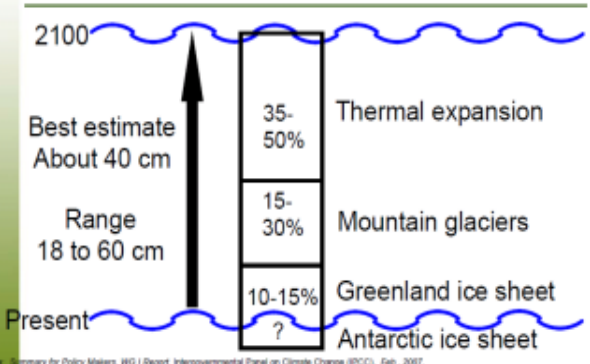
Projected Global Sea Level Rise to 2100



Source: Summary for Policy Makers, WG I Report, Intergovernmental Panel on Climate Change (IPCC), Feb., 2007.

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Projected Sea Level Rise Bras D'Or Lakes

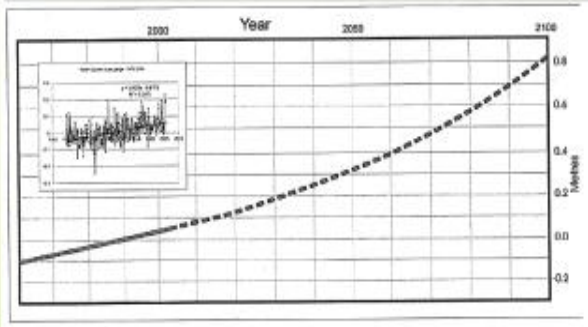

Fig. 30. Projected sea-level rise in the lakes by 2100 AD. The blue line represents the historic trend (also shown in the inset which shows the tide-gauge record at North Sydney).

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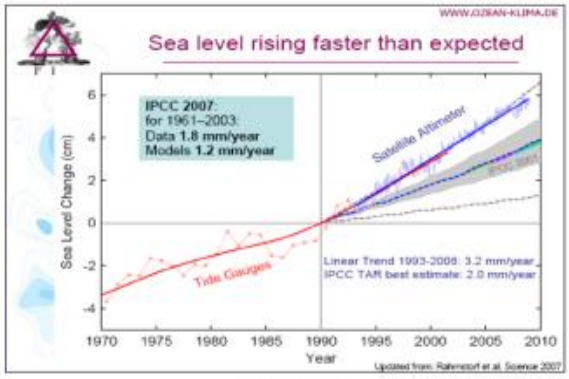
Sea level Rise – Recent History



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Sea Level Rise Projections (2001-present)

- IPCC 2001 – 9-88cm by 2100 (average **48cm**)
- IPCC 2007 – 18-59cm by 2100 (excluding Greenland and Antarctica ice sheets changes) (average **40cm**)
- Delta Commission 2008 - 50cm-1.3m by 2100 (average **90cm**)
- Rahmstorf et al. 2009 – 75cm-1.9m by 2100 (average **1.32m**)

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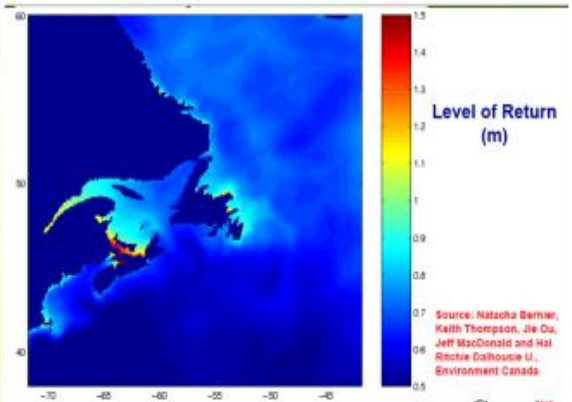
Level of Return - 40 Years for Storm Surge Events



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Summary

- Temperature Change
  TMax 1-3.3C TMin 1.8-3.7C
- Precipitation Change
  14-20% (average around 15% - most change in Autumn)
- Sea Level Rise
  50cm – 1.3m (possible 1.9m rise by 2100) plus 20cm
- Extreme Events
  Extreme precipitation events impact stream flow
- Impact on Ecosystem
  Shift to temperate climate from boreal
  Impact on tree species (and other flora and fauna)

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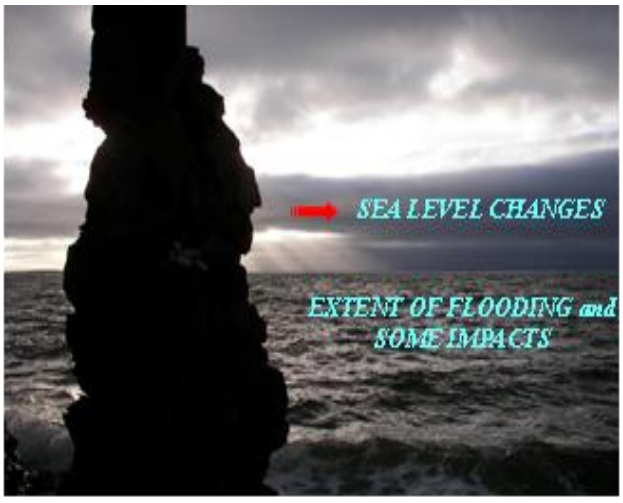
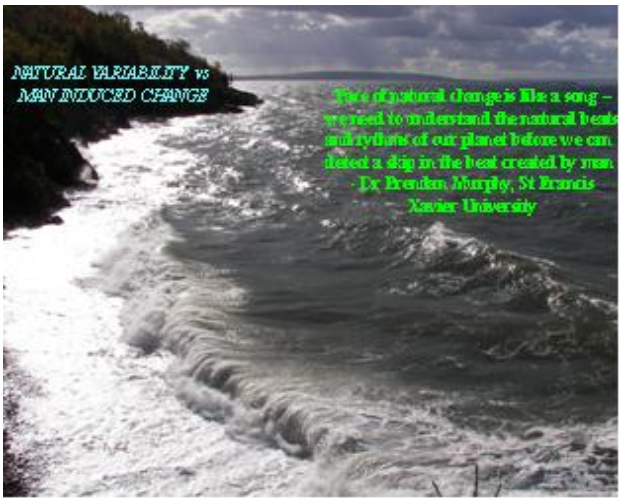
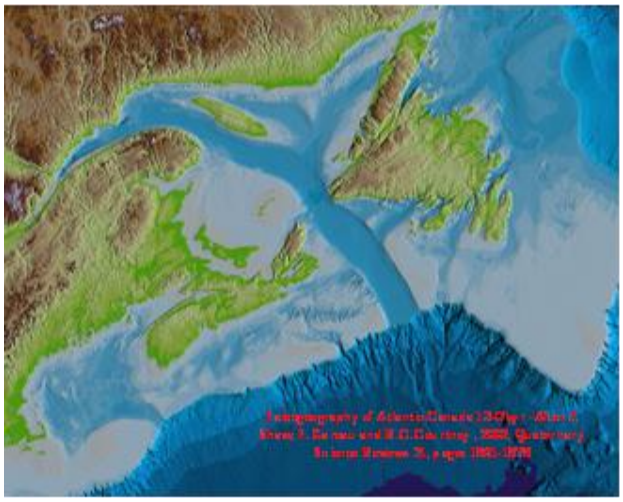
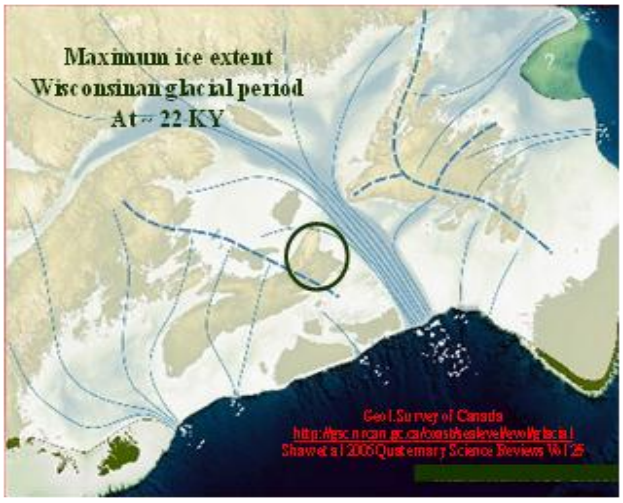
Canada

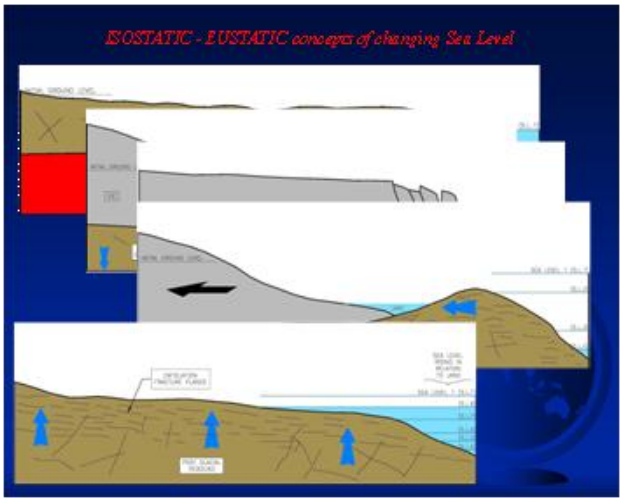
6.5 Presentation by Fred Baechler



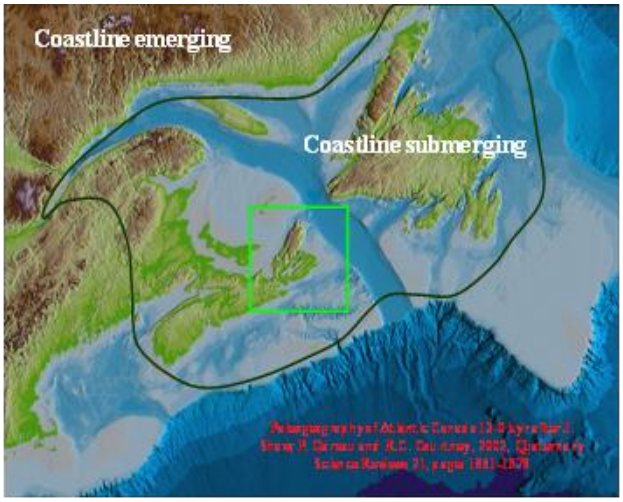


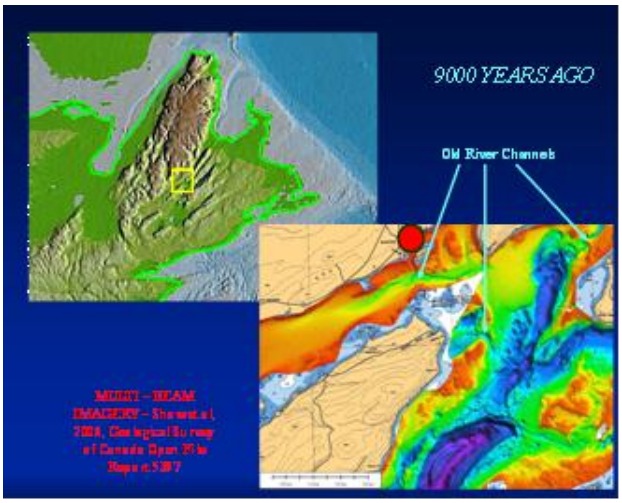


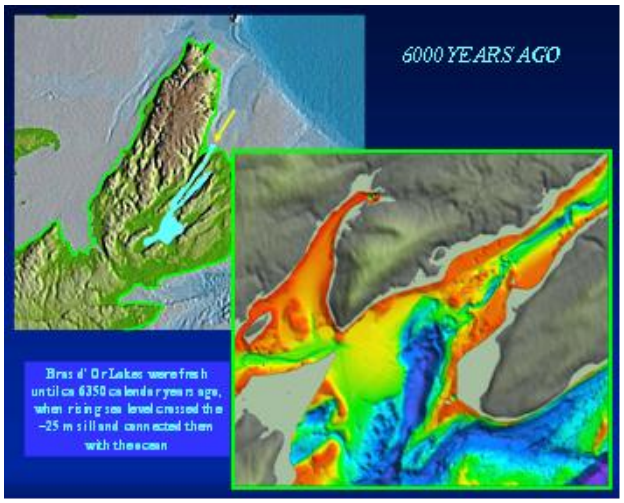


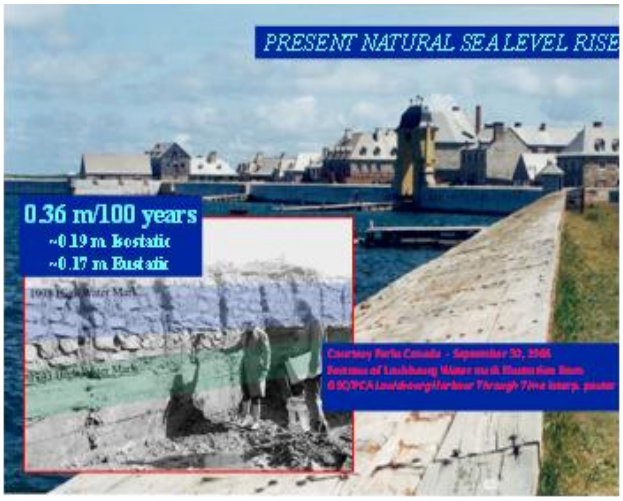



Post-Glacial
Sea Level Rise
Thousands of Years Ago
Sea Level Change (m)

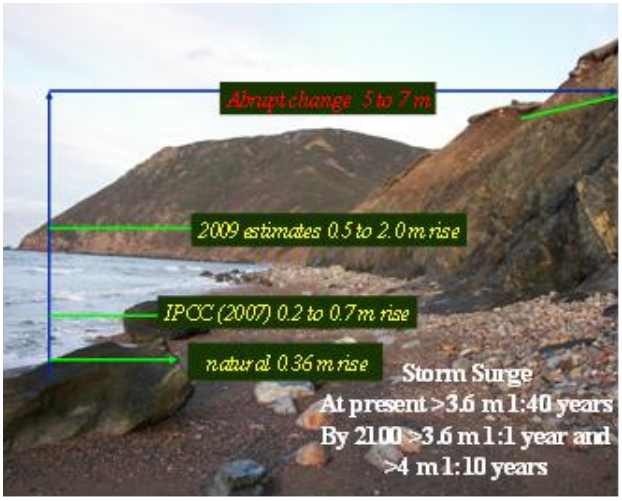

Coastline emerging
Coastline submerging


9000 YEARS AGO
Old River Channels


6000 YEARS AGO
Bras d' Or Lakes were fresh until ca 6350 calendar years ago, when rising sea level crossed the ~25 m sill and connected them with the ocean

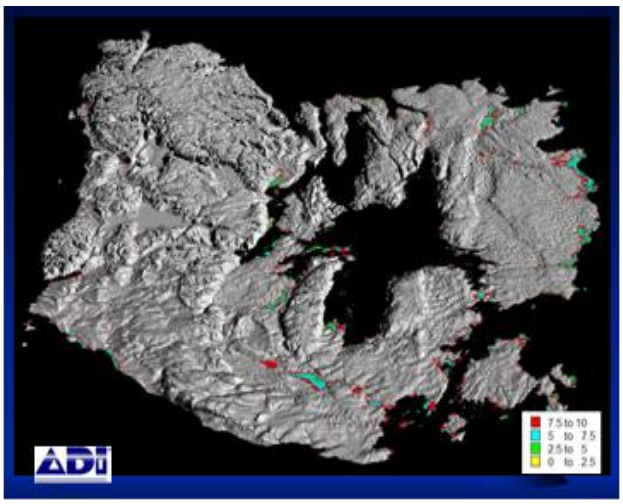

PRESENT NATURAL SEA LEVEL RISE
0.36 m/100 years
~0.19 m Isostatic
~0.17 m Eustatic

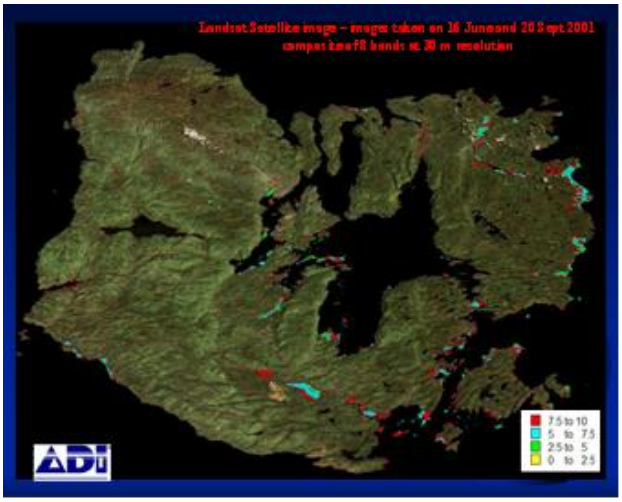

SEA LEVEL RISE IN THE FUTURE - LOOK TO THE PAST

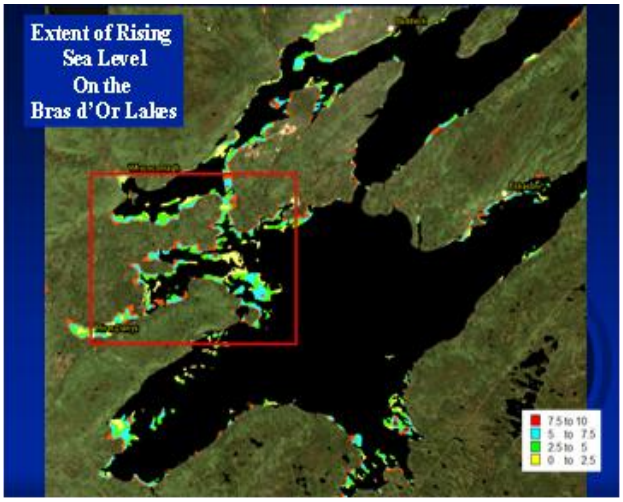

Abrupt change 5 to 7 m
2009 estimates 0.5 to 2.0 m rise
IPCC (2007) 0.2 to 0.7 m rise
natural 0.36 m rise
Storm Surge
At present >3.6 m 1:40 years
By 2100 >3.6 m 1:1 year and
>4 m 1:10 years


SEA LEVEL CHANGES
EXTENT OF FLOODING and
SOME IMPACTS

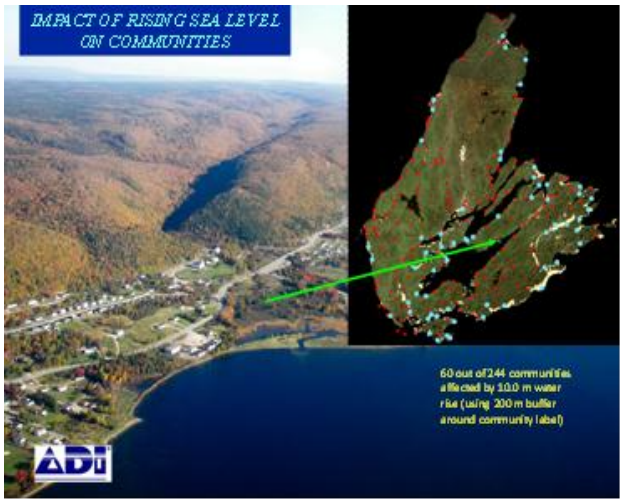

IMPACT OF RISING SEA LEVEL
ON CAPE BRETON


7.5 to 10
5 to 7.5
2.5 to 5
0 to 2.5


ADI
7.5 to 10
5 to 7.5
2.5 to 5
0 to 2.5


Extent of Rising
Sea Level
On the
Bras d'Or Lakes
7.5 to 10
5 to 7.5
2.5 to 5
0 to 2.5


2008
MID1930'S


IMPACT OF RISING SEA LEVEL ON COMMUNITIES
60 out of 244 communities affected by 10.0 m water rise (using 200 m buffer around community label)
ADI


IMPACT OF RISING SEA LEVEL ON ROAD NETWORK
Dingwall
Ingonish
Margaree
Sydney Mines
Sydney
Louisburg
Locations of roads affected by 7.5m rise in water levels
1,695 line kms of road affected
ADI


BARACHOIS, ESTUARIES –
Acting as Nurseries
Over 400 barachois ponds within
The Lakes – Bras d' Or Stewardship Society


In terms of Adaptation – "We have options,
but the past is not one of them"
CONCLUSIONS
"The further backward you
can look, the further forward
you are likely to see"
Winston Churchill