Bay of Fundy Ecosystem Partnership
Climate Change Project 2012-13

Final Report

elemental sustainability CONSULTING LTD

BOFEP BAY OF FUNDY ECOSYSTEM PARTNERSHIP

Environment Canada

BoFEP is a not-for profit organization dedicated to:

- promoting the ecological integrity, vitality, biodiversity and productivity of the Bay of Fundy ecosystem in support of the social well-being and economic sustainability of its coastal communities, and
- facilitating and enhancing communication and co-operation among all citizens interested in understanding, sustainably using and conserving the resources, habitats and ecological processes of the Bay of Fundy and greater Gulf of Maine.

In contribution to a Bay of Fundy Ecosystem Partnership-Environment Canada Atlantic Ecosystem Initiative Funding Agreement for a 2012-2013 Climate Change Project

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- Graham Fisher of Service Nova Scotia Municipal Relations
- Alexa Vodicka of Nova Scotia Environment Climate Change Directorate
- Patricia Hinch , BoFEP Steering Committee, Climate Change Project Manager, administrator and document editor

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1.0 Introduction

1.1 Context

"There is now widespread scientific consensus that accelerated climate change is happening and that human activities are the principal cause. However, measures to reduce emissions are only part of the climate change challenge. Even if significant reductions in emissions were put in place tomorrow, the lag in the climate system means that past emissions will continue to affect the climate for several decades to come. Climate change will have impacts on places where citizens live. Proactively adapting to climate change is therefore an essential part of ensuring our communities remain safe and sustainable". (Richards and Daigle, 2011).

Referring both to the warming of the earth's atmosphere and oceans and to an increase in the natural variability of the climate (Province of Nova Scotia, 2011), climate change is becoming an increasingly important issue to communities throughout the world. A warming world will be accompanied by increased intensity, frequency, duration, and geographic range of extreme weather and climatic events and increases in sea level rise. There is no doubt that climate change will pose both challenges and long term planning implications for governments at all levels. In Nova Scotia, the impacts of changes in climate and extreme weather events are already being observed. Low lying areas and dykelands are experiencing frequent flooding, and the Bay of Fundy Bay shore has historically reported large rates of erosion with resulting property loss and infrastructure damage. For those in municipal government, the ability to develop strategies to adapt and respond to climate challenges is becoming an extremely important issue.

The Nova Scotia Government has acknowledged that municipalities are a key player in the response to climate change both in terms of mitigation and adaptation. Service Nova Scotia Municipal Relations (SNSMR) and thirteen municipalities in six locations partnered on climate impact and adaptation research with the Atlantic Climate Adaptation Solutions Association (ACAS) in 2009-2012. The Association was established to manage an Atlantic regional adaptation collaborative under the federal Regional Adaptation Collaboratives Climate Change Program led by Natural Resources Canada. This three-year (2009-2012) $30 million program was a cost-shared program aimed at stimulating climate adaptation planning and decision-making, particularly at the municipal level. In Nova Scotia, the Department of Environment, through their Climate Change Directorate (CCD) was the Provincial ACAS lead.

In recognition of the important role that municipalities play in climate change response, a requirement of the 2010-2014 Gas Tax Agreement and the Municipal Funding Agreement is that municipalities prepare a Municipal Climate Change Action Plan (MCCAP) by December 31, 2013. The MCCAP will form an amendment

to the municipality's Integrated Community Sustainability Plan (ICSP). To aid in this undertaking, SNSMR, released a MCCAP Guide (Province of Nova Scotia 2011) to assist municipalities in developing their MCCAP.

1.2 The BoFEP Climate Change Project

Using the initial steps of the MCCAP Guide as the framework for the design of BoFEP's climate change project, the purpose of this project was to support MCCAP development. In a workshop setting, the objectives of this project were to: a) build greater capacity within municipalities to understand local climate trends and projections, and identify potential hazards and resulting impacts (local and regional) to natural areas, structures, and buildings anticipated to occur as a result of climate change and b) cultivate learning and provide useful climate change resource materials for municipal use.

Two workshops were offered. The workshops were intended to: help municipal participants determine what climate change hazards and impacts might be expected to occur and where; define and prioritize impacts that warrant further assessment; and understand how to incorporate this impact into their municipal climate change action plans. Workshop discussions also helped to identify specific impact research, information (e.g., spatial data), skills training, expertise, and tools needed by municipalities for adaptation strategy development and implementation.

BoFEP contracted Anne Warburton, Director of Elemental Sustainability Consulting, to complete the objectives of the BoFEP Climate Change Impacts and Hazards Project. Her resume can be found in Appendix A. A BoFEP Advisory Committee worked closely with Anne Warburton to ensure that the workshop, design, content, the case study scenarios/interactive sessions, and planned discussions reflected and were relevant to the needs of the municipalities in attendance. Advisory Committee members included:

- BoFEP Steering Committee member and Chair of the Climate Change Project Advisory Team, Pat Hinch, who secured the Atlantic Ecosystem Initiative funding, administered the project, and edited this document;
- Senior Planner Graham Fisher with Service Nova Scotia Municipal Relations, who authored the MCCAP Guide and has actively been providing support for MCCAP development to all Nova Scotian municipalities; and
- Alexa Vodicka, a Program Administration Officer with the Nova Scotia Environment Climate Change Directorate.

This final report reviews key documents used as reference materials on climate change hazards and impacts, describes the overall approach used to develop the workshops, and lists the research that underpinned workshop content and gave rise to selected presentations. The report also provides an overview and analysis of

workshop results, and offers key recommendations on opportunities for follow up that would mutually benefit local and provincial level governments, and more importantly, the citizens of our coastal province.

In originally preparing the proposal to Environment Canada for this project, it was BoFEPs intent to build on two previous BoFEP projects funded by Environment Canada between 2010 and 2012. The 2010-11 project focused on the impacts/implications of land-based activities on water quality and mechanisms to reduce the risk posed by chemical contaminants in runoff. The 2011-12 project involved municipalities in discussions on stormwater management and the emerging issue of pharmaceuticals in municipal wastewaters.

2.0 Method

The design of the workshop began with a review of relevant Nova Scotian climate change literature. First there was a thorough review of the MCCAP Guide with emphasis on steps two and three of the framework. This was followed by a review of climate trends and projections as reported in the ACAS research, the report by Richards and Daigle (2011), as well as technical reports prepared by BIO. Third, reports from the Nova Scotia Department of Natural Resources, Geological Services Division connecting geohazards and land use planning were reviewed. Next, ACAS research specific to dykelands hazard risk vulnerability and saltwater intrusion were inspected to further inform key hazards and impacts as identified by the MCCAP Guide and DNR studies, and supported/warranted by climate trends and projections.

The literature review was augmented by interviews and conversations with:

- Graham Fisher, Senior Planner with SNSMR and author of the MCCAP Guide;
- Garth DeMont, DNR Geoscientist and author of key DNR literature reviewed;
- Blair Greenan, Head of Physical Oceanography at Bedford Institute of Oceanograhpy;
- Dr. David Greenberg, DFO research scientist;
- Dr. Danika van Proosdij, Geologist and Associate Professor at St. Mary's University, as well as author of ACAS dykeland vulnerability research;
- Real Daigle, Climatologist and co-author of *Scenarios and Guidance for Adaptation to Climate Change and Sea-Level Rise – NS and PEI Municipalities*; and
- Gavin Kennedy and John Drage, DNR hydrogeologists

The literature review and preliminary preparation for the Bay of Fundy Climate Change Workshop agenda was supported and guided by Anne Warburton's previous experience as a: participating consultant in the Mentor Project, author of the MCCAP

Assistant, presenter of a climate adaptation webinar series funded by the NS Climate Change Directorate, a consulting team member for the identification of coastal impacts for the Village of Chester, and presenter at SNSMR-hosted MCCAP workshops.

The MCCAP Guide (Province of Nova Scotia, 2011) served as a framework model for the design and content of two workshops and an interactive scenario exercise. The MCCAP Guide suggests that municipalities organize and analyze identified hazards and impacts in a hazard impact matrix (see Figure 1). The matrix is also used to describe locations of the impacts, convey impact severity and probability, and record priority rankings. One of the objectives of the BoFEP climate change workshops was to always keep the hazard impact matrix in mind, and ensure the participant's learning experience would facilitate the completion of a hazard impact matrix within their own MCCAP.

To this end, a pre-workshop survey was developed. A copy of the pre-workshop survey is found in Appendix B. The survey asked municipalities to rank seven hazards based on their importance/relevance to the municipality. The seven hazards listed were:

- Storm surge / coastal flooding
- Coastal erosion
- Surface / groundwater contamination
- Karst terrain
- Inland flooding
- Drought
- Land slides / slope stability

Results of the survey confirmed ideas for presentation topics and the need for a hands-on mapping exercise to practice delineating potential impact areas. Garth DeMont of the DNR, Laura Trudell (DNR and Dalhousie School of Planning Honours student), Jacqueline Wightman (Dalhousie School of Planning Honours student) and Anne Warburton determined mapping needed to facilitate the primary interactive mapping (scenario) activity and developed a 'key' (i.e. a decision flow diagram for identifying coastal areas warranting further erosion analysis) to guide the group mapping work. DNR hydrologists were also consulted for assistance, particularly to provide saltwater intrusion data and spatial information about wells.

NS Environment Climate Change Directorate posted workshop resource materials on a provincial website to make information available to all participants for download. BoFEP will also post workshop materials on the BoFEP website once reformatted in a usable form to make them available to a broader community, as well as offer an alternative web resource site should the provincial site be short-term.

Details on the approach used in workshop development can be found in Appendix C.

3.0 Literature Review

The following presents an overview of information obtained from the relevant literature on climate change in Nova Scotia or the Maritime region and how it was applied or adapted for workshop purposes.

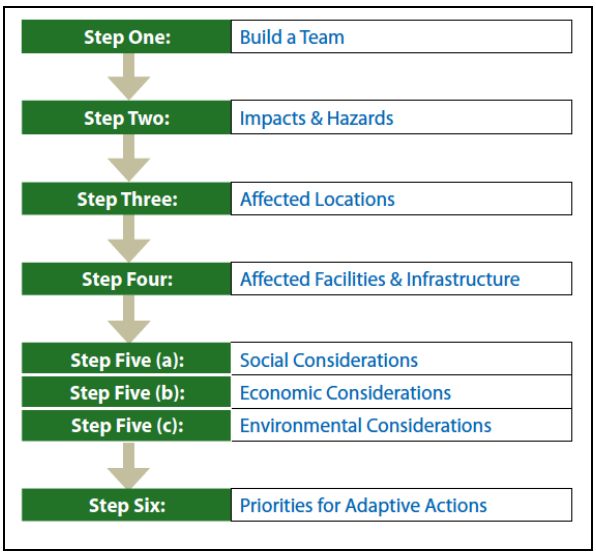
3.1 MCCAP Guide

The MCCAP Guide (Province of Nova Scotia, 2011) is a six-step framework to help municipalities prepare climate change action plans and to identify priorities for climate change adaptation (Figure 3). The MCCAP Guide is about gaining perspective on what natural hazards municipalities should be protecting themselves from or be ready to respond to in the context of climate change. In essence, the MCCAP is a *screening process*. It is about figuring out what hazards municipalities need to address, to protect infrastructure, community well being, and existing and future development. The MCCAP is about delineating the places or issues that warrant action.

While not *required* to follow this framework exactly, the framework is the starting point from which Nova Scotian municipalities are designing their climate change action plans.

A full understanding of the MCCAP Guide was paramount in meeting the climate change contract requirements and in achieving the workshop learning objectives because the design of BoFEP workshops was based on Step two (hazard and impact identification) and Step 3 (affected areas) of the MCCAP Guide (Province of Nova Scotia, 2011).

Figure 1 Six-step framework of the MCCAP Guide (Province of Nova Scotia, 2011)



Within each step of the Guide are a series of self-assessment questions "designed to probe more deeply into climate impacts, affects and accompanying municipal issues" (Province of Nova Scotia, 2011). The questions posed for steps two and three are as follows:

Step Two

1. What hazards or impacts resulting from the changing climate and the weather have become issues for your municipality in the past?
2. What kinds of events caused these issues?
3. What kinds of actions or measures (if any) were undertaken in order to address or respond to these issues?
4. How well prepared is your municipality if such events occur again; especially if such an event becomes more frequents or severe as a result of climate change?
5. Does your municipality have the capacity/resources to manage the next event?
6. How often do these events occur; are they occasional or frequent; do they affect a large or small part of your municipality; was the impact level severe or minimal?
7. Describe and record the range of issues that occurred as a result of past climate events. Document as much specific detail as possible regarding the effects on your municipality.
8. Do you think these types of events and associated hazards will continue into the future and become more problematic unless actions are taken to minimize their effects?
9. Describe how and why you think climate impacts will become more of a problem for your municipality over time.
10. Do you think your municipality will experience other kinds of climate related issues in the future, which have not affected you in the past? What are they?
11. What new information do you need to know to be able to plan effectively for the future of your municipality, with respect to the impacts and issues you have identified?
12. Do you have this information, and/or do you know where it can be obtained?
13. Do you see any new opportunities for your community in the future as the climate changes?

Step Three

1. Do the climate change-related hazards you identified in Step Two, impact your entire municipality or only certain portions or geographic areas?
2. If there is variation, can you identify and map areas where impacts and issues are most likely?
3. Will the issue cause more of a problem (or benefit) in certain areas of the municipality?
4. If issues are specific to certain areas, which parts of the municipality are most greatly affected?

5. Do you think this pattern will change in the future: will these issues become more problematic with predicted changes in weather and climate?
6. What resources and tools can your municipality use in order to map-out and determine which parts of your municipality are at high risk?
7. What additional information, skills, expertise or resources do you need to make proper decisions?

Each of these questions influenced the content/subject matter of workshop presentations, the design of interactive scenarios, and the selection of tools and resource materials shared with participants.

3.2 SNSMR-ACAS Mentor Project

The Mentor Project involved pairing three mentor-consultants with three municipalities to 'test drive' the MCCAP Guide (Province of Nova Scotia, 2011) developed by SNSMR and to prepare reports describing municipal insights and lessons learned. During this project, mentor consultants integrated research results from the ACAS program into the municipal adaptation planning process, evaluated their usefulness, and identified both additional resource needs and challenges to and solutions for MCCAP completion.

After the Mentor Project, SNSMR and ACAS jointly tendered the Municipal Learnings Project to synthesize and build on information generated during the Mentor Project. The resulting product of this project was the MCCAP Assistant (Elemental Sustainability Consulting Ltd., 2012). Information drawn from the MCCAP Assistant for the BoFEP workshops included definitions of terms (Figure 2), suggestions for modifying the Hazard Impact Matrix, and descriptions of how to interpret the water levels (Table 2) described in Richards and Daigle (2011).

Figure 2 Relationship between trend, hazard and impact as defined in MCCAP Assistant (Elemental Sustainability Consulting Ltd., 2011)

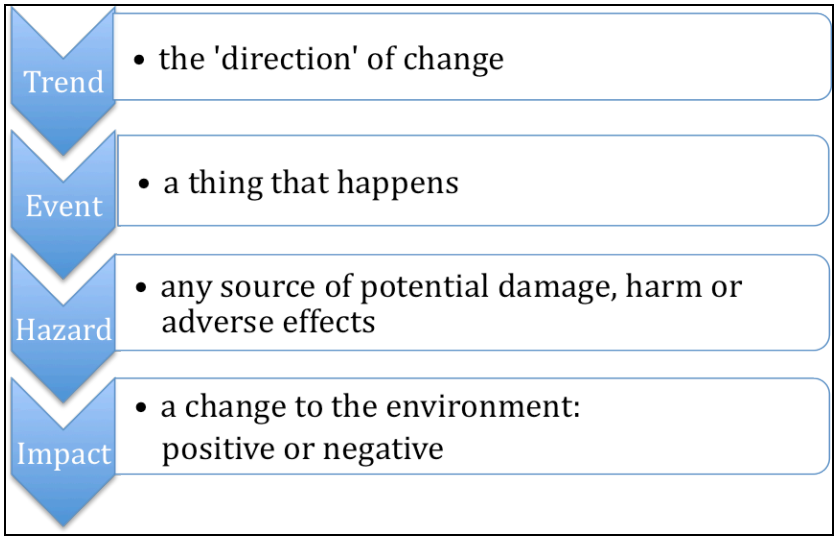


Table 1 Understanding phrases defining water levels in Richards and Daigle (2011) as described in the MCCAP Assistant (Province of Nova Scotia, 2011).

Water level phrase	What it means
Total Sea Level Rise	This is another way of saying Relative Sea Level Rise: estimated sea level rise + subsidence (sinking) of a particular region.
Extreme TSL (total sea level)	This is how high the water will be if you add: • relative sea level rise (change in general water level) • to a significant storm-surge event for the respective return-periods (10 year, 20 year, 50 year, 100 year) • at the highest astronomical tide possible at a given location. In other words, this is where the water will be during a BIG storm if it occurs during your highest tide.
Plausible Upper Bound Water Level	This is how high the water will be if you add relative sea level rise to the truly worst case flooding scenario resulting from a storm surge as previously recorded by meteorologists (e.g., Saxby Gale in 1869, Groundhog Day storm of 1976, Hurricane Juan in 2003), and if it occurs during the highest astronomical tide possible at a given location.

3.3 NS Department of Natural Resources Literature

Many of the DNR's Mineral Branch's Report of Activities dating back to 2009 were reviewed to identify geohazards that are pertinent to land use planning and development. Identified geohazards were further researched to articulate if and how changing climate conditions may exacerbate them. References to such effects were found within the DNR literature, and confirmed in interviews of subject experts and reviews of ACAS research.

After attending a NS Department of Natural Resources educational seminar in 2007, John Bain, Eastern District Planning Commission Director, Geological Services Division, made a decision to include geology in the Central Antigonish County Land-use Plan. He, and the Antigonish Area Advisory Committee have since been working with the DNR to develop a methodology to incorporate geology into the planning process through the design and production of a geological map and digital database products, in formats (GIS datasets) that can be readily used by land-use planners. The progress made during this DNR project underpins the geohazards focus of the BoFEP Climate Change Workshops because in the world of climate change hazard vulnerability assessments, Geology is often overlooked. This could pose a significant problem for provincial planners who must design a climate change adaptation strategy, because understanding geology is critical for the design and

implementation of new policies and action plans (DeMont 2009). In fact, community health and safety and the economic bottom line, can all be compromised if geology is not considered in development decisions (DeMont *et al.* 2010). Municipal adaptation projects need a base of accurate scientific data, coupled with the involvement of local land-use planning authorities that are willing to apply the scientific conclusions to formulate sound government policy (Utting and Gallacher 2009; DeMont *et al.* 2012).

The DNR's Environmental Geology Program educates provincial and municipal decision makers about the role of geology in their daily lives. The province's geological databases will become extremely important in the future as the Province develops new policies required to adapt to natural hazards exacerbated by climate change (DeMont, 2009).

Hazards that infrastructure near shorelines will face include (but are not limited to), shoreface erosion and mass movements, flooding, and wind damage (Fink and Utting 2010; DeMont *et al.* 2012). Setbacks for infrastructure built near shorelines should, at a minimum, consider these three main risk factors, and hazards need to be assessed with respect to short, intermediate and long-term effects (Fink and Utting 2010). Additionally, land use planners will increasingly need to pay attention to acid rock drainage, karst, and heavy metal transport into water sources.

One of the challenges GSD faces, is presenting geological data in a map format that provides useful information for people having no prior geological training (DeMont 2009). Traditional geology maps list the rock units by age and stratigraphic position, but it is recognized that new maps will likely list and describe rock units by their degree of environmental risk and mineral/aggregate/ groundwater resource potential (DeMont 2009).

3.4 ACAS Research

The following summarizes ACAS research that proved relevant to Bay of Fundy Climate Change Workshop.

An ACAS study that is central to municipal climate change action planning is the research of Richards and Daigle (2011). This research provides an overview of the climate change scenarios that municipalities are planning for and an explanation as to how to interpret and apply climate change projections. Information drawn from this document included trends and projections of climate indices for four climate normals and water levels for four storm return periods over five climate normals. This data was used to explain trends and projections for sea level rise and precipitation and to in interpret water levels for varying storm surge return periods. A summary of the climate trends addressed in their research is provided in Table 2.

Table 2 Summary of Richards and Daigle (2011) Climate Scenario Guidelines

Climate elements or indices	Projected change	Seasonal notes
Temperature	Increase	Winter warming the most
Precipitation	Increase	Greatest increase in moisture will likely come in winter
Heating Degree Days	Fewer	Warmer winter and shoulder season temperatures are likely to reduce the requirement for heating in the Maritimes
Cooling Degree Days	More	Warmer summer temperatures are likely to increase cooling demand, but the effect will vary by municipality
Hot Days (over 30° C) and Very Hot Days (over 35° C)	Slightly more	Na
Cold Days (< -10° C) and Very Cold Days (< -20° C)	Fewer	Na
Growing Degree Days	Substantial increase	Affects the choice in varieties of perennials we should be planting
Growing Season Length (Freeze Free Season)	Longer	Likely to increase by 1 to 2 months by 2100
# of Days with Rain and Days with Snow	Increase	More rain in winter—snow days turning to rain days
# of Times Passing Through Freeze-Thaw Cycle	Decrease	The number of freeze-thaw cycles in winter stays nearly the same or increases, and decreases in shoulders seasons
Water Surplus	Depends on municipality	Overall, changes are slight and poorly timed
Water Deficit	Increase	Increased summer water deficits
Change in Intensity Short Period Rainfall	Increase in Intensity (amount and duration)	Unknown

Because flooding is a priority hazard for many municipalities around the Bay of Fundy, all ACAS research dealing with dykeland vulnerability was reviewed. Key findings from that review, which were highlighted in workshop presentations, dealt dyke construction and an overview about their management, vulnerabilities to overtopping and erosion, and the current state of knowledge and available mapping. Of particular interest was the fact that dykes in Nova Scotia are particularly vulnerable to overtopping and erosion due to original construction being designed to protect agricultural land, not built communities like elsewhere in the world (van Proosdij and Page, 2012). The fact that municipalities have allowed development in dykelands has introduced a significant risk that the MCCAP process is well suited to address.

Saltwater intrusion is a growing concern in the Maritimes and was a focus of ACAS research, particularly in New Brunswick. In Nova Scotia, approximately 90% of private wells intercept fractured bedrock aquifers (Kennedy, 2012). “There are

limited tools available, however, to groundwater managers and land use planners for evaluating the sustainability of groundwater supplies . . . which are vulnerable to the effects of seawater intrusion" (Kennedy, 2012). The Bay of Fundy communities of Lawrencetown, Wolfville, and Canning are areas where saltwater intrusion has been identified in ACAS research. For this reason, a paper by DNR Hydrologist, Gavin Kennedy (2012) was provided to workshop participants as reference material, and findings were presented at during the workshops.

3.5 Additional Research

The publication by Greenberg *et al.* (2012) included as reference material for workshop participants, presented new research on changes to mean sea level and high tide heights in the Bay of Fundy. This information was incorporated into the climate change workshop water level scenarios.

Information from Stantec Consulting Limited (2012) contributed to the explanation of a 5-step process used by municipalities to prioritize climate adaptation actions. This process was recommended by Anne Warburton in the workshop, and links to a forthcoming socioeconomic self-assessment tool being developed by the NS Climate Change Directorate. The 5-step process and the potential application of socioeconomic data in adaptation strategy development, was the focus of the workshop's final presentation, "When does an impact become a priority?"

4.0 Workshop Results

4.1 Overview of Workshop Content

The workshop agendas for both locations are found in Appendix D.

The Bay of Fundy Climate Change Workshop was premised on the following ideas: climate change is anticipated to exacerbate geological risk for existing and future development, and municipalities can mitigate some of that risk. As a means of examining this risk, presentations and discussion focused on the relationship between geological processes, climate trends and projections, and land use planning.

The first morning presentation *Framing the Day* by Anne Warburton, provided a review of climate trends, projections and hazards that are central to hazard and impact assessment. As such, this presentation underpinned the rest of the day's discussions and activities. Ensuring a shared understanding of the intent and expectations of the MCCAP was an important component of this presentation in terms of defining how municipalities should direct their efforts in MCCAP development. *Framing the Day*, reviewed MCCAP expectations of Service Nova Scotia Municipal Relations-Municipal Services Division, and the Canada-Nova Scotia Infrastructure Secretariat and what the *scope* of the geohazards assessments should

be in MCCAP submissions. As well, this first presentation conveyed the message that the hazard impact assessment process as defined in step two of the MCCAP Guide, *is* achievable at the municipal level. Time was also spent in reviewing projected water levels for return period storms as, most participants who had responded to a pre-workshop survey, had ranked coastal flooding and inland flooding as their top two concerning hazards. Coastal erosion was also a top issue. Specifically, this portion of the presentation emphasized what to keep in mind when interpreting and applying estimated water levels in a land use planning context, and *how* exactly water levels relate to geohazards. The same analysis was applied for anticipated changes in return periods for short period rainfall.

In the next presentation, *The Relevance of a Historical Perspective* by Jacqueline Wightman), participants were presented with the question of whether analyzing historic storm risk patterns offers insight into how development trends may affect future vulnerability to storms. The following presentation, *Dykes in the Bay of Fundy* by Dr. Danika van Proosdij, reviewed dyke vulnerability and the consequent risk posed by overtopping or breaching and coastal flooding. The presentation, *Linking Climate Change and Geohazards* by Anne Warburton, reviewed the relationship of changing climate conditions to geohazards (specifically coastal erosion, karst, the mobility of heavy metals, acid rock drainage and slope stability), and implications for land use planning. The question, "why do land use planners care?" was then posed. This review set the stage for Garth DeMont's more detailed exploration into *Styles of Coastal Erosion*.

Garth DeMont's presentation provided lessons needed to identify areas that warrant further assessment in the mapping activity that followed. What was of particular interest was not just coastal erosion per se, but using this geohazard as a means of demonstrating *how to present geohazards within the 2013 MCCAP framework* in a manner that is responsibly accurate and financially prudent (i.e., it begins to define a reasonable scope of work for a future detailed site assessment). This type of mapping activity is encouraged in the MCCAP framework as described in the MCCAP Guide. Once groups had worked through their coastal erosion mapping activity, which also provided ample time to ask other geological questions to their group mentors/guides, the workshop slightly switched focus. Laura Trudell's map prototype of acid rock drainage was put before the groups following her introduction of the subject matter. The groups then evaluated how could geological mapping be modified so that potential risk in the context of land use planning can be easily interpreted.

After the two mapping activities, Anne Warburton introduced a case study of the Stratford, Prince Edward Island (PEI) Stormwater Management Plan Update (CBCL Engineering, 2012). This work was highlighted because it demonstrates a shift from solely relying on a historical data to define infrastructure needs (i.e., intensity duration frequency curves) to considering climate-wise, downscaled design rainfall events. As well, it demonstrates a watershed-based approach to flood mitigation aimed at minimizing infrastructure capital costs without sacrificing public safety.

The last presentation of the day addressed an overarching requirement of the MCCAP framework and resulting municipal adaptation strategies: the requirement to prioritize impacts and short-list adaptation actions. Additionally, there is a need to ensure that the current and plausible future socio-economic realities of the community can support these adaptation actions. As well, it is valuable for communities to realize that by incorporating socio-economic information and considerations in their evaluation adaptive actions, they can discover and pursue strategies that will benefit the municipality regardless of how the climate changes.

In its entirety, the content presented throughout the day flowed logically and smoothly. The presentations that served as the 'anchors' of the day, and provided the most valuable content included: the review of climate trends and the MCCAP framework, a review of dykelands vulnerability in the Bay of Fundy, linking geohazards to climate change and land use planning, the case study scenario exercises, and a look at climate-wise stormwater management. A summary of each of these presentations follows.

4.2 Summaries of Workshop Presentations and Interactive Scenario Exercises

4.2.1 Framing the Day (Anne Warburton)

Water level estimates

The Richards and Daigle report (2011) can be used as a substantiated climate reference for municipalities. Their report uses three key terms when discussing water levels, so these terms were reviewed. The terms are:

- **Total Sea level rise (or relative SLR):** global mean increase in sea level plus local subsidence levels. This is also often referred to as relative sea level (BIO uses term relative sea level rise).
- **Extreme water level**: The combination of a high tide and storm surge is referred to as an extreme water level. This number comes from examining HHWLT data, storm surge water levels generated during benchmark storms, and water levels based on varying storm surge return periods.
- **Plausible Upper Bound Water Level:** combine the upper limits of global sea-level rise, local crustal subsidence and the highest storm-surge Return Period (Years) factor previously recorded by a tide gauge, or where available, some high precision measurements of identified high water marks.

Participants were encouraged to keep in mind that these sea level rise estimates do not include the contribution of ice sheet melt. Such a contribution would pose serious consequences to coastal infrastructure in a relatively short time span. To put this point of scientific uncertainty into perspective, participants were reminded that observed sea level rise exceeded what the Intergovernmental Panel on Climate

Change (IPCC, 2007) predicted by 50% for the period 1990–2006. As well, 80% of the rise in sea level between during 2003–2008 is believed to be from ice melt, indicating a general underrepresentation of the role of ice melt in sea level rise calculations (Cazenave *et al.,* 2008).

While the issue of ice melt is interesting, of more direct and immediate concern is the issue of waves. Water level estimates for return period storms do not include wind stress and propagating waves, and local effects such as seiches and wave runnup, all contributing factors of shoreline erosion and coastal flooding. Given the workshops focus on the Bay of Fundy Ecosystem, an introductory discussion was had about the shortening of the resonant period of the Bay of Fundy - Gulf of Maine system. It is hypothesized that as a result of this shortening, the amplitude of the M2 tide (primary lunar tide of the day) is increasing by approximately 5-10 cm/century at tide-gauge sites, depending on location (Greenberg *et al.,* 2012). On the 50-Year time scale this should contribute to an increase in extreme high tides in the Bay of Fundy and southwest Nova Scotia by 30-50 centimeters in general and about 10 centimeters in the upper Bay, associated with accelerated sea level rise (Greenberg *et al.,* 2012).

From the perspective of a municipality, the issue behind changing tide level is, of course, related to flooding. In a conversation with Réal Daigle, co-author of the Richards and Daigle (2011) report, Anne Warburton confirmed that the projected change in the amplitude of the Bay of Fundy tide was not included in water level estimates for municipalities located on the Bay of Fundy (pers. comm., January 10, 2013). Réal Daigle's advice, which was shared with workshop participants, was to use the upper uncertainty limits, outlined in the climate scenarios provided in Richards and Daigle (2011) report. Doing so would account for changes in tidal amplitude.

Storms

Storms were discussed as they related to flooding. It is often stated in media and elsewhere that storms will become more frequent. This is a bit misleading. Global Circulation Model results analyzed by the Bedford Institute of Oceanography do not indicate a trend of an increasing number of storms over Nova Scotia. That being said, oceanographers caution that the Canadian Regional Climate Model, and possibly other climate models underestimate the track density over the northwest Atlantic area (Blair Greenan, pers. comm., September 7, 2012). The take away message being, it is not that we expect to be receiving more storms: it is that we expect the storms we *do* receive to generally be more intense.

Changes in precipitation

In addition to significant concerns about storm surge and coastal flooding, municipalities are concerned about changes in precipitation. Richards and Daigle (2011) provide three climate indices related to precipitation: water surplus, water

deficit, and intensity short period rainfall. Water surplus is the excess remaining after the evaporation needs of the soil have been met and soil storage has been returned to the water holding capacity level. Surplus creates runoff. Water deficit is the amount by which the available moisture fails to meet the demand for water. Water deficit is a drought indicator. From a municipality's perspective, summer water deficits, should be considered when assessing fresh water supplies, and indeed, many municipalities have undertaken water management reviews to identify, protect and enhance fresh water resources.

As stated in Richards (2011), "information on the impact of climate change on intensity short period rainfall rates is inconclusive at this point in time as there is no standard or accepted research methodology to determine how future sub-daily extreme rainfall could change in intensity and frequency over a small area in the future climate." However, there is enough evidence to state that the Maritime region can expect an increase in short period rainfalls of a certain magnitude. Said another way, the amount of water (expressed as millimeters of rain received within 24 hours) that we now expect from an event with a 20-year return period short duration/period rainfall event will increase. The amount of water that will fall in a 20 year return period rainfall (i.e., an event that has a 5% chance of happening any given year) will be: 5% more rain fall by the 2020s; 9% more rain will fall by 2050s; and 16% more rain fall by the 2080s (Richards and Daigle, 2011). Now juxtapose this with the fact that we expect an increase in annual water deficit. The pattern is one of alternating wet and dry periods—much more exaggerated than what we currently experience.

Hazard impact matrix

The discussion turned now to *how* to record and organize climate hazards and impacts within the MCCAP. The MCCAP Guide suggests using a hazard impact matrix. This matrix is a simple tool that appears fairly regularly in risk assessment work. The matrix shown in the Guide focuses on listing and ranking hazards: the extent to which the *hazard* will cause problems.

Figure 3 Hazard impact matrix as illustrated in the MCCAP Guide (Province of Nova Scotia, 2011)

Hazard	Severity			Frequency			Area		
	Severe	Moderate	Minor	Often	Sometimes	Rarely	Large	Medium	Small
Sea Level Rise		X			NA			X	
Erosion		X		X				X	
Flooding		X			X		X		
Landslides	X					X			X
Storm Surge	X				X		X		
Hurricanes & Wind	X					X	X		
Forest Fires	X					X	X		
Drought		X			X				X

A revised version of the matrix prepared by Anne Warburton was presented to workshop participants which listed *impacts* associated with a hazard, and provided a means of ranking the impacts. It also included an additional column in which to describe the location in which the impact was expected to occur (for those impacts that are spatial in nature). Another column was *added* for recording a general level of risk tolerance. Additionally, the column for ranking impact severity was improved by adding definitions (i.e., parameters) to severe, moderate or minor. The definitions proposed at the workshop came from a tool called the Hazard Risk Vulnerability Assessment, adopted by Nova Scotia Emergency Management Office (Heather Mackenzie-Carey, pers. comm., November, 2011). Lastly, where the Guide's original hazard impact matrix defined frequency as often, sometimes or rarely, the revised version uses storm return periods relevant to the hazard being assessed. For example, 'often' could be enhanced by adding, 'has a 20% chance or more of occurring in a given year.'

Figure 4 Example revised hazard impact matrix and associated definitions of impact severity

Hazard: Blizzard										
Blizzard warnings are . . .										
	* Severity			** Frequency			*** Level of risk tolerance			**** Overall Risk
Location: Debert through Cobequid Mountains are snow belts/areas of concern	Severe	Moderate	Minor	Often: 20% chance or more a year	Sometimes: 2-20% chance a year	Rarely: 2% chance or less a year	High	Medium	Low	High, Moderate, Low
		X		X			X			High
Impacts	Severity			Frequency			Level of risk tolerance			Overall Risk
Public safety (fatalities / injuries)	X					X			X	High
Displacement			X			X		X		Low
Prolonged isolation			X			X			X	Low
Property damage			X			X	X			Low
Crop/livestock damage			X			X	X			Low
Power / utility disruption			X	X					X	Moderate

**** Overall Impact Score from HRVA**

	5	**Catastrophic**, over 100 people affected; multiple fatalities; injuries, long term health effects; prolonged displacement; extensive environment & property damage; long term effects to environment; serious infrastructure disruption; community unable to function without significant support
	4	**Significant;** 51-100 people affected; multiple serious injuries; long-term hospitalization required; displacement for 6-24 hours; significant impact to environment- medium to long term effects; external resources required; community only partially functioning, some services unavailable
X	3	**Moderate**; 11-50 people affected; no fatalities, some hospitalization and treatment required; localized small numbers displaced for 6-24 hours; no long term environmental or property damage; localized damage rectified by routine arrangements; normal community functioning with some inconvenience, no resources required outside of mutual aid agreements
	2	**Minor;** less than 10 people affected; no fatalities, small number of injuries requiring first aid only; small numbers displaced for less than 6 hours; no external resources required; minor localized disruption to community services for less than 6 hours
	1	**Insignificant;** no fatalities, injuries or impact on health; no persons displaced; no damage to properties or environment; no disruption to community services or infrastructure; no mutual aid resources required

Rank of 5 being a severe impact rating in matrix

Rank of 3 & 4 being a moderate impact rating in matrix

Rank of 1 or 2 being a minor impact rating in matrix

4.2.2 The relevance of a historical perspective (Jacqueline Wightman)

Land-falling hurricanes, winters storms, and extratropical storm remnants have all created extensive damage in coastal Nova Scotia communities. Given that storms are estimated to intensify due to climate change (Williams and Daigle, 2011) and the population density along Nova Scotia's coast is increasing (Wightman, 2013), Wightman's thesis research examines how community vulnerability has evolved over time due to changes in land use development patterns.

The magnitude of a storm, combined with land use, infrastructure, and development patterns determines (in large part) the amount of devastation that a hurricane inflicts on a community (Wightman, 2013). Step two of the MCCAP framework asks municipalities to take stock of historical weather events, damages that occurred because of those events, if the municipal response was adequate, and if the municipal response (e.g., changes land use policy) mitigated damages from subsequent events of a similar magnitude. Jacqueline Wightman's thesis research was introduced to workshop participants because she identified a method for "comparing the damages from past storms to the type and pattern of land use at the time of each storm." The idea being, this method can be employed to assess the degree to which a "community is prepared for potential changes in frequency and intensity of severe storms" (Wightman, 2013). It is a means of illustrating whether development patterns are making a community more or less vulnerable to storms. Of particular interest to workshop participants, was the use of historical fire insurance maps as a basis for the spatial analysis of land use changes. Also of interest was that to assess the vulnerability of the built environment, the attributes used were: type of use, permanency, level of investment, and building materials.

It is expected that research findings will show that municipal vulnerability increases in proportion to the degree/density of coastal development and the type: were residential and commercial exacerbates municipal risk (Wightman, 2013)

4.2.3 Dykeland vulnerability (Dr. Danika van Proosdij)

Dr. Danika van Proosdij, along with colleagues and students from the Department of Geography and Maritime Spatial Analysis Research Centre at Saint Mary's University, were commissioned by ACAS to conduct research on dykelands in the Maritimes. Given the presence of dykes in the Bay of Fundy Ecosystem, Dr. van Proosdij was invited to the Bay of Fundy Climate Change Workshops to speak specifically about research results on the vulnerability of dykes to climate change and comment on mitigation and management recommendations for the future.

Danika van Proosdij (2012) conducted an analysis of best practices for climate change adaptation in dykelands using information from Nova Scotia, New Brunswick and British Columbia as well as other regions in the world where dykelands are present (e.g. United Kingdom, France, Netherlands). The research involved:

- a physical assessment for dykes in Fundy ACAS study areas,
- determination of new critical elevations and associated engineering modifications,
- an assessment of current and potential future management practices (e.g. maintenance of foreshore, placement of armour rock, creek modifications), and
- recommendations of mitigation strategies and recommendations of coastal engineering practices to protect existing foreshore marsh.

Figure 5 ACAS study areas for Best Management Practices for Climate Change Adaptation in Dykelands: Recommendations for Fundy ACAS Sites (van Proosdij and Page, 2012)

The NS Department of Agriculture, Land Protection Section, Agriculture and Food Advisory Service's is responsible for the protection of agricultural land behind dykes and the maintenance of dykes which are privately owned. Given that the impact of an overtopped or breached dyke is *felt* at the local level, it is critical that municipalities understand what is known or being planned for dyke upkeep and maintenance and engage in conversations about how to lessen dyke vulnerabilities to climate impacts and extreme weather events.

Dyke elevations are maintained so that their height is one to two feet (0.3–0.6 m) above predicted maximum water levels. This is to account for a natural setting of the earthen materials the dykes are constructed from. It is estimated that dykes have settled by 0.30m in the last 50 years (van Proosdij and Page, 2012). As well, Dr. van Proosdij pointed out that the predicted maximum, or critical elevation, for each marsh body is different because maximum water levels vary as a result of dominant wave orientation and wave set-up. As well, these elevations are based on predicted maximum water levels from the 1960s.

Some municipalities use marsh body boundaries as jurisdictional lines denoting flood risk and the restriction of development (unless a variance is granted). The Maritime Marshland Rehabilitation Administration (MMRA) of the Canadian Department of Agriculture originally determined these boundaries in the 1950s based on observed high water levels at the time within each individual marsh. The contemporary issue is that people just outside of these boundaries may have a false sense of security: they may assume they are outside of the flood zone when in reality boundaries no longer accurately delineate the true flood boundary.

Dr. van Proosdij pointed out that in Nova Scotia, historically dykes were built to create and protect agricultural land. Over time, however, people have taken advantage of the protection afforded by the dykes to develop important

infrastructure (such as roads, rail, and residential and commercial properties) behind these structures. Dykelands are therefore of value not only to farmers but also to a host of individuals, businesses, and provincial governments (van Proosdij, 2012).

Dr. van Proosdij indicated that there are multiple factors at play that cause or compound flooding. First, over time the elevation difference between the foreshore marsh and the marshland behind the dyke increases because of sediment accretion on the natural, foreshore marsh and surface compaction and lowering within the drained agricultural soil. As well, she explained that aboiteauxs may be silted shut preventing drainage of fresh water during a falling tide. In addition to these factors that keep floodwaters on the 'wrong' side of the dyke, are issues with dyke construction that cause overtopping, or potential breaching.

Dr. van Proosdij explained that modern dykes typically have a vertical to horizontal ratio on the seaward side of 1:3 to 1:6 to dissipate wave energy, and they are armored. On the landward side they are generally steeper with 1:2 or 1:3 vertical ratio (van Proosdij and Page, 2012). This landward steeping was to minimize the amount of land used. The seaward side of a dyke in the Bay of Fundy tends to be steeper than other places in the world. The MMRA designed Fundy dykes to have a 1:3 and 1:2 seaward and landward slopes respectively (van Proosdij and Page, 2012). Over time however, repeated dyke topping with minimal adjustment of toe placement (perhaps because they didn't want to give up agricultural land) has resulted in a 1:1.5 seaward slope and 1:3 or 1:4 landward slope (van Proosdij and Page, 2012). The steepening slope increases the potential for erosion through wave reflection and scour, despite any amouring that may be present.

The parameters that are used to determine dyke crest elevation vary globally although most places use the higher high water level or highest recorded tide level plus a freeboard elevation that is typically 0.5-0.6 m (van Proosdij and Page, 2012). On top of this, a potential storm surge elevation is added. The return period chosen relates to the value of land being protected. For example, if the land behind the dyke is deemed highly valuable, jurisdictions may use a 100-year return period. The thinking being, 'we want to plan for the 'worst case' storm scenario.' If the land is not deemed valuable, then a lower return period may be chosen, such as 10 year return period. The Fundy dykes were based on a 1950s-based 10-year return period. When the critical elevation of individual dyke segments (~15 m intervals) was assessed, it was found that most sections were above this elevation, particularly in Hants County (van Proosdij and Page, 2012). There were seven sections of dykes however, with imminent risk of overtopping for a 1:10 year storm event (van Proosdij and Page, 2012).

Dr. van Proosdij provided a table from her research (van Proosdij and Page, 2012) that recommended elevations for each marshbody to protect them from storm surge alone or sea level rise or both scenarios combined. She noted that it is important to recognize that increases in critical elevation will also require additional landtake for

dyke heightening to maintain proper slope ratios. She also pointed out that it will be up to provincial and local officials to determine the degree of risk they are willing to assume, which will ultimately depend on cost and the value of the land that is being protected. She also provided nine recommendations based on an analysis of international best practices and existing conditions within the Fundy ACAS communities as follows (van Proosdij and Page 2012):

1. Conduct a cost benefit analysis for marshbodies containing significant infrastructure to balance the value of the land protected and cost of required infrastructure as well as degree of risk that the communities are willing to assume.
2. Develop a differential determination of critical elevation incorporating sea level rise and storm surge for dykes protecting valuable infrastructure. For example, use a 1:100 year storm return period for high value areas (1.13 m) versus a 1:10 year storm (0.85 m) in primarily agricultural land. In these high value areas, a minimum of the predicted 2055 sea level rise estimate should be included.
3. In areas where dykes are being topped, it is recommended that the proposed cross sectional profiles be carefully assessed and a decrease in slope (e.g. 1:2 or 1:3 ideally) be applied on the seaward side. Although this may come at the expense of some agricultural land, as the dyke crest will need to shift landward, the tradeoff of a loss of 10 m of agricultural land versus the significant financial cost of dyke repair due to erosion is warranted.
4. The allocation of variances should be significantly limited and flood proofing requirements should be mandatory. Applicants of proposed variances should be shown detailed maps of the extent (and depth) of potential inundation so that they are fully aware of the risk of building within this zone.
5. Managed re-alignment should be considered in those areas that have less than 80 m of foreshore. In those cases, dykes should be re-aligned so as to provide a minimum of 100 m of foreshore and that foreshore be armoured. Efforts should be focused on proactive rather than reactive protection. However, not all foreshore should be armoured as sediments released through the erosion process will in turn nourish new marsh growth in other areas within the estuary.
6. Small, underutilized tracts should be considered as candidates for salt marsh restoration if the cost of maintenance is significantly more than the value of the land that is being protected. However, large, intact tracts of agricultural land that are threatened yet underutilized should not necessarily be seen as immediate candidates for large scale restoration activities. Constrained managed realignment in areas of concern should be undertaken to prevent breaching and to protect fertile agricultural land for future generations.
7. No additional salt marsh should be reclaimed even if there is significant growth of foreshore marsh seaward of an individual dyke structure. This foreshore marsh serves as a buffer for erosion and wave energy dissipation for future generations. Natural processes of erosion and progradation should be encouraged.
8. In areas where communities benefit directly from the protection of dykes for

their critical infrastructure, these communities should bear some of the costs of maintenance (e.g. 'protection tax' proportional to the amount of land at risk) in addition to the province and federal government. No one entity should bear the cost in its entirety.

9. Planning for flood risk requires collaboration and partnerships at all levels. This will include engaging provincial, municipal and community stakeholders in education and visioning activities to raise the understanding of current and future flood risks, use the products generated through ACAS to quantify this risk and decide as a community and a province, how best to address these risks. It is important to note that while this report provides an evaluation of dyke vulnerability and adaptation options that can be applied to non-ACAS areas, it does not negate the need to conduct site-specific vulnerability assessments for other areas of the Province.

4.2.4 Linking geohazards, climate change and land use planning (Anne Warburton)

Municipalities were already aware of the geohazards causing issues within their jurisdiction. What was less clear was how to deal with geohazards in MCCAPs. There has been concern and confusion over the capacity of municipalities to complete this work, so discussion focused on *when* in the MCCAP process do they need to address geohazards and *why* external scientific or technical assistance could be useful.

Geohazards
Events caused by geological features and processes that present severe threats to humans, property and the natural and built environment. (Engineering Conferences International, 2006)

The geohazards most relevant to Nova Scotian municipalities in the context of their climate change plans include:

- Coastal flooding and riverine flooding
- Coastal erosion
- Karst terrain & sinkhole development
- Contamination of water from heavy metals or acid rock drainage
- Landslides / slope failure

The presentation, Linking Climate Change and Geohazards, was a brief but important review of the relationship between geohazards, climate trends and projections, and land use planning. The geohazards of focus were: coastal erosion (which was described in detail by Garth DeMont), karst, and geological conditions that lead to contaminated groundwater. Landslides were touched on briefly, and flooding was specifically addressed earlier in the workshop.

4.2.5 Styles of coastal erosion (Garth DeMont)

The key message regarding coastal erosion was that increasing water levels contribute to changing wave dynamics: helping to create waves that have a greater

ability to erode and or change coastal shorelines, as well as damage coastal infrastructure. As stated in DeMont (2009), "Using geology as the rationale for setbacks (if that's a planning tool of interest) will provide the principal legal argument for planners if a developer challenges the setback legislation in court. A short walk along the coastline provides the informed observer with all of the visual evidence required to justify coastal setbacks." Garth DeMont illustrated this point with highly visual slides and detailed descriptions of how varying geological compositions defined a shoreline's sensitivity to erosion. Garth's presentation on *Styles of coastal erosion* underpinned the workshop's case study scenarios (i.e., the mapping exercise), in which participants practiced locating coastal shoreline susceptible to erosion using layers of mapped data about geology and the built environment. The following outlines key points of Garth DeMont's presentation.

Karst terrain

Karst terrain is land that is prone or susceptible to sinkholes. Sinkhole development occurs in limestone and gypsum. These rocks are dissolved by surface water as it percolates down through fractures and voids, and circulating groundwater. Caverns developed in the buried rocks can collapse without warning, causing a sinkhole to appear at surface.

Sinkhole development is caused in part by periods of alternating wet and dry weather: a weather pattern projected for Nova Scotia's future. From the land use planning perspective, if development happens to be underlain by gypsum karst, the municipal risk is having the ground beneath a parking lot, backyard, or building literally fall. As well, planners should be aware that sinkhole development is of most concern when groundwater aquifers are over pumped. So planners must ask if karst terrain is present, where, what are the development patterns on that karst, and what thresholds for water withdrawal need to be established? Karst terrain is also particularly susceptible to groundwater contamination because surface water often has a direct path to the groundwater through the many voids in the bedrock. Therefore, any contaminants present at the surface can quickly be introduced into the groundwater. Also of interest to planners is the fact that finding a source of potable water in Kart terrain can be a challenge.

Heavy metals

Unstable climatic conditions where rocks and soils are saturated one week and dry the next exacerbate the risk of heavy metal transport into groundwater systems. The Goodwin *et al.* (2010) report, *Toenails, Tapwater and You: The Arsenic Connection* was shared with workshop participants as background resource material, and key messages from the report were presented at the workshop. The report states the following.

The most common arsenic-bearing mineral found in Nova Scotia is arsenopyrite, an iron-arsenic sulphide. Arsenopyrite is relatively soluble and highly mobile under

certain Eh-pH conditions. As a result of its solubility, arsenopyrite will readily break down liberating arsenic (and iron and sulphur) into the surface water or groundwater, regardless of whether or not an area has been subjected to mining activity.

Arsenopyrite is a very common arsenic-bearing accessory mineral that occurs in every gold district throughout Nova Scotia but also occurs naturally throughout Nova Scotia in rocks and soil: even in areas where mining has never occurred. Numerous regional soil and till geochemical surveys (i.e. Stea and Fowler, 1979; Woodman, 1994) demonstrate that arsenic is very common in these sample media and (mean) concentrations often exceed the Canadian Soil Quality Guidelines (CSQG) of 12 ppm arsenic (for residential, parkland, agriculture, commercial and industrial lands) (Goodwin *et al.*, 2010).

There are practices within the land use planning profession that could help to mitigate the risk of groundwater contamination from heavy metals such as arsenic. At the very least, information about the potential presence of heavy metals in the groundwater can be attached to a parcel of land at time of sale or redevelopment, but this practice does not currently take place for a variety reasons, not the least of which this information is not currently readily available. Another example of a link to land use planning and development would require water testing as a condition of subdivision or site development approval. Indeed, areas of concentrated heavy minerals *can be* identified on land-use planning maps to inform the development of protective covenants that restrict land-use activities. This identification would require the assistance of a geoscientist to interpret existing DNR data for areas where the land is or has been staked for metallic mineral exploration, because those areas have a good chance of having soils and bedrock that contain anomalous concentrations of heavy metals. The DNR Mineral Occurrences and Geochemical databases are also good sources of information for locating areas of elevated heavy minerals. Workshop participants agreed that efforts to mitigate risk would obviously be best accomplished in partnership with Nova Scotia Department of Environment (which has jurisdiction over wells) and the DNR that has relevant geological information.

Slope stability

According to pre-workshop surveys, slope stability is not generally a concern to municipalities around the Bay of Fundy. Nonetheless, it was explained to workshop participants to emphasize that a slope stability assessment is different than a coastal erosion assessment. Slope stability involves measurements of soil cohesion, friction angle, soil density and calculation of Erosion Hazard Limits. A geotechnical engineer must carry out slope stability assessments.

4.2.6 Changing the way geohazards are mapped (Laura Trudell)

Acid rock drainage is most common in the southern Nova Scotia mainland where it develops when mineralized slates are exposed to oxygen and water. The slates contain disseminated pyrite and pyrrhotite that oxidize when the slates are exposed to air, resulting in the production of sulphuric acid and iron oxides. Sulphuric acid is soluble: able to be carried by moving water into wells and other water systems, resulting in contaminated wells and/or the acidification of aquatic ecosystems.

The issue of acid rock drainage is largely not an issue for Bay of Fundy communities (though acid rock does occur in pockets). However, the climate change trigger (i.e. the anticipated increase in unstable conditions alternating between too dry (the time of oxidation) and too wet (the time of transport), is of interest in that this process creates ideal conditions for the release of heavy metals (e.g. arsenic) from rock into the aquatic/soil environment.

4.2.7 Activity: Using existing maps to assess geohazards - Case study scenario exercises

The afternoon mapping exercise focused on coastal erosion, as that topic provided a stage to consider sea level rise (as a contributing factor to storm surge and heighted wave energy) and development in the context of surficial and bedrock geological information. After Garth's presentation on Styles of Coastal Erosion, participants were broken into groups for the mapping exercise. Each group was given a suite of four maps, as well as tracing paper, markers, and the Decision Flow Diagram. The maps included information on surficial and bedrock geology, buildings (from which development density could be interpreted), roads, coastal flood risk based on elevation, the location of known wells (dug and drilled) and reported spots of saltwater intrusion.

Two areas of the Annapolis Valley were chosen as case study sites. Having two case study sites allowed for a comparison of climate change impacts involving different dominant rock types. While the first case study site focused on the general Windsor area, the second was located at the head of the Digby Neck. Softer surficial materials characterize the Annapolis Valley site while the Digby Neck area presents a greater presence of exposed bedrock. Two sets of four site maps were prepared in duplicate by DNR for each of the case study sites, for a total of 16 maps. The preparation and printing of these maps marked quite a financial contribution on the part of the DNR and Anne Warburton who shared in the printing costs.

Planners at the workshop were encouraged to join one of two case study groups representing the geology of the Digby Neck or the Annapolis Valley Minas Basin area. Not surprisingly, the more popular of the two case study sites involved the Minas Basin that focused on softer surficial materials and low lying developed areas.

Jacqueline, Laura, Garth and Anne designed a Decision Flow Diagram to serve as a key to guide participants through the process of identifying locations where concerns about coastal erosion are backed by geological evidence. A copy of the Decision Flow Diagram is found in Appendix F. This key provided planners with a process to guide their MCCAP teams in hazard site assessment. In fact, the development of such keys is now of interest to the DNR, Service Nova Scotia Municipal Relations, and Dr. Danika van Proosdij (Associate Professor in the Department of Geography and Maritime Spatial Analysis Research Centre at Saint Mary's University) as a means of facilitating a group through a hazard risk assessment process.

Each group had a mentor / guide to assist with the process. The mentors for the exercise were: Garth DeMont, Laura Trudell and Jacqueline Wightman (as a team), Graham Fisher, Danika van Proosdij (in Annapolis Royal only), and workshop participant Ken Adams, Director/Curator of the Fundy Geological Museum (at Bible Hill only). At the end of the day, Anne asked how participant's knowledge shifted or evolved over the course of the workshop, and the response was that the mapping activity was very useful and provided relevant experience and material that could be applied in preparing their own MCCAPs.

The second hands-on exercise of the afternoon was an introduction to Laura Trudell's research and an opportunity to look at and critique her map prototype illustrating acid rock drainage risk vulnerability. To facilitate this exercise, Laura first briefly introduced her research then asked participants to sign a "Consent to participate in Research Project" form from Dalhousie University. With consent forms signed, participants formed groups and each group was given a copy of the map and a few copies of an accompanying brochure (an complimentary item that was identified as important to have by Planners interviewed early in Laura's research). Participants were invited to write their feedback directly on the map. As well, each participant was given an evaluation survey form where they could detail their assessment of the mapping product for Laura's use. A copy of Laura's evaluation survey is found in Appendix G. It should be noted that Laura read all the evaluations provided at the February 7th workshop and responded by updating / further refining her map *before* the February 13th workshop. Thus, the attendees of the February 13th workshop were building upon feedback of the previous group. When a copy of Laura's final map product and accompanying brochure is released, workshop participants will be notified.

4.2.8 Changing precipitation and inland flooding case study (Anne Warburton)

The Town of Stratford in Prince Edward Island served as a case study for a climate-wise update of a stormwater management plan. The case study was shared at the workshop because it serves to illustrate the direct connection between climate trends and projections and infrastructure planning.

In 2012, the town of Stratford hired CBCL Consulting Engineers to complete a study on the impacts of climate change on stormwater management and to update the town's stormwater management plan that had been prepared in 2003. (CBCL Engineering 2012). The update was to reflect development through 2010 because the Town had grown quickly. As well, the update was to recommend Stormwater best management practices so that future development would not increase peak runoff flows in the drainage systems. In other words, the Town was seeking to manage water in such a way that their current drainage system would be adequate (to the extent possible) going forward.

This is interesting in the context of climate change because traditionally, design rainfall events (scenario rainfall amounts which are the basis of how big our culverts are) have been created using information from historical events as summarized in intensity-duration frequency (IDF) curves. If rainfall intensities are increasing due to changing climate, then past rainfall is no longer a good indication of what might be expected in the future.

CBCL was also asked to assess the effects of climate change on rainfall intensity and the impact of these projected changes on the stormwater management plan. This assessment required a new climate change-wise design rainfall projection to enter into their stormnet model to estimate runoff. They turned to Environment Canada's Meteorological Services Centre to simulate changes in 24-hour precipitation amounts in two global climate change models, and then to the extent possible, downscale results to Stratford.

Both global climate change models predicted that extreme values of the 24-hour rainfall would increase and then decrease again over the next 70 years. The models differed, however, in the magnitude and timeline of the projected increase.

The Canadian Climate Change Scenarios Network validated the results of the models for the Town so that CBCL would know which model results to use for design rainfall. This validation process revealed that the HadCM3 (Hadley Centre Coupled Model, version 3) produced results that most closely matched precipitation amounts *observed* at the Charlottetown airport for the time period associated with the historical information that was fed into the models.

Hydrotechnical engineers are not just interested in how much rain might fall in 24 hours, but also what is the rainfall pattern throughout the day. This kind of information is used to make IDF curves, but no global climate change model

provides sub-day durations. CBCL ended up looking at historically derived rainfall intensities for rain events less than 24 hours in length, and assumed that the sub-day duration pattern of rainfall would be similar in the future. This is referred to as the 'ratio' approach (CBCL, 2012).

CBCL entered projected rainfall data into Stormnet. Stormnet then simulated runoff. The runoff values were then used to assess upgrades required of the Town's existing drainage system. This assessment required physically measuring 77 culverts. The Town already knew that some culverts did not have the capacity to convey the estimated peak flows based on historical records, much less estimated peak flows based on the climate projections provided by Environment Canada.

With new runoff simulations based on future rainfall estimates, CBCL could now update the 2010 work and:

- redefine peak flows to be associated with potential future rainfall events
- estimate the equivalent pipe diameter of culverts required to convey the peak flows, and
- estimate the costs for culvert replacements to accommodate peak flows

Two strategies were recommended to achieve the Town's original objective of mitigating, to the extent possible, peak runoff flows in the drainage system (CBCL Engineering, 2012). The strategies included addressing water storage (i.e., natural or human-made ways to hold runoff) and allowing for a slower release of stormwater. As well, it was recommended that new development, or redevelopment of land, not be allowed to result in greater amounts of runoff than those that existed pre-development (CBCL Engineering, 2012) .

When considering water storage with a major drainage system, it is interesting to keep in mind that natural water channels tend to have capacity for a one in two year rainfall event based on historical records. Any volume beyond that has the likely potential of causing significant erosion and changing the shape and alignment of the channels, as well as carving out new channels (CBCL, Engineering, 2012).

Workshop participants were reminded that when taking climate change projections into consideration, natural systems are undoubtedly vulnerable to change and become increasingly vulnerable to overland flooding *unless* there is a means within that natural system to manage water. Culverts and bridges are examples of water management structures within a major drainage system. Typically, these structures have been designed to accommodate a 1-100 year rainfall, again, based on historical record.

CBCL's recommendation for managing stormwater in the minor drainage system stated:

> All structures with capacity less than the estimated maximum peak

runoff flows predicted by the modeling completed in this study should be upgraded: so culverts in poor condition should be replaced with larger culverts, or culverts that are in good condition, but not big enough, should be twinned with a second pipe where the combined capacity will be greater than the estimated peak runoff flows (CBCL Engineering, 2012).

For major drainage systems, there were four actionable recommendations (CBCL Engineering, 2012):

1. Examine each watershed in the Town, starting with the watershed where the potential risk of flood damage is greatest, and figure out
    a. if and where there are opportunities to increase the capacity for water storage/detention and
    b. if existing culverts and structures could withstand a 1 in 100 year return period rainfall as defined by simulated rainfall events modeled in the study.
2. Identify flood limits generated by the design rainfall event with a 1:100 year return period on Town and use planning mapping.
3. Conduct consultations with all stakeholders (including the Town, property owners at risk, and the Department of Transportation) and define an acceptable level of service for each system.
4. Develop a prioritized list of modifications to existing structures (like culverts), based on what they now knew about the condition and capacity of existing culverts, as well as stakeholder views on acceptable levels of flood risk.

4.2.9 When does an impact become a priority? (Anne Warburton)

As the MCCAP Guide (Province of Nova Scotia, 2011) explains, *how vulnerable* something is to climate change is a function of its exposure and sensitivity to stressors, climatic or not. Adaptive capacity defined as "initiatives and measures to reduce the vulnerability of natural and human systems against actual or expected climate change effects" (Province of Nova Scotia 2011) has always been an inherent part of land use planning, but focusing on this concept as a means of improving strategy development, is a relatively new endeavor.

A 5-step process used in Saanich, British Columbia and Kings County Washington, USA, (Stantec Consulting Limited, 2012) for prioritizing adaptation actions, was introduced to workshop participants as an example of how to consider adaptive capacity in climate change planning. In the first step, the process involves ranking the severity of potential impacts and their probability of occurrence (i.e. a traditional risk heat map) and completing a Capacity Assessment. The Capacity Assessment asks two fundamental questions: how easily can we prepare for this, and is there a natural ability to absorb the impact. The assessment also provides a potential list of adaptive actions to mitigate identified impacts.

In the second step of the process, an urgency assessment is done. This recognizes that if a municipality's risk is high, and their adaptive capacity is low, issues are classified as highly urgent. But if risk is high and adaptive capacity is high, then an issue is not as urgent. Of interest to workshop participants was the timeline provided to define urgency. A high urgency rating required immediate initiation to understand the impact and develop appropriate responses that would be undertaken within 1-3 years of the final deployment of the Adaptation Plan. A medium urgency rating would require the initiation of the action in 3-10 years. A low urgency rating would suggest that there is no need to act within the next 10 years as the risk is low or there is a lot of capacity to absorb the identified impact.

The third involves vetting the results of the urgency assessment with staff to make sure there was agreement followed by prioritization of impacts. Prioritization is based on the urgency of the impact and each action's "threat reduction potential" (i.e., a measure of the action's ability to reduce the risk of damage to buildings, economic conditions, and/or disruption to segments of the population).

This process captured the interest of many workshop participants. Basically, the process simply took further the prioritizing they were already working on through their own MCCAP development. The completion of the hazard impact matrices by the municipalities under the MCCAP process constitutes the first step of the above-presented 5-step process. The second step, the Capacity Assessment, is of particular interest because the current MCCAP framework touches on adaptive capacity only lightly, and not in way that could clearly be used to inform the selection of adaptation options. For that very reason, Kyla Milne, an Adaptation Specialist with NS Environment's Climate Change Directorate, has been working on developing a tool to help municipalities understand how socio-economic characterizations shape

vulnerability and adaptive capacity. The intent of the tool is to offer an informed method to answer capacity assessment questions. In other words, the socioeconomic tool currently being developed aligns with the second step of the 5-step action prioritization process introduced at the workshop and for this reason, the forthcoming socioeconomic tool was introduced to workshop participants.

Through the use of carefully selected indicators, the tool aims to highlight community characterizations that contribute to an impact becoming an issue. The work is premised on a two ideas: it is possible to lessen social vulnerability, improve adaptive capacity and strengthen community qualities that generally characterize resilience, and it is possible to ID attributes (qualities) of community vulnerability to climate change.

What the NS Climate Change Directorate has been exploring (winter of 2013) is, whether or not there are key attributes/qualities that should be included in any and all understandings of adaptive capacity. As well, it has been examining the core (i.e. essential) indicators to track and measure over time because they influence the ability of a community to respond to threats, changes and shifts related to change (climate-related or not).

Research for the socioeconomic tool evaluated over 100 indicators that were discussed in literature and research pertaining to adaptive capacity and social vulnerability. The aim is to reduce this long list to a core list of indicators that can manageably be researched and tracked. Each indicator will have an accompanying metric for assessing the community's status, along with data sources where information can be located. As well, there will be a description on how performance on each indicator can be viewed through the lens of general community characterizations: scenarios that aid in the interpretation and understanding of the communities socioeconomic trends, and desired future.

As indicated by Wilson and Ralston (2006), as a decision maker it is important to be specific about which aspects are of future concern to an organization, and then determine what the organization can do with that information. Every organization must ask three important questions:

- What critical uncertainties face the organization?
- What major strategic decisions do you have to make?
- What do you need to know about the future in order to make these decisions?

Discussions generated by these questions would reveal insights into adaptive capacity, threat reduction capability, and the consideration of climate trends. A powerful structure for exploring these questions is scenario planning, and the Climate Change Directorate will in future, provide interested municipalities with guidance and/or training on the intuitive logics scenario planning model to enhance organizational adaptive capacity.

4.3 Workshop Participants

The BoFEP Climate Change Workshop at Bible Hill was held on February 7th. Another workshop was held in Annapolis Royal on February 13th. There were thirty-two and eighteen registrants, respectively. Participants were primarily municipal and elected staff. A list of participants can be found in Appendix G.

4.4 Workshop Products

The BoFEP climate change contract required specific products be delivered, including:

- A review of key background reference material;
- The design, organization, hosting and facilitation of two workshops;
- Provision of all needed reading, reference/resource materials used in workshop scenarios/interactive sessions to workshop participants;
- Provision of a list of useful resource/reference materials for use by municipalities in Steps 2 and 3 and subsequent steps of the guideline process;
- The design of a pre-workshop survey and participant workshop evaluation form;
- A summary of workshop evaluation results; and
- The preparation of an article about the workshops for the BoFEP newsletter, *Fundy Tidings.*

The review of key reference documents is contained in 3.0 Literature review. A summary of the workshop content and an overview of presentations is provided in section 4.0. The many resources specifically gathered in support of the BoFEP climate change workshop and MCCAP development are provided online via the Climate Change Directorate's webpage: http://climatechange.gov.ns.ca/content/impactsWorkshop. Appendix H provides a list of documents available at this site.

Copies of the pre-workshop survey and evaluation form are included in Appendix B and I respectively and a description of evaluation results is provided below. The *Fundy Tidings* article is provided in Appendix J.

4.5 Workshop Generated Ideas

'Posters' were spaced around the room to capture participant's thoughts and questions throughout the day. Numerous sticky notes and markers were available at each table so that at any time a person could record a thought and post it for communal use or consideration.

One poster was specific to MCCAP action items: ideas for action items in response to the hazards and impacts being discussed. Another poster was titled, "Things I want to know/learn more about." At the Bible Hill workshop there were also posters for each hazard being addressed in workshop presentations, and participants were invited to post hazard-specific impacts as they occurred to them. Because these hazard-impact posters were the least used at Bible Hill, and because there was very limited wall space in Annapolis Royal, the hazard-impact posters were not repeated at the second session. Ideas recorded on the posters for MCCAP action items and learning follow-up are provided in Table 3.

Table 3 Workshop generated ideas for MCCAP action items and further learning

Example MCCAP action items
Flood proofing requirements for development in marshbodies and bordering
Get downscaled design rainfall data from Environment Canada
Educate residents regarding home insurance and federal disaster assistance. Partner with the IBC.
Back-water / surcharge valve programs
Update EMO hurricane / stormsurge response plan
Map land uses existing behind all dykes in the municipality. Identify areas where flood boundaries overlap/exceed zoning.
'Zone in' and collect information (baseline data) in critical areas at risk.
Make it a practice to mark and record high water levels during storm surge / flooding
Update building codes
Urban tree / forest management program for shade and flood mitigation, and to reduce downed trees during storm
Land use overlay zoning (based on floodplain management strategy)
Locate aggregate quarries
Detailed coastal erosion assessments for high risk, developed areas
Realign / update marshbody boundaries
Dissallow further variances in designated marshbodies
Things I'd like to learn more about
What is the possibility of storm surge happening at high tide? *
Is it okay to do a high level scan of all potential hazards and then focus most of the MCCAP on the folding challenge in the Plan because that's the data you have? Then acknowledge other areas will be reassessed in more detail later?
Is there any merit to requiring not a zero net objective (runoff) but a -10% requirement (for example) in order to build added capacity for existing parts of that won't develop?

4.6 Workshop Evaluations

The evaluation for the BoFEP workshop mirrored the agenda, asking participants to rank each presentation/session. A copy of the evaluation is found in Appendix I. A four-point scale was used to gauge the usefulness of the workshop to the MCCAPs of

participants. The scale was: 1) very useful, 2) will directly inform / confirm MCCAP work, 3) somewhat useful, 4) not directly applicable to MCCAP work, and 5) undecided. Most sessions scored a one across the board. A handful of evaluations scored two sessions as a two (i.e. the Relevance of a historical perspective and Dykelands in the Bay of Fundy). Participants expressed the afternoon mapping activity as a clear highlight.

Table 4 Evaluation results summarized

Presentation / exercise	**Approval rating** Scale: 1 (best) to 3 (not applicable)
Framing the day: Assessing climate trends & our perspectives on MCCAP Development	1
The relevance of a historical perspective	1.2
Dykes in the Bay of Fundy: Introduction to recent research	1.2
Linking climate change and geohazards	1
Styles of coastal erosion	1.8
Activity: Using existing maps to assess geohazards	1+
Activity: Changing the way geohazards are mapped	1.9
Changing precipitation and inland flooding: case study	1.8
When does an impact become a priority?	1.8

5.0 Analysis

5.1 Workshop Benefits

The climate change workshops provided a forum and opportunity for municipalities, experts planners, geologists, ecologists, engineers and other municipal and provincial staff to discuss and obtain guidance on the initial stages of MCCAP development. They learned what is meant by the terms risk and vulnerability in the context of municipal climate change planning, how to identify climate change hazards, impacts and areas affected and to prioritize issues that warrant further study and adaptive action. Participants also received information on current climate change research, projections and trends, and available tools, resources, and maps to support the design of an MCCAP for their own municipality. Most importantly, an interactive scenario exercise provided practice in identifying areas along Bay of Fundy shores anticipated to be most vulnerable to erosion using map overlays and a key /decision flow process: tools that municipalities can later apply to their own area/situation.

5.2 Workshop Evaluations

All participants were outwardly satisfied by the usefulness of the workshop, direct relevance to the MCCAP, and ability to convey relevant information to key

stakeholders (e.g., Council members or MCCAP team members) who were brought to the workshop. The evaluations showed strong consensus that focusing on geohazards made sense, and the hands-on mapping activity was *very* well received.

The presentation on *The Relevance of a Historical Perspective* was based on a thesis proposal and thus it was a bit unclear if and how a municipality could *apply* the same or similar method proposed, and if there was any clear benefit of investing the time to do so (relative to a quicker approach).

Dykes in the Bay of Fundy and *Styles of coastal erosion* were excellent presentations based on sound science. The 1.2 and 1.8 rankings, respectively, are indicators of success, but also perhaps evidence of overwhelming participants with information. It should be noted that the applicability of the information in *Styles of Coastal Erosion* became evident during the afternoon mapping activity.

The activity, *Changing the Way Geohazards are Mapped* was likely ranked the lowest (1.9 out of 3) not because it wasn't interesting to the Planners, but because it wasn't directly applicable to their MCCAP in the near-term (by end of 2013). The investment of time by the planning community in the group discussion about how to change geological mapping to make it more useful in the land use planning and development context, goes beyond the MCCAP.

The case study on *Changing Precipitation and Inland Flooding* demonstrated what could arguably be a MCCAP action item i.e. the climate-wise updating of a stormwater management plan using downscaled design rainfall data and best management practices for net zero peak flow. While it could be argued that simulating runoff for design rainfalls (plausible rain events) is a prudent way to truly assess the hazard of shifting return periods for short intensity rainfalls, it is unlikely that a municipality can secure the budget and time to conduct this exercise before the MCCAP is due (December 31st, 2013).

The final presentation dealt with prioritizing impacts and action ideas, as well as incorporating socio-economic information in that process. The rank of 1.8 (as opposed to a 1) may reflect the lack of time (and participant energy) at that point in the day to discuss the merits of the presented methods. As well, the prioritization scheme shown focused on prioritizing actions. While the MCCAPs *do* need to list and adaptation options, they are not required to provide thoughtful evaluation or prioritization of these ideas. While it would be beneficial to do so, the lack of requirement makes such an effort unlikely in the MCCAP 2013 timeframe, and thus the method proposed less of interest.

The socio-economic component of the last presentation reviewed provincial work underway to provide guidance on how to include socio-economic information in impact assessments and adaptation strategy development. Although the work provides a much needed framework for considering social and economic characterizations and issues within the MCCAP (and is the focus of Steps 5a and 5c),

there is resistance to new / more 'guidebooks' and 'frameworks' due largely to organizational capacity issues.

5.3 Workshop Format

In the past 4 years BoFEP has hosted a series of workshops focusing on environmental issues of interest and concern to municipalities. The 2010-11 workshop focused on Impacts and implications of land-based activities on water quality and mechanisms to reduce the risk posed by chemical contaminants in runoff. The 2011-12 workshops emphasized Mitigating Impacts of Stormwater, Wastewater and Pharmaceuticals in the Environment. Both workshops were well attended and feedback was very positive. The evaluations of these workshops and the climate change workshops of this year are proof that a hands-on, exercise-based approach to capacity building for municipalities is a well-received model to workshop design, and effectively achieves learning objectives.

5.4 Workshop Organization/Logistics

While rankings for all presentations indicated a strong degree of participant/client satisfaction, there were a few ways in which the workshop could have been improved logistically. Despite the fact that land use planning is a profession that relies on and often requires public engagement, the municipal audience as workshop participants is seldom interactive. The use of the posters on the wall to collect information was largely unsuccessful in that people simply focused on listening and taking notes, but did not record their ideas/insights publicly. Thus, the desire for the posters to create participatory leadership required a greater attention by the workshop coordinator/host than was given. For example, dedicated time for each person to write one idea for an MCCAP action item, or one topic which they would like to learn more about, would have been the best way to capture such input. Leaving it them to do 'as inspired' throughout the day did not work.

Secondly, the evaluation form could have been used to ask for additional workshop ideas or ways in which the workshop could have been improved. Instead, the evaluation focused merely on the degree of usefulness of the presentations and activities. As well, it would have been a means of asking what additional information/resources would be useful for MCCAP Development and what should be the topic of future workshops.

Third, the means of advertising the workshop was very specific to municipalities, as this was the target audience. Although Emergency Management Coordinators *are* municipal staff, only a small number of these professionals were in attendance. The question remains, is there a list server that goes to municipal Emergency Management Coordinators that could have been accessed? As well, the initial invite should have been more explicit with the idea that entire MCCAP teams were welcomed and encouraged to come.

5.5 Additional Support and Research for Municipal Climate Change Action Planning

Municipal needs for additional resources to support MCCAP development and implementation were confirmed and/or revealed during workshop research (literature review and conversations with subject experts), discussion during the workshops, and post-workshop conversations. This section attempts to summarize some of the issues creating the need for additional resources.

5.5.1 Water level data

When reviewing climate trends and projections early in the workshop agenda, questions arose about probabilities associated with water levels. For example, the water levels provided in the Richards and Daigle report (2011) include: Total Sea Level, Extreme Total Sea Level, and Plausible Upper Bound. Both the Extreme Total Sea Level and the Plausible Upper Bound water levels are based on storm surges for various return period storms happening at high tide. What planners are trying to understand is, what is the *probability* that those storm surges *would* happen at high tide as opposed to lesser tide levels. For example, if a storm surge is anticipated to be two feet, what storm surge return period is a surge of that height associated with, and what is the probability that surge would occur at Higher High Water Large Tide (HHWLT) versus low tide, or somewhere in between? Additionally, the water levels provided in the Richards and Daigle report are provided in Chart Datum. The need to convert this data to Canadian Geodetic Vertical Datum 28 (what land use maps are based on) was mentioned to municipalities, but from experience, Anne Warburton has discovered that most Planning/GIS technicians do *not* have the needed information to make these conversions. As well, the information needed to make the conversions is not easily found. Therefore, guidance specific to this issue is of great importance.

5.5.2 Dyke vulnerability assessments

Related to water levels are questions about dyke vulnerability. The mere extent of ACAS research devoted to this issue is evidence of its importance to the Province. To date, most dyke vulnerability research has been focused on ACAS communities / study sites. This means only a fraction of the 364km of dykes in the Province have been assessed. Municipalities with dykelands that were *not* ACAS communities have limited guidance on how to determine if dyke vulnerability warrants attention or not. This fact became clearer during Danika van Proosdij's presentation at the BoFEP climate change workshops.

5.5.3 Response to municipal questions

Under ordinary circumstances, it is likely that municipal staff and MCCAP teams work individually to seek out answers to their climate change questions. Undoubtedly, multiple municipalities are asking the same questions and all are

investing time and money in seeking out the same/similar answers. Climate change workshops hosted by BoFEP, SNSMR, and other groups provide forums for these questions to be aired. Ideally, the workshop host or presenters will be able to answer the questions, or could assign a committee to get back to participants with the answer to questions posed.

5.5.4 Ongoing research monitoring and interpretation

Although efforts to lead climate impact and adaptation research in the province is led by NS Environment Climate Change Directorate, and the application of this research is led by SNSMR, neither Department is currently structured to provide ongoing monitoring for and interpretation of climate impact and adaptation research. While multiple non-government organizations are positioning to fill this void, a science-based (not policy-based) organization would be best, with some reliance on organization members or consultants to translate the information into land use planning terms and practices.

5.5.5 Digital forum for posting questions and research products

There is also an absence of a central forum to enable municipalities to digitally post questions of mutual interest and receive responses. Such a forum could prove beneficial to all municipalities and also be used to notify municipal members of product or research releases (e.g., new maps from DNR, updated elevation levels of dyke segments, socio-economic scenarios to assist with adaptation strategy development). BoFEP has assembled a reference library that is currently hosted by the NS Climate Change Directorate. However, what would be ideal is a non-government science-based group like BoFEP supporting a more *interactive* site.

One group that would use such a forum for notification of product release is the Nova Scotia DNR. The DNR Geological Services Division is poised to provide a variety of interactive, web-based applications for geohazard interpretations and emergency management planning, mitigation, response and recovery. Unfortunately, the timing is such that these tools and data are not yet available, nor will they be before the MCCAP is due. There are significant budgetary and staffing issues delaying the creation and release of these much-needed products. This is causing frustration amongst both municipalities and provincial employees. Other non-government organizations, such as the Atlantic Coastal Zone Information Steering Committee (ACZISC), may be in a better position to respond to municipal (and provincial) needs with storage of spatial data or completed mapping projects once it is understood what those needs are. That being said, many municipalities have the capability to create data layers themselves, or at least the ability to collect data that could be 'fed' to the Province to enable a province-wide spatial analysis of an issue. In recognition of this fact, one workshop participant suggested the province develop and share mapping protocols, and data collection protocols specific to impact themes. For example, if municipalities are willing to survey residents about water quantity issues in dug wells, this information could be shared

with DNR hydrogeologists to confirm water quantity trends and patterns, and identify needed provincial actions. The commitment to create a mechanism for specific data collection with the intent of sharing it with the Province would be considered an MCCAP action.

5.5.6 Building capacity and knowledge of adaptation options

While the bulk of the MCCAP effort is based on identifying impacts and hazards in 2013, step six of the MCCAP Guide requires a description of priority action areas and a preliminary list of adaptation options. There is a breadth of opportunity to build capacity and knowledge on impact specific adaptation options and regional adaptation themes. As well, there is an opportunity for the Province to provide leadership on methods for determining what priority actions are.

5.5.7 Consideration of Socio-economic indicators in climate change action planning

At the ACAS conference in March of 2012, Kyla Milne of the NS Climate Change Directorate received significant positive feedback for her presentation on the importance of considering socio-economic information and scenarios in climate change action planning. In winter of 2013, an Experts Workshop hosted by the NS Climate Change Directorate 'tested' the influence of the use of socio-economic indicators when generating adaptation options in response to provided (hypothetical yet plausible) climate impact scenarios. Anne Warburton was part of this workshop and thus was able to introduce this element of climate change action planning into the BoFEP climate change workshops. In essence, socio-economic realities and projections have a role in determining if and when an impact becomes an issue. Anne's presentation on the prioritization tool for *actions*—as opposed to impacts—generated interest during the BoFEP workshops.

5.6 Workshop Follow Up

Since the completion of the workshop, several participants have been in contact with contracted organizer, Anne Warburton. The main reason is to request map data/layers as were used during the workshops afternoon mapping activity. These requests have been passed along to the DNR, and an online discussion has ensued about the availability of certain layers of data that were used in the workshop maps. Unfortunately, the DNR will not likely release most of the information presented to workshop participants soon enough for the data to be included in the MCCAPs. The Department is developing an on-line interactive mapping application, and is planning on releasing the data layers as part of that application in late autumn of 2013. The Department's intent is that the data will also "eventually be available for free download (Brian Fisher, Manager Information Services and Environmental Geology Mineral Resources Branch, Nova Scotia Department of Natural Resources, pers. comm., March 2013). Part of the reason the information has not yet been released is they are diligently considering potential political, economic or legal consequences of this data being misused/misinterpreted in the public sphere. There

have also been staffing shortages. As well, there was a concern that in its present form, few could make use of the data (i.e. only Geomatic Information System Technicians with specific software). On a positive note, post-workshop conversations about the need for access to the coastal flood risk layer (which was used at the workshop) has prompted an early (April) release of the data that will be useable by municipalities with GIS capacity.

Another follow-up question asked about the probability of a storm surge during a high tide. Anne Warburton is working to collect information that answers this question and will synthesize it into a digestible format to share with all participants via email.

Anne Warburton was also contacted for additional information about the case study she presented on climate-wise stormwater management planning. Specifically, the participants who followed up on this presentation wanted to be put in touch with the Town of Stratford, Prince Edward Island, where the case study was based. The current discussion prompted by this case study is about how by-laws will reflect the stormwater management plan. Given that the Town of Stratford's Council only adopted the updated stormwater management plan in January 2013, the Town has not yet developed the policies and any required bylaw amendments to implement the plan. Robert Hughes, Chief Administrative Officer for the Town of Stratford stated that, "We are developing a new Official Plan, based on our sustainability principles, and we are using the stormwater management plan (as well as the climate adaption plan, sustainability plan, housing demand study, master transportation plan based on sustainability principles etc.) as resources to inform new Official Plan policies and implementing bylaws amendments. Our intent, I believe, is to require the stormwater management plan to be completed at the subdivision approval stage and then again at the individual lot phase only if they are doing something that would alter the original design stormwater flow and storage in any significant way."(Robert Hughes, pers. comm., February 14, 2012).

5.7 Potential Opportunities for BoFEP Involvement

A logistical issue that has arisen since the workshops deals with NS Environment Climate Change Directorate hosting workshop reference materials. Due to Departmental reorganizations, the longevity of this site is unknown and therefore, BoFEP has offered to also host these materials on its website. Should the NS Environment Climate Change Directorate be removed, workshop participants will have to be contacted and invited to visit the BoFEP website for downloading resources relevant to the February workshops in support of steps two and three of the MCCAP Guide.

Public education is needed on the topic of natural disaster planning, to cover socio-economic consequences of disasters to communities and the availability of disaster relief insurance and financial assistance. This idea was raised during a workshop

plenary discussion and was seen as important topic for future workshop consideration.

A general follow up item that exists aside from specific questions and issues that have arisen since workshop completion, is the fact that the municipalities will still have quite a bit of action planning to do after their MCCAPs. The MCCAPs position municipalities for detailed action planning in that they identify what the actions need to be addressed and where. Therefore, the Province, perhaps in partnership with groups like BoFEP, has an opportunity to support discussions about MCCAP implementation: how to mainstream adaptive practices and decision-making.

6.0 Recommendations

6.1 Recommendations for BoFEP in Supporting Municipal Climate Change Efforts

1. Revive the dormant BoFEP Coastal Development working group and modify it to a *Coastal Risk Vulnerability* group (or similar title) with a focus on interpreting and providing summaries of climate impact and/or adaptation research that contributes to municipal and provincial efforts in natural hazard risk vulnerability assessments. BoFEP's credibility as an ambassador of science positions BoFEP to be a host site for, and disseminator of existing and forthcoming climate science information on topics of:
    a. Projected water levels for the Bay of Fundy, including changing resonate periods, and taking into consideration latest research (e.g., IPCC's 5th Assessment Report and BIO publications)
    b. Updates on forthcoming modifications to Chart Datum *and* a host site for information required to convert chart datum to Canadian Geodectic Vertical Datum 28 for all tidal gauges in the Bay of Fundy-Gulf of Maine system
    c. Dykeland vulnerability research, in partnership with the NS Climate Change Directorate, St. Mary's Geography Department—via Dr. Danika van Proosdij, and NS Department of Agriculture, Land Protection Section, Agriculture and Food Advisory Services
2. Leverage existing partnerships with ACZISC and ACCESS to encourage the development of practical tools /resources (e.g., GIS data layers, analysis and comparison of coastal adaptation strategies, guidance documents on how to assess when and where a particular strategy is most appropriate)
3. BoFEP's workshops offered to municipalities between 2010 and 2012 and these climate change workshops are proof that a hands-on, exercise-based approach to capacity building for municipalities is a well-received model for workshop design, and effectively achieves learning objectives. It is recommended that BoFEP continue to apply this model in all future workshops that it offers.
4. Pursue funding for a 2014 workshops focused on the exploration of adaptation

options specific to emergent themes from the priority areas for adaptive action as identified in the MCCAPs.

6.2 Recommendations for the Provincial Government

1. Develop and distribute directly to municipalities mapping protocol so that municipal mapping done in the context of climate change action planning can be assimilated into a larger provincial database and used seamlessly for subject analysis to inform provincial climate change efforts (i.e., identify data gaps, municipal needs, and areas of priority action to ensure public safety and opportunities for community wealth)
2. Budgetary support (i.e., staff and operating) so that NS Department of Natural Resource's vulnerability and risk assessment products and tools are completed is *critical* to fostering community and provincial resilience for inevitable natural disasters
3. Service Nova Scotia Municipal Relations, the NS Department of Agriculture, Land Protection Section, Agriculture and Food Advisory Services, and the NS Environment Climate Change Directorate needs to increase partnership with academic institutions (e.g., St. Mary's Geography Department, NSCC COGS) to lead and support municipal-public conversations about flood risk, flood risk tolerance, and flood mitigation options in dykelands.
4. Program and policy support within SNSMR and NS Environment for hosting or financially contributing to capacity building around adaptation options for priority adaptation areas as identified in the MCCAPs.
5. Policy and program support within SNSMR and NS Environment for skills training around adaptation strategy development (e.g., scenario planning, processes for the prioritization of adaptation actions)
6. Partner with the IBC on a public education campaign regarding homeowners insurance and disaster financial assistance
7. Policy and program support within Service Nova Scotia Municipal Relations and NS Environment Climate Change Directorate in the form of a *commitment to and framework for* climate change action plan *implementation and monitoring* is *critical* to fostering community and provincial resilience, no matter how the future climate unfolds.

6.3 Recommendations for the Municipal Government

1. Ensure that mapping created during the MCCAP process aligns with provincial mapping protocols so that data can contribute to a larger provincial database and used seamlessly for subject analysis to inform provincial climate change efforts (i.e., identify data gaps, municipal needs, and areas of priority action to ensure public safety and opportunities for community wealth)
2. Pursue funding from nontraditional sources (e.g., HRDC and health organizations) for the study and inclusion of socio-economic indicators as a means of informing adaptation strategy and a monitoring program

3. Create an information collection system to which citizens could report water shortages (i.e., dry wells) or saltwater intrusion, and provide this information to the NS Department of Natural Resources (e.g., hydrogeologists John Drage and Gavin Kennedy
4. Prepare to cost-share and host public engagement on flood risk, flood risk tolerance and flood mitigation options for dykelands or low lying (frequently flooded) areas
5. Prepare to cost-share dyke upgrades (e.g., realignments, restoration of foreshore, heightening of constructed elevation)
6. Make it a regular practice to tell Environment Canada's Meteorological Services Centre (i.e., Bob Robichaud) of experienced water levels during storms to inform their storm surge prediction model
7. Ensure that MCCAP action items are 'main streamed' into existing daily operations, decision making processes, and annual budgeting processes

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Appendix A: Resume of Contractor

Anne Warburton, B.Sc., M.Plan, LEED Professional

Director, Elemental Sustainability Consulting Ltd.

EDUCATION

Master of Land Use Planning
Dalhousie University, Halifax, Nova Scotia, 2004
THESIS: *Examining Utility-Scale Wind Energy Development in Nova Scotia; A Planning Perspective*

Bachelor of Science in Recreation, Parks and Leisure Services—Natural Resource Management
Minnesota State University, Mankato, Minnesota, 1994

Bachelor of Science in Speech Communications
Minnesota State University, Mankato, Minnesota, 1994

EXPERIENCE

Director, Elemental Sustainability Consulting Ltd., Halifax, NS, 2010 to present
Co-founder and Director of a consulting company focused on municipal climate adaptation planning, leadership development, sustainability and organizational learning. Projects within the last two years include, but are not limited to:

- Implemented a collaborative, climate-savvy hazard and impact risk assessment process for the Town of Truro and County of Colchester based on an emergency preparedness plan prioritization tool, and simultaneously investigating the intersection and divergence of municipal and emergency planning.
- Designed municipal climate change workshops on behalf of the Bay of Fundy Ecosystem Partnership. Workshops will focus on geohazards and how to infuse socio-economic considerations into the selection and prioritization of climate change adaptation options.
- Working with the Climate Change Directorate for the development of a municipal 'tool' that facilitates the use of socio-economic indicators in the development of climate adaptation strategy.
- Co-host of an Adaptation Planning webinar series funded by the Climate Change Adaptation Fund, focused on tools for and case studies of hazard and impact assessments, and plan implementation.
- Researcher and lead author for the development of a community guidebook on ways to use socio-economic indicators and scenario planning alongside climate scenarios when conducting climate change impact assessments and developing adaptation plans.

- Authored the *Municipal Climate Change Action Planning Assistant* on behalf of Service Nova Scotia and Municipal Relations; a guidance document for municipalities as they undertake a provincial requirement to develop climate change action plans.
- Presented at four provincial workshops with Service Nova Scotia Municipal Relations, clarifying the Municipal Climate Change Action Plan requirement and introducing the resource document, the *Municipal Climate Change Action Planning Assistant.*
- Served as a Mentor to a municipality for the development of a Municipal Climate Change Action Plan in order to further inform and define the Province's role in supporting local plan creation and implementation, as well as evaluate and facilitate municipalities' use of climate change research available through the federal-provincial program, Atlantic Canada Adaptation Solutions Program.
- Worked with the Municipality of the District of Chester to introduce scenario planning as a decision-making tool for the evaluation and prioritization of climate adaptation responses in the context of long-term infrastructure investments and improved community adaptive capacity.
- Guest lecturer for Dalhousie University's Graduate School of Marine Affairs Management Program regarding scenario planning as a tool for adaptation planning at the local government level.
- Conducted a Climate Change Impacts and Vulnerabilities Assessment for Fisheries and Oceans Canada (DFO). Interviewed DFO sectors (Coast Guard, Canadian Hydrographic Service, Real Property and Safety Services, and Small Craft and Harbours) to determined perceived climate impacts to core operations, and synthesized results in a working paper serving as a basis for DFO's National Climate Risk Assessment.
- Analyzing identified DFO sector impacts against climate trends and projections provided by DFO Science to validate anecdotal accounts of climate impacts and identify areas where science-based research is most needed to support adaptation efforts for the continued provision of DFO services.
- Designed a hands-on workshop for the Cheticamp Annual Tourism Summit to demonstrate the use of scenario planning for identifying and prioritizing climate-related concerns in business planning.
- Developed a "Registration to Certification Action Plan" for Transportation and Infrastructure Renewal, concerning LEED project files whose certification process has stalled.
- Facilitated business and cooperative governance planning for the Off the Hook Cooperative.
- Project Manager for Carbon Management and Electric Neutrality for Windhorse Farm, involving research for and acquisition of a system design for a 30kW net-metered solar photovoltaic installation, managing the upgrade of off-grid systems, developing a plan for mitigating space and water heating demand, and the authorship of a funding prospectus.
- Presented to three HRM Watershed Advisory Boards on how to apply the Canadian Green Building Council's LEED green building rating system to their planning and development reviews and recommendations.

Sustainability Planner, Stantec, Dartmouth, NS, 2008 to 2010
Responsible for developing business in the realm of climate change adaptation and greenhouse gas emissions mitigation. Secured the company's first contracts related to climate change adaptation, including original work on behalf of Atlantic provinces to secure climate adaptation money for Natural Resources Canada (what later became the ACAS program). Contributed to greenhouse gas emission inventories, audits and mitigation plans. Completed the company's first Integrated Community Sustainability Plan (ICSP), and assisted with six others throughout Atlantic Canada. ICSP work included formally amending Municipal Planning Strategies and Bylaws, and designing and implementing public engagement strategy. As well, designed and facilitated numerous community

workshops across Atlantic Canada on behalf of municipalities participating in the Partners for Climate Protection program.

Climate Change Specialist, Climate Change Unit, Environment Canada, Dartmouth, NS, 2005 to 2008
Lead climate change specialist for two key files of the Climate Change Unit Atlantic: Climate Change Education and Biomass. Education highlights included coordinating and largely authoring Environment Canada's contribution to an Environmental Science Grade 12 textbook for the province of Newfoundland and Labrador, managing the design and development of a large interactive Climate Change display for the Gros Morne Discovery Centre in partnership with Parks Canada, and managing community files for the One Tonne Challenge. The biomass file involved researching, and managing contracted research regarding Nova Scotia's biomass potential, and analyzing potential impacts to Atlantic Canada from federal biofuel and other energy-related policies.

Energy Issues Coordinator, Ecology Action Centre, Halifax, NS, 2004-2005
Responsible for the developing, supporting and disseminating the energy policy positions of Nova Scotia's largest non-profit environmental organization. Provided numerous media interviews (print, tv and radio) regarding the need for an Efficiency Nova Scotia agency, proposed changes to electricity rates and regulations, and federal and provincial climate change initiatives. Researched demand side management practices, analyzed the testimony and evidence of Nova Scotia Power Inc., and cross-examined witnesses as a formal intervenor during a public hearing to increase electricity rates and change regulations.

Energy Policy Research Assistant, Whale Lake Research Institute, Halifax, NS, 2004
Researched the implications of Nova Scotia's changing energy policy to land use planning, and the role of planning in utility scale wind energy development. Pulled together a research team and assisted with research to assess agricultural and woody biomass potential for a private developer and the Nova Scotia Department of Energy.

Public Program Coordinator, University of Wisconsin-Stevens Point, Treehaven-Biological Field Station, WI, 1994-1999
Developed the public education component of a University education centre to the extent that my position evolved from naturalist-intern to full-time program coordinator with twelve support teaching staff. Participants ranged from preschoolers to seniors and came from diverse backgrounds. Managed budgets, program design and staff for collaborative grants between education centers, government departments, non-government organizations and private business.

Appendix B: Pre-workshop Survey

BoFEP MCCAP Workshop Survey

The Bay of Fundy Ecosystem Partnership (BoFEP) is offering a one-day working session to support MCCAP development. We'll discuss ways to deal with geohazards in the hazard impact matrix and provide applicable resource material.

Please help us make sure the hazards addressed at the working session are of interest to you and the resources compiled are what you need by completing this brief survey. You may find that you need to save the survey once completed, then attach it to your email reply: awarburton@elementalsustainability.com

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1. To what extent has your municipality already assessed climate-influenced hazards and impacts? (check)

☐ not at all ☐ cursory beginning ☐ half done ☐ nearly done

2. Please rank the following hazards based on their importance to your municipality. (1 being most important and 8 the least important. If you dont know, leave blank.)

storm surge / coastal flooding	inland flooding / flash flooding
coastal erosion	drought
surface / groundwater contamination	land slides / slope stability
karst (sink holes)	other:

3. Please indicate which hazards you'd like to know more about. (check)

☐ storm surge / coastal flooding	☐ inland flooding / flash flooding
☐ coastal erosion	☐ drought
☐ surface / groundwater contamination	☐ land slides / slope stability
☐ karst (sink holes)	☐ other:

4. To what extent are you comfortable / confident evaluating risk for the following hazards? (1 being not at all; 2 being somewhat confident we can figure it out; 3 being completely comfortable)

storm surge / coastal flooding	inland flooding / flash flooding
coastal erosion	drought
surface / groundwater contamination	land slides / slope stability
karst (sink holes)	other:

5. What resource materials / data are most needed by your municipality to skillfully assess impacts related to changing storm surge return periods (coastal flooding) and precipitation changes (inland flooding)?

Appendix C: Approach to Workshop Development

The BoFEP MCCAP workshops were well-timed. There was momentum garnered from previous MCCAP kick-off workshops held by Service Nova Scotia Municipal Relations, and a well-received Nova Scotia climate adaptation webinar series funded by the Nova Scotia Climate Change Directorate which began in November and continued through February. More poignantly, winter of 2013 marked the point at which most municipalities were either poised to begin or had recently begun work on MCCAP development, and were planning for such work to be completed in their annual budgeting process so wanted to fully understand what the task would require.

> *The climate change connection to geology is apparent to geologists, but most people fail to recognize it. The principal reason for this is a general lack of educational exposure to this science. The vast majority of Nova Scotians will graduate from high school without taking a geology course. This could pose a significant problem for provincial planners who must design a climate change adaptation strategy, because understanding geology is critical for the design and implementation of new policies and action plans.*
>
> DeMont, G. J. 2009: *in* Mineral Resources Branch, Report of Activities 2008; Nova Scotia Department of Natural Resources, Report ME 2009-1, p. 9.

An early phase of municipal climate adaptation strategy development calls for municipalities to accurately interpret regional climate trends and link trends to potential affects on their physical and social landscape. This is exactly what the BoFEP climate change workshop focused on. The approach to the workshop was to focus on step 2 (identifying hazards and impacts) and step 3 (identify affected locations) of the Municipal Climate Change Action Plan Guide (the Guide) authored by Service Nova Scotia Municipal Relations. The Guide is the framework defining the nature of the required MCCAPs. Information pertinent to steps 2 and 3 of the Guide were addressed at the workshop with thoughtfully selected presentations, case study scenarios and exercises, and open discussions.

Of the seven hazards listed in the pre-workshop survey, the resounding top two hazards of concern were inland and coastal flooding. When asked if there was an *unlisted* hazard of concern, the one hazard put forward was 'storms'. The hazard of least concern was karst (sinkhole development). This likely stems from the simple fact that areas with karst terrain in Nova Scotia are relatively limited. It is also reflective, however, of a limited understanding of how changing climate conditions relate to the worsening of this hazard. This brings to bear the questions of how well the linkages between climate trends and geohazards are understood, and **to what degree have geological processes as influenced by weather previously received consideration in land use decisions**?

Within the last four years, the Nova Scotia Department of Natural Resources (DNR) Mineral Resources Branch has been paving the way—via the leadership of Geoscientist Garth DeMont—in improving communications with municipalities and orienting DNR products (e.g., spatial data and geological capacity building workshops) toward improved usefulness for land use planning exercises. The intent for doing so is multitudinous. Of course, citizen safety is at the forefront of the rationale for better understanding and planning around geological hazards exacerbated by climate change. But there are other reasons as well. Significant regional economic benefits can be gained not only if disasters are avoided, but if mineral resources are accounted for and protected for future use. For example, hauling aggregate is incredibly costly and these costs are rising. If a municipality needs aggregate for local roads, trails or upgrading dyke construction, having a local source can accrue direct financial benefit. This type of long-term thinking and planning for *resources* in addition to public safety is an exciting shift that is taking place within the planning profession, and is catalyzed in part by having to respond to climate change and concerns about energy security.

With the need for the workshop clearly understood, attention was turned to *how* to design an experience that met workshop-learning objectives. Central characteristics of the workshop approach were: to invite and allow adequate time for discussion and reflection, engage the participants through opportunities to interact with the material, and provide dynamic, highly visual and directly relevant presentations. The primary limitation to workshop design was simply available time: time to address all the information of interest, time to partake in a field trip, and time to balance interactive activities with presentation material. In the end, the workshop's flow was one of presentations in the morning, interactive sessions in the early afternoon, and closing with presentations. What ended up being a 'packed' agenda was given lightness through thoughtful hosting that was personal, humorous, always attentive to the needs of the participants, and conscientious of continually 'checking in' to see if clarification of a point/idea was desired.

Hazard: Storm Surge

Storm surge is defined by Environment Canada as:
The positive or negative difference in sea level from the predicted astronomical tide, due to the forces of the atmosphere. The two main atmospheric components that contribute to a storm surge are air pressure and wind.
Deep low pressure systems can create a dome of water under the storm (much like the low pressure in a vacuum on a carpet). High winds along a coastline can also elevate the water levels at the shore, depending on the direction of the wind with respect to the coast. For powerful storms like hurricanes, the abnormally high water levels are due mostly to the high winds and high waves at the coast.

	* Severity			** Frequency			*** Level of risk tolerance			**** Overall Risk
Location: North Shore: specifically . . .	Severe	Moderate	Minor	Often: 20% chance or more a year	Sometimes: 2-20% chance a year	Rarely: 2% chance or less a year	High	Medium	Low	High, Moderate, Low
	X			X			X			High

Impacts	Adaptation Options
Public safety (fatalities / injuries)	List specific land use by-law and EMO policy and protocol changes that mitigate impacts and enhance response capacity here.
Displacement	
Erosion of land / shore	
Road/infrastructure erosion	
Water contamination (increased salinity)	
Utility disruptions	
Economic impacts (e.g., farmland, business disruption)	
Dyke erosion	
Dyke overtopping / breaching	

Figure C1: Example hazard impact matrix

The details of the interactive mapping exercise in the afternoon arose from conversations Anne Warburton had with Garth DeMont, as well as information Garth had shared with Anne about a pilot project to assess climate change risk and land-use planning in central Antigonish County. Once the main idea for the exercise

was crafted, Anne posed the premise of the exercise to the workshop Advisory Committee. With the Advisory Committee's support, Anne then went back to the DNR where she and Garth began to detail how the exercise would run and what resources were needed.

Simultaneously, Garth had introduced Anne to Laura Trudell, a fourth year Honours student at Dalhousie University School of Planning. Laura's thesis research project for the Environmental Planning major of the Community Design Program was to develop a map of acid rock drainage risk potential that was informative and easy to use by land use planners. While Laura's test case study area was southwestern Nova Scotia, Anne believed the *approach* she was taking to modify geological maps in order to convey potential risk would be of great interest to Planners attending the BoFEP Climate Change workshop. As well, Anne and Laura felt there was an opportunity to not only showcase the way in which geological maps could be modified for land use application, but also get the planners feedback on what those modifications should be. In other words, as the workshop touched on multiple geohazards topics in the context of climate change, it was exciting to show that the DNR was developing tools to assist with geohazard interpretation *and* was *interested* ensuring future mapping products met the needs of the planner end-user.

Evaluating Laura's draft risk map for acid rock drainage became the second interactive session at the BoFEP climate change workshops. Participants were encouraged to focus less on the acid rock drainage issue, but instead on the type and way in which information was presented. While acid rock drainage *is* an issue that is exacerbated by the climate trend of increasingly exaggerated alternating wet and dry periods (i.e., projected increases in short intensity rainfall as well as an increasing water deficit index), and the linkage between acid rock drainage and projected changes in climate *was* addressed during the workshop, this geohazards is not an issue for most municipalities in the Bay of Fundy ecosystem. However, Laura's research allowed us to explore of intersection of what kind of information land use planners need (especially in light of climate change), and how the DNR can provide that information in a way that is useful and easy to implement in traditional planning practices and daily operations.

Laura became part of the planning team for the afternoon mapping exercise that provided practice on delineating geohazards areas warranting further assessment: what would become priority action areas as described in the Guide. In fact, Laura ended up being the geographical information systems (GIS) technician that assimilated the team's desired data layers and made the maps for the activity.

Also joining the team was Jacqueline Wightman. Like Laura, Jacqueline was a fourth year Honours student at Dalhousie University School of Planning. Jacqueline was brought onto the team because her research was also relevant to the climate change workshop. In fact, it was strongly suggested to Anne by a manager within the DNR that the workshop highlight the importance of needing to be prepared for extreme weather events, and that a historical look at previous storm damage would serve to

remind us of the importance of storm preparedness, mitigation and response. Indeed, Step 2 of the Guide asks a few questions about the past, requiring municipal MCCAP teams to list past events, the general community impact of those events, and any actions that were then taken to mitigate the impact of similar future events. Because Jacqueline's research reflects on how a historical perspective can inform and help to mitigate future risk, she was invited to present at the workshops, addressing the question of whether analyzing historic storm risk patterns provided insight into how development trends may affect future vulnerability to storms.

In addition to working with Garth, Laura and Jacqueline, Anne reached out to Dr. Danika van Proosdij to join the workshop team. Anne was familiar with Dr. van Proosdij's work on assessing and mitigating flood risk in Nova Scotian floodlands through her Atlantic Climate Adaptation Solutions (ACAS) program research.

The ACAS program was a federal cost-shared program aimed at stimulating climate adaptation planning and decision-making, particularly at the municipal level. In Nova Scotia, the Department of Environment, through their Climate Change Directorate (CCD) was the Provincial lead on this project. There is a large library of ACAS research available—from all of the Atlantic Provinces (http://atlanticadaptation.ca/projects). The ACAS projects were part of a larger national program developed by Natural Resources Canada (NRCan) that cost-shared efforts to improve climate change adaptation decision-making. The program was designed to support a regional focus on the most pressing issues in each of six areas across Canada. Collectively, the four Atlantic Provinces have undertaken projects to assess coastal and inland vulnerability to climate impacts. In Nova Scotia, research focused primarily on coastal issues.

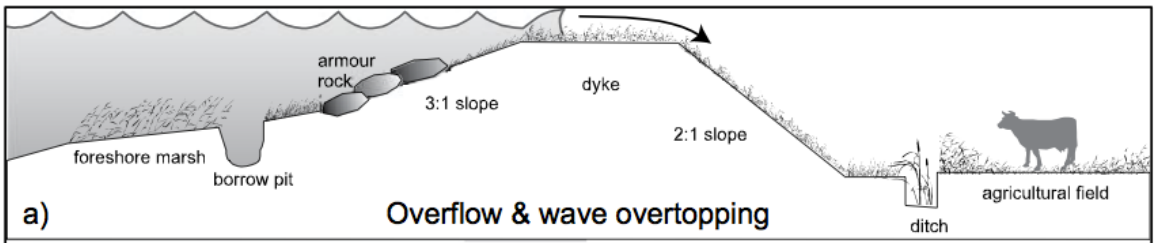


Figure C2: A type of mechanisms that can result in dyke failure, image taken from *Best Management Practices for Climate Change Adaptation in Dykelands: Recommendations for Fundy ACAS Sites*

Although not all communities in the Bay of Fundy host dykelands, where they *do* exist they pose a significant issue. For this reason, Anne asked Dr. van Proosdij to talk about what was learned / what is known about that nature of vulnerability of dykes within the Bay of Fundy and take questions.

With the presentations that Anne Warburton brought to the table, the presentations and exercises supported by Garth DeMont of the DNR, the participation of Laura Trudell and Jacqueline Wightman, and the help of Dr. Danika van Proosdij, the agenda was full. Anne brought a draft agenda to the project's Advisory Committee

and received full support, with minor suggestions for improvement. It was now time to entice participants. Simultaneous to workshop design, Anne had been working on logistics: securing workshop sites and dates, and catering. Having these details largely secured allowed for the focus to shift to workshop promotion and registration of participants, which was also handled by Anne.

Two list servers were used to promote the workshops. One list server sends notices to all municipal planners in Nova Scotia. The second goes to Planning Directors in all 54 municipalities. Jeff Merrill, Planning Director of the Municipality of the District of Lunenburg and Chair of the Nova Scotia Planning Directors' Association posted the workshop notices on Anne's behalf. An initial workshop announcement was sent in early December notifying people to 'save the date' for the BoFEP climate change workshops coming in February. This was followed up on January 3rd with a complete workshop announcement and invitation. Additionally, Graham Fisher posted to the general municipal list server to support and encourage registration. Given Graham authored the MCCAP Guide, this was a powerful endorsement. As well, Debbie Neilson of the Union of Nova Scotia Municipalities (UNSM) also promoted the workshops on the UNSM website. Not surprisingly, registration started strong, dwindled during mid-January then was capped with multiple 'last-minute' sign-ups.

photo by Mike W. Boulanger, Engineering Technician and EMO with the Municipality of the District of Lunenburg

Municipal Planners were welcomed and encouraged to bring other members of their MCCAP teams, as well as Council members. Emergency management professionals are of particular importance to the MCCAP process, as are GIS technicians. Indeed, workshop locations benefited from having emergency management coordinators and GIS technicians in the room and part of the conversations. Council members were also in attendance at each location.

To compliment the workshop themes and presentations, the BoFEP Advisory Committee desired that participants be provided reference materials. Due to the number and length of reference materials collected by Anne Warburton, it was decided that the material should be provided digitally. Alexa Vodicka, Program Administrator with the Climate Change Directorate, offered to create a webpage within the Climate Change Directorate's website that was specific to the BoFEP climate change workshops. Once this site was created, workshop materials and presentations were uploaded, organized by Alexa to parallel the agenda, and then a link was sent to all workshop participants. Participants could now download what they wanted when they needed it. Because the longevity of the site is unknown due to forthcoming changes within the Department of Environment's structure (the

Climate Change Directorate is an 'arm' of the Department of Environment) and to Communications Nova Scotia policy, BoFEP's Communications Coordinator, Jon Percy, posted workshop reference materials to the BoFEP website as well.

There were specific workshop details that worked well. One such detail was the length of presentations. They averaged forty-five minutes, which proved to be a timeframe in which participants could maintain focus. Another detail was that the receptivity of the workshop content and even the credibility of the MCCAP process benefited by having a third-party host the workshops, versus SNSMR or the NS Environment Climate Change Directorate. It also worked well that a member of the workshop Advisory Committee was summarizing points heard in the room and posting them to the communal posters where ideas for MCCAP action items and desires for further training / capacity building were being collected. This effort somewhat compensated for the fact that the participants themselves were not actively contributing to these posters. During a final workshop Advisory Committee meeting, one of the Advisory Committee members highlighted that the pre-workshop survey was a strength in that it fostered participant investment prior to the workshop, as well as informed workshop design and presentations. This particular practice will be replicated for future workshops. Another feature that will likely be replicated is the production and use of a 'key' to guide group work and decision-making in the context of climate change action planning. The 'key' used for the afternoon mapping activity proved to remove intimidation from the mapping requirement, and provide an approachable step-by-step process that can be easily adopted by municipal working groups, no matter the subject matter.

Aspects of the workshop that, in retrospect, could have been improved largely involve facilitation techniques. For example, the fact that the posters did not generate comments/insights from participants as intended could have been addressed through providing focused time for garnering participant feedback using the provided sticky notes and collaboratively organized on the posters. As well, prior to engaging participants in the mapping activity, it should have been reiterated, very explicitly, that the activity was demonstrating an expectation of the province for MCCAP reporting. Knowing that the activity was demonstrating how to achieve a mapping expectation would have negated some initial resistance to the activity.

Appendix D: Agendas

Acadia Centre for Estuarine Research
Acadia University
P.O. Box 115
Wolfville, Nova Scotia
Canada B4P 2R6

Bay of Fundy Ecosystem Partnership MCCAP workshop
February 7th, 2013
Bible Hill

8:15-9:00 Register and settle in

9:00 Framing the day: Anne Warburton

Objective: Review of climate trends and hazards of focus, and how to make best use of the day

Questions to answer:
- Are the water level numbers in 'the Richards and Daigle report' the best ones to use?
- What *water-related* climate trends, besides increasing mean sea level, do we need to think about?
- How does any of what I'll hear help me write my MCCAP?
- The evolving hazard impact matrix

9:30 The relevance of a historical perspective: Jacqueline Wightman

Objective: Step 2 of the MCCAP asks a few questions about the *past*. Jacqueline's research reflects on how a historical perspective can inform, and help to mitigate, future risk

Question to answer: Does analyzing historic storm risk patterns provide insight into how development trends may affect future vulnerability to storms?

10:00 Dykes in the Bay of Fundy: Anne Warburton introduces information recently made available by Dr. Danika van Proosdij

Objective: Learn about ACAS studies discussing what is presently known about the risk of dykes around the Bay of Fundy overtopping or breaching.

Questions to answer:
- Why are dykes within the Bay of Fundy vulnerable to overtopping or breaching?
- What's been assessed?
- If not already assessed, how can we determine if the dykes in our jurisdiction warrant adaptation dollars for assessment? What are the right questions to ask?

10:30 Break

10:45 Linking climate change and geohazards: Anne Warburton

Objective: Set the context for a discussion and activity about how to best deal with coastal erosion and other geohazards during MCCAP development in 2013.

Questions to answer:
- What' the short list of geohazards relevant to MCCAPs?
- How are they relevant and are they *priorities*?
- How far do we need to go given MCCAP's intent for 2013, and the information and capacity readily available to us?

11:00 Styles of coastal erosion: Geoscientist Garth Demont

Objective: To understand different styles/types of coastal erosion.

Questions to answer:
- Does the style of erosion have bearing on degree of inherent risk? (important in terms of risk ranking & setting priorities)
- How to use geology maps to narrow down if and *where* you need to have coastal erosion professionally assessed and what that means.

11:45 Lunch

12:30 Activity: Using existing maps to assess geohazards

Objective: to confirm or introduce how available geological mapping can inform the presence and delineation of geohazards for step 2 and 3 of the MCCAP.

Questions to answer:
- What mapping or information is available to determine which geohazards warrant being in your hazard impact matrix, and which are priority action areas?
- How to use geology maps to narrow down if and *where* you need to have coastal erosion professionally assessed and what that means.

1:45 Changing the way geohazards are mapped: Laura Trudell

Objective: To hear about and provide feedback for Laura's research which is experimenting with more land use planning-friendly geological mapping.

Question to answer:
How can geological mapping be modified so that potential risk in the context of land use planning can be easily interpreted?

2:30 Break

2:45 Changing precipitation and inland flooding: Anne Warburton

Objective: Hear a case study on how changes in precipitation were incorporated into the updating of a stormwater management plan.

Questions to answer:
- What might be involved in determining an inland flooding impact severity ranking?
- What are some adaptation option ideas for inland flooding?

3:10 When does an impact become a priority: Anne Warburton

Objective: Discuss if and how a community's adaptive capacity plays into impact prioritization and adaptation strategies.

Question to answer:
- What does adaptive capacity have to do with impact severity rankings, prioritization of actions, and selection of adaptation options?
- What are some ways to 'fold' social considerations in the Hazard Impact Matrix?

3:45 Closing and check out

4:00 Safe travel home

Acadia Centre for Estuarine Research
Acadia University
P.O. Box 115
Wolfville, Nova Scotia
Canada B4P 2R6

Bay of Fundy Ecosystem Partnership MCCAP workshop
February 13th, 2013
Annapolis Royal

8:15-9:00 Register and settle in

9:00 Framing the day: Anne Warburton

Objective: Review of climate trends and hazards of focus, and how to make best use of the day

Questions to answer:
- Are the water level numbers in 'the Richards and Daigle report' the best ones to use?
- What *water-related* climate trends, besides increasing mean sea level, do we need to think about?
- How does any of what I'll hear help me write my MCCAP?
- The evolving hazard impact matrix

9:30 The relevance of a historical perspective: Jacqueline Wightman

Objective: Step 2 of the MCCAP asks a few questions about the *past*. Jacqueline's research reflects on how a historical perspective can inform, and help to mitigate, future risk

Question to answer: Does analyzing historic storm risk patterns provide insight into how development trends may affect future vulnerability to storms?

10:00 Dykes in the Bay of Fundy: Dr. Danika van Proosdij

Objective: Learn about ACAS studies discussing what is presently known about the risk of dykes around the Bay of Fundy overtopping or breaching.

Questions to answer:
- Why are dykes within the Bay of Fundy vulnerable to overtopping or breaching?
- What's been assessed?
- If not already assessed, how can we determine if the dykes in our jurisdiction warrant adaptation dollars for assessment? What are the right questions to ask?

10:45 Break

11:00 Linking climate change and geohazards: Anne Warburton

Objective: Set the context for a discussion and activity about how to best deal with coastal erosion and other geohazards during MCCAP development in 2013.

Questions to answer:
- What' the short list of geohazards relevant to MCCAPs?
- How are they relevant and are they *priorities*?
- How far do we need to go given MCCAP's intent for 2013, and the information and capacity readily available to us?

11:15 Styles of coastal erosion: Geoscientist Garth Demont

Objective: To understand different styles/types of coastal erosion.

Questions to answer:
- Does the style of erosion have bearing on degree of inherent risk? (important in terms of risk ranking & setting priorities)
- How to use geology maps to narrow down if and *where* you need to have coastal erosion professionally assessed and what that means.

12:00 Lunch
Guest presentation at 12:30

12:45 Activity: Using existing maps to assess geohazards

Objective: to confirm or introduce how available geological mapping can inform the presence and delineation of geohazards for step 2 and 3 of the MCCAP.

Questions to answer:

- What mapping or information is available to determine which geohazards warrant being in your hazard impact matrix, and which are priority action areas?
- How to use geology maps to narrow down if and *where* you need to have coastal erosion professionally assessed and what that means.

2:00 Changing the way geohazards are mapped: Laura Trudell

Objective: To hear about and provide feedback for Laura's research which is experimenting with more land use planning-friendly geological mapping.

Question to answer:
How can geological mapping be modified so that potential risk in the context of land use planning can be easily interpreted?

2:45 Break

3:00 Changing precipitation and inland flooding: Anne Warburton

Objective: Hear a case study on how changes in precipitation were incorporated into the updating of a stormwater management plan.

Questions to answer:
- What might be involved in determining an inland flooding impact severity ranking?
- What are some adaptation option ideas for inland flooding?

3:20 When does an impact become a priority: Anne Warburton

Objective: Discuss if and how a community's adaptive capacity plays into impact prioritization and adaptation strategies.

Question to answer:
- What does adaptive capacity have to do with impact severity rankings, prioritization of actions, and selection of adaptation options?
- What are some ways to 'fold' social considerations in the Hazard Impact Matrix?

3:45 Closing and check out

4:00 Safe travel home

Appendix E: Decision Flow Diagram Used for Interactive Mapping Activity

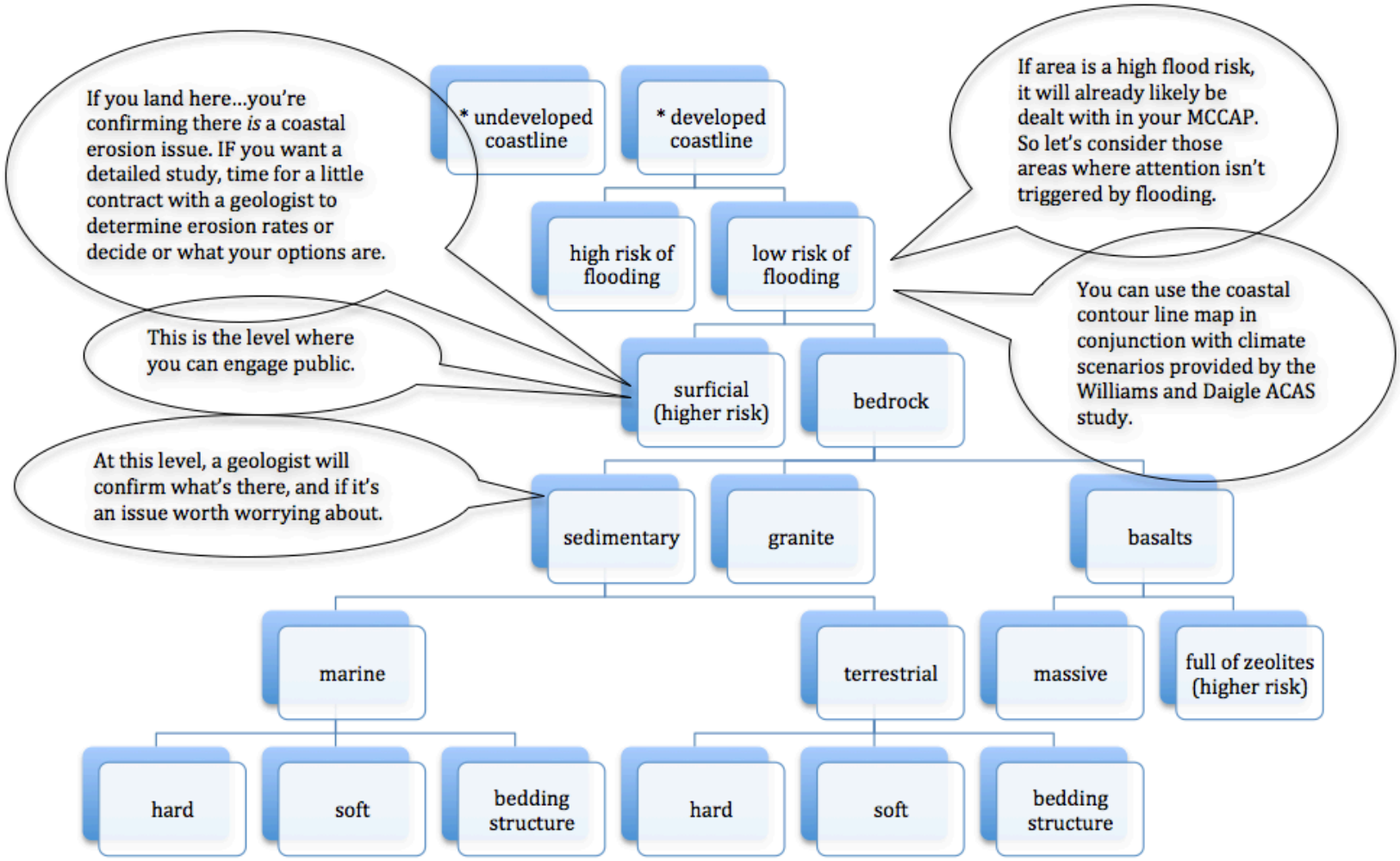
Decision Flow Diagram for Identifying Coastal Areas Warranting Further Erosion Analysis

Bay of Fundy Ecosystem Partnership MCCAP Workshop
February 2013

In municipalities where coastal erosion and land use and/or development interface, coastal erosion may be one of the natural hazards listed in the Municipal Climate Change Action Plan (MCCAP). The intent of MCCAP development in 2013 is to identify which natural hazards will be exacerbated or introduced by changes in climate, and which of these hazards and associated impacts warrant further study and/or action.

The following diagram is a simple discussion guide designed to help local MCCAP teams decide if and where a section of their coast is problematic enough, or potentially problematic enough, that a reasonable MCCAP action item would be to engage a professional geoscientist for a detailed coastal erosion analysis. Prior to that engagement, it is recommended that a geologist be hired for a short (one-two day) contract to either confirm the municipality has identified problematic areas correctly, or to do this high level analysis on behalf of the municipality, setting the stage for further work if and where needed. This short contract could occur before the 2013 submittal of the MCCAP, or be a 'first step' adaptation action item regarding coastal erosion.

A comment on public engagement: There is a role for public engagement in the assessment of coastal erosion, though it needs to be handled cautiously in order to manage expectations and ensure valid information is provided. Specifically, for those sections of the coast that are (as identified using the flow diagram) low flood risk, you can ask local residents and coastal land owners to send in photos of the coast in that area. You can also ask them about the land beneath their feet: can you shovel it all along your property line? What's on your shoreline? This information, and photos, can help your MCCAP team or hired geologist to quickly and affordably zero in on the areas that truly need more detailed consideration. A word of caution, don't simply ask, "what's the erosion like?" Due to the dynamic nature of coastal erosion and natural rebuilding, people often have an erroneous sense of erosion rates, influenced more by storm events than actual long-term erosion/ rebuilding regimes.



** Your municipality will want to figure out criteria for what's considered 'developed.' Is it based on development density? What density? Or infrastructure?*

Appendix F: Evaluation Rubric for Geological Map Prototype

EVALUATION SURVEY: RUBRIC						
Acid Rock Drainage Risk Potential Map for southwestern Nova Scotia – Draft 0.2						
Map Element	Rank useless↔ useful bad ↔ good no ↔ yes 1	2	3	4	5	Comments
Symbology						
Does the hillshade provide context to the map?						
Are the road symbols and their classes helpful for wayfinding?						
Are the base map layers helpful? (ex. roads, lakes)						
Are the watershed boundaries helpful?						
Colour						
Is the choice of colours aesthetically pleasing?						
Are the colours appropriate to represent ARD?						
Are the risk potential categories clearly visible and legible?						
Map text						
Is the title informative of what the map is about?						
Are the place names suitable?						
Is the font size big enough?						
Are the county names convenient?						
Are the county names well placed?						
Terminology						
Are the terms used in text familiar?						
Is the language appropriate for planners?						
General						
Is the map overall pleasing to look at?						
Is the map at a useable scale (1:50 000)?						
Is the size of this printed map useable?						
Is the description of the map production and risk classification categories helpful?						
Brochure						
Is the description of ARD useful?						
Are the factors of ARD clear?						
Are the impacts of ARD understandable?						
Is there just the right amount of detail and description?						
Are the terms and language familiar?						
Is the length of text appropriate?						

Appendix G: Workshop Participants

	Bible Hill on February 7th, 2013	
	Registrant's Municipality	**Registrant's Name**
1	Mun of the Dist of Colchester	Crawford MacPherson
2	Municipality of the County of Cumberland	Jim Hannon
3	Municipality of the County of Cumberland	Steve Ferguson
4	Municipality of the County of Cumberland	David Buell
5	Municipality of the County of Cumberland	Maggie Pitts
6	Municipality of the County of Cumberland	Penny J. Henneberry
7	Municipality of the County of Cumberland	Thomas Trenholm
8	Municipality of the County of Cumberland	Ergin Nemburt
9	Municipality of the County of Cumberland	Mike Carter
10	Municipality of the County of Cumberland	Lynne Welton
11	Municipality of the County of Cumberland	Ernie Gilbert
12	East Hants Municipality	Debbie Uloth
13	East Hants Municipality	Erin Berry
14	Joggins Fossil Centre	Ken Adams
15	Town of Hantsport	Grant Cooke
16	County of Kings	David Poole
17	Municipality of the District of Lunenburg	Doug Reid
18	Mayor of Parsboro	Lois Smith
19	SNSMR	Melissa Williment
20	Town of Windsor	Bill Butler
21	Town of Windsor	Jon McDonald
22	Municipality of the District of St. Mary's	David Gillis
23	Municipality of the District of St. Mary's	David Clark
24	Municipality of the District of St. Mary's	Michael Mosher
25	Town of Amherst	Andrew Fisher
26	City of Moncton	Ginny Cosgrove
27	City of Moncton	Sebastien Arcand
28	Université Sainte-Anne, Centre de recherche marine	Michelle Theriault
29	Université Sainte-Anne, Centre de recherche marine	Aleasha Boudreau
30	University of Ottawa C-Change project	Dan Lane
31	University of Ottawa C-Change project	student of Dan Lane
32	Richmond County	Chris Bodreau

	Annapolis Royal on the 13th	
1	**Municipality**	**Registrant**
2	Mun of Dist of Lunenburg	Jeff Merrill,
3	Mun of Co of Annapolis	Albert Dunphy
4	Mun of Co of Annapolis	Gregory Heming,
5	Mun of Co of Annapolis	Stephen McInnis
6	REMO Mun of Co of Annapolis	David McCoubrey
7	Mun of Co of Annapolis	Cheryl Mackintosh
8	Town of Wolfville	Gregg Morrison
9	Yarmouth-Argyle	Brad Fulton
10	Municipality of Argyle	Danny Muise
11	Municipality of Argyle	John Sullivan,
14	Region of Queens Municipality	Mike MacLeod
15	Town of Hantsport	Rob Frost,
16	Mun of the District of Yarmouth	Roger Devine
17	Mun of the District of Yarmouth	Derek Sutherland
18	Municipality of Barrington	Dave Andrews
19	Mun of the District of Yarmouth	Arthur MacDonald
20	Mun of the District of Yarmouth	Tracy Bruce

Appendix H: Workshop Reference Materials

The many resources specifically gathered in support of the BoFEP climate change workshop and MCCAP development are provided online via the Climate Change Directorate's webpage: http://climatechange.gov.ns.ca/content/impactsWorkshop. The documents available at this site include:

- Workshop presentations
- Framing the Day: Climate Trends and Projections and the MCCAP, by Anne Warburton
- Development Trends and Vulnerability to Severe Storms, by Jacqueline Wightman
- Dykelands: Strategic Importance for Climate Change Adaptation, by Dr. Danika van Proosdij
- Linking Climate Change and Geohazards, by Anne Warburton
- Styles of Coastal Erosion, by Garth DeMont, NS DNR
- Stratford PEI Case Study for Climate-wise Stormwater Management Plan Update, by Anne Warburton
- When Does an Impact Become a Priority, by Anne Warburton
- Climate Change, Mean Sea Level and High Tides in the Bay of Fundy
- Global Sea Level Rise Scenarios for the United States National Climate Assessment
- Scenarios and Guidance for Adaptation to Climate Change and Sea Level Rise: NS and PEI Municipalities
- Development Trends and Vulnerability to Severe Storms, Thesis Proposal of Jacqueline Wightman
- Best Management Practices for Climate Change Adaptation in Dykelands: Recommendations for Fundy ACAS Sites
- Coastal Vulnerability: Reports and Maps
- Shore Zone Characterizations for Climate Change Adaptation in the Bay of Fundy
- Coastal Hazard Assessment Along the Blue Beach Fossil Cliffs, Kings County
- A Decision Flow Diagram for Identifying Coastal Areas Warranting Further Erosion Analysis
- A Description of Work Underway to Develop a Method for Assessing Social Vulnerability to Climate Change in Nova Scotia Communities
- Additional Background materials
- Adapting to Climate Change in Saanich: A Discussion Paper
- Municipal Climate Change Action Plan Guide
- MCCAP Assistant
- Final Report – Mitigating Impacts of Stormwater, Wastewater and Pharmaceuticals in the Environment

Appendix I: Workshop Evaluation

Acadia Centre for Estuarine Research
Acadia University
P.O. Box 115
Wolfville, Nova Scotia
Canada B4P 2R6

Bay of Fundy Ecosystem Partnership
MCCAP Workshop Evaluation

Please rate the usefulness / applicability of the following presentations.

Metric: **1 Very Useful. Will directly inform / confirm my work**
2 Somewhat useful
3 Not directly applicable to my work
0 Undecided

Appendix J: Fundy Tidings Article

BoFEP Municipal Climate Change Workshops Successful

Under the 2010-2014 Gas Tax Agreement and the Municipal Funding Agreement, NS municipalities are required by December 31, 2013, to complete Municipal Climate Change Action Plans (MCCAP). Funded by Environment Canada, BoFEP and Anne Warburton of Elemental Sustainability, hosted two workshops in February 2013, to assist municipalities in the initial stages of climate change action planning. A workshop at Bible Hill was held on February 7th, and another in Annapolis Royal on February 13th. There were thirty-two and eighteen registrants, respectively. Participants were primarily municipal and elected staff. The Advisory Committee that helped shape the workshops included: Pat Hinch, who secured the funding from Environment Canada for the project; Senior Planner Graham Fisher with Service Nova Scotia Municipal Relations; and Alexa Vodicka with the NS Climate Change Directorate.

The workshops were designed to assist with an accurate interpretation of climate trends and projections and enhance understanding of how these trends may exacerbate geohazards including (but not limited to) coastal and inland flooding, coastal erosion, sinkhole development, and groundwater quality within the Bay of Fundy ecosystem. The climate drivers of primary focus were: sea level rise as a contributor to erosion processes, flooding, and changes in the Bay of Fundy's resonate tide period; changes in precipitation in concert with increasing water deficit indicators; and a comment on latest findings regarding storms.

A workshop highlight was a hands-on exercise where groups worked with a specially developed key and a suite of maps to practice, and build capacity around delineating locations where detailed site assessments for coastal erosion are warranted. The exercise of identifying priority areas/issues for further study and adaptive action is the fundamental purpose of the 2013 MCCAP process.

Other workshop highlights included an opportunity to review prototype mapping being developed by Laura Trudell as a Thesis project for the DNR, whereby the map presentation and legend is being designed to convey a description of geological risk so that it can be easily interpreted by land use planners with limited or no geological training. As well, participants heard from Geoscientist Garth DeMont with the NS Department of Natural Resources (NS DNR) on: coastal vulnerability and styles of coastal erosion; the role of geology on flood risk; types of erosion risks inherent with unconsolidated sediment coastlines, combined bedrock and surficial geology coastlines, and coastlines of bedrock. Garth also talked about the strengths and potential pitfalls of armouring the coast, and efforts being made within the Canadian

Council of Professional Geoscientists and the NS DNR to train geotechnicians for the type of work municipalities will soon be tendering.

Workshop materials are currently hosted by the Climate Change Directorate (click here) as well as on BoFEP's website.

A great deal of thanks goes to Geoscientist Garth DeMont, Senior Planner Graham Fisher with Service Nova Scotia Municipal Relations, and Dr. Danika van Proosdij of St. Mary's Department of Geography and the Intertidal Coastal Sediment Transport Research Unit, for providing subject expertise and guidance during the workshops' activities and discussions. Special thanks also goes to Pat Hinch as BoFEP's Project Manager and document editor, Alexa Vodicka of the NS Climate Change Directorate for providing an online resource site for all participants, Laura Trudell for presenting her thesis research and creating maps for workshop use, Jacqueline Wightman for addressing the relevance of a historical perspective when assessing the linkages of land development and storm impacts, and John Drage and Gavin Kennedy of the NSDNR for providing hydrogeological data and expertise for workshop maps.