



Climate Change Adaptation A Toolkit

Sackville
Port Elgin
Dorchester
Memramcook

Prepared by Amanda Marlin
April 2013



Adapting to Climate Change

This Toolkit has been prepared for residents and communities in the Tantramar Region (Sackville, Port Elgin, Dorchester and Memramcook) of southeast New Brunswick who are looking for local information on climate change and adaptation options to use in their outreach, education and communication efforts. Information in the toolkit has been compiled by Amanda Marlin, Climate Change Adaptation Project Coordinator for EOS Eco-Energy with funding from the New Brunswick Environmental Trust Fund and the NB Regional Adaptation Collaborative.

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April 2013

This toolkit can be accessed online at
www.eosecoenergy.com

Disclaimer: The information contained in this toolkit is based on the best science available at the time of development; however, there are many unknowns associated with climate change and flood risk and it is impossible to anticipate everything. As a result, the toolkit offers the best available resources at this time and will be updated online as new information becomes available.

Foreword

Dear Reader,

Thank you for opening this toolkit on climate change adaptation in Tantramar and Memramcook. It is filled with great information to help you understand what climate changes we are expected to see in our region and the impacts they will have on residents, infrastructure, and agriculture. The second part of the toolkit will help you (whether you are a municipal councillor, community leader, planner, resident, farmer, teacher, or anyone else concerned about climate change in our region) to understand what is being done to adapt to the changes we are already seeing and the ones predicted for the future, and also what you can do. The toolkit ends with a section on where to find more information, resources and support.

There are many unknowns with climate change, but this toolkit uses the best available science to inform the reader. We all have a role in planning for and adapting to changes in our region. Emergency Measures Organizations in Sackville, Port Elgin, Dorchester and Memramcook offer emergency response during critical situations such as floods. We conduct mock disasters (including dyke breaches and flooding) and plan and update our emergency response plans for a variety of disasters. By reading this toolkit and becoming better prepared for climate change disasters, such as flooding, you can help keep yourself, your family, your business safer during emergencies. Floods may slow our response time, or inhibit us from reaching flooded parts of town (or areas beyond a washed out road). So we, the EMO coordinators in Tantramar and Memramcook urge you to read this toolkit, heed its warnings and predictions and plan for potential floods in the future.

Sincerely,

Craig Bowser, Sackville EMO Coordinator

Terry Murphy, Port Elgin EMO Coordinator

Kim McLeod, Dorchester EMO Coordinator

Emery Bourque, Memramcook EMO Coordinator



Table of Contents

Foreword.....iii

Preface.....1

Part One

What is Climate Change?.....2

What is Climate Change Adaptation?.....3

What does Climate Change Mean for Tantramar?.....3

 Temperature Rise.....3

 More Extreme Storms More Often.....4

 Sea Level Rise5

 Changing Precipitation Patterns.....7

Predicted Impacts.....7

 Dyke Breaches and Flooding.....7

 Transportation17

 The Economic Cost of Future Flood Damages18

 Agriculture.....20

 Health Issues23

Part Two

What can be done? Ideas and Suggestions for Preparing and Adapting.....24

 Municipal Governments.....24

 Community Leaders.....25

 Planners26

 Dyke Managers27

 EMO Coordinators28

 Residents28

 Farmers.....31

 Educators.....32

Additional Resources33

 Local Contacts for Further Help and Support33

 Useful Websites33

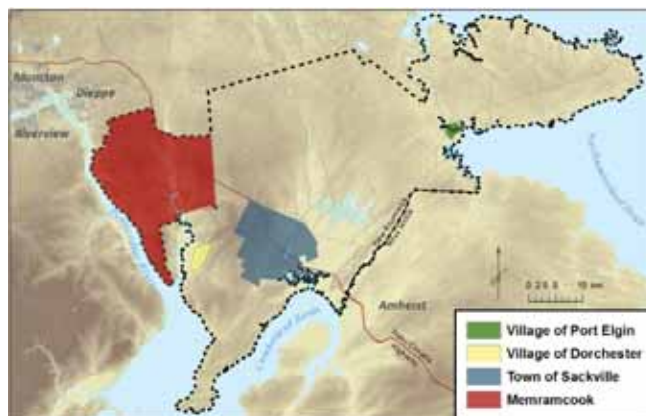
 References and Resources34

Preface

The Tantramar Region in southeast New Brunswick (home to the communities of Sackville, Port Elgin, Dorchester, Memramcook and the rural areas in between) is one of the most susceptible areas of the province to climate change impacts. This is because much of the region is low lying, including areas that are below sea level. Some of the region's infrastructure, businesses, homes and community assets are also located behind an aging system of dykes that were built originally to protect agricultural fields. When these realities are combined with rising sea levels and the forecast of more intense storms happening more often, the region becomes very vulnerable. Indeed, we have already witnessed devastation from severe storms in the past (1869, 1917, 1962, 2010, etc.).

Because of past and forecasted future impacts and the region's vulnerability as a low-lying area, a lot of research has been completed through the Atlantic Climate Adaptation Solutions Association (ACASA) from 2009 through 2012. EOS Eco-Energy obtained funding through the NB Regional Adaptation Collaborative and the New Brunswick Environmental Trust Fund to compile this research into a toolkit full of easy to understand information for individuals, community groups and municipal offices interested in learning more about climate change.

The toolkit is based on the best science available at the time of development; however, there are many unknowns associated with climate change and flood risk and it is impossible to anticipate everything. As a result, the toolkit offers the best available resources at this time and will be updated online as new information becomes available at www.eosecoenergy.com. This toolkit allows the reader to become familiar with the kinds of climate changes the Tantramar Region is expecting as well as ideas for how to plan, prepare and adapt.



The Tantramar area of Southeast New Brunswick

Source: J. Bornemann

Part One

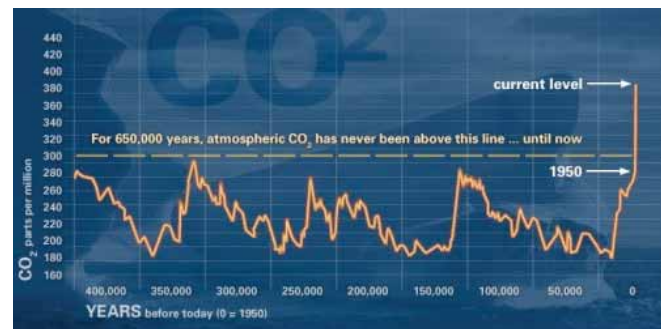


Source: 2010-801P ©INKCINCT Cartoons www.inkcinct.com

What is Climate Change?

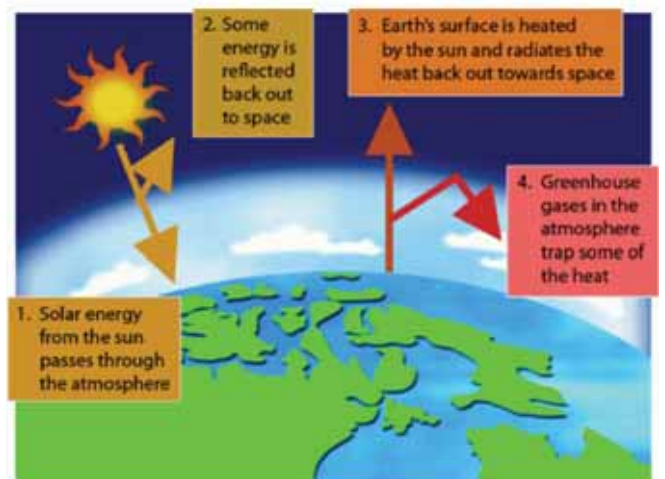
Climate is the average weather pattern over many years; it is not the weather. Climate dictates what parts of the planet tend to be warmer, colder, wetter, drier, and how often we see extreme weather events such as hurricanes. The earth's climate has been changing for millions of years, but since the 1970s scientists have reported increases in greenhouse gases (carbon dioxide, methane) in the atmosphere due to human activities such as the burning of fossil fuels, large scale agriculture, deforestation, etc. The graph (above right) shows that for hundreds of thousands of years carbon dioxide (CO_2) has never been above 300 parts per million, until recently.

Greenhouse gasses trap heat in the earth's atmosphere and cause the overall temperature to rise (as described in the diagram bottom right). The earth's climate is in a careful balance so even a small overall rise in the average global temperature will affect the climate. Rising temperatures also melt glaciers, icebergs, permanent ice fields and permafrost, which will lead to rising sea levels.



Carbon Dioxide Levels in the Atmosphere

Source: <http://globalpatriot.com/wp-content/uploads/2010/02/NASA-CO2-Historical-Levels-e1266421441178.jpg>



The Greenhouse Effect

Source: New Brunswick Department of Environment and Local Government, http://www2.gnb.ca/content/gnb/en/departments/elg/environment/content/climate_change/content/what_is_climate_change.html

What is Climate Change Adaptation?

We can adapt to climate changes by adjusting how we live and the choices we make. Making these adjustments will help decrease the negative effects of the changing climate, and allow us to take advantage of any new and favourable opportunities. Examples of adaptation measures can include:

- Choosing not to build houses in flood plains
- Having a storm emergency kit and evacuation plan
- Relocating houses from at-risk areas over time
- Maintaining natural buffers to floods (wetlands, stream vegetation)
- Adjusting storm water and sewage infrastructure either by moving them, or by increasing their capacity
- Reducing run-off and the burden on storm water infrastructure by increasing permeable pavements, and increasing tree and vegetation covers
- Growing new foods better suited to a hotter climate

Is it too late to do anything about climate change?

No! We can use ‘**mitigation**’ which refers to the things done to lower greenhouse gases in the air, to slow down the rising temperatures around the world.

Here are some ways to cut your carbon use and reduce greenhouse gas emissions:

- Install solar panels for hot water
- Get rid of oil heating and install a heat pump
- Drive a small fuel efficient car, or better yet, buy a hybrid or electric car
- Join a ride share or car share program, carpool, take the bus, ride your bike or walk more often
- Eat local food, eat less meat
- Choose organic foods
- Choose energy efficient appliances
- Insulate your home so you use less heat
- Compost, recycle, reduce, re-use

What does Climate Change Mean for Tantramar?

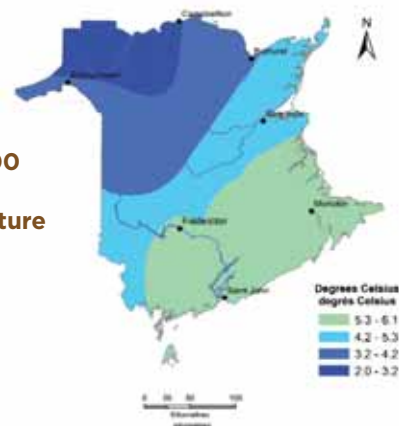
Climate change in Tantramar means four things:

- 1 Temperature rise
- 2 More extreme storm events more often
- 3 Sea level rise
- 4 Changing precipitation patterns

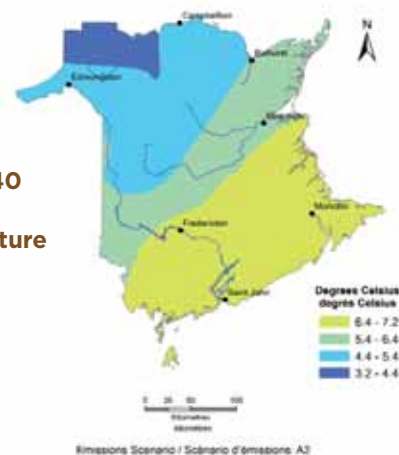
Temperature Rise

Warmer temperatures may extend our growing season, but animals and crops may not respond well. Unfamiliar pests and diseases may spread into our region, such as deer ticks and Lyme disease. The maps below show the average temperatures for New Brunswick in the past and potential increases in the future.

**Average
1971-2000
Mean
Temperature**



**Average
2011-2040
Mean
Temperature**



Average temperature today and in the future for New Brunswick. It will be getting warmer.

These maps can be downloaded free of charge from New Brunswick Climate Futures at www.acasamaps.com

More Extreme Storms More Often

The Tantramar Region has seen extreme storm events in the past. Storms which overtopped or broke the dykes and caused flooding were witnessed in 1759, 1869, 1903, 1904, 1906, 1909, 1917, in the 1930s and 40s. The 1759 storm resulted in floods that damaged houses and delayed British settlement. The most famous storm to affect the Tantramar area was the Saxby Gale, which hit on October 4-5, 1869. It flooded low-lying areas and overtopped the dykes by about 0.9 m. The following are accounts of the aftermath on the Tantramar Marshes.

Accounts of the Saxby Gale, 1869

There was fearful destruction of property all through the New England states ... doing great damage to the Sackville Marshes, and also all of the Bay of Fundy coast; destroying hundreds of tons of hay, washing away cattle of all descriptions, horses, oxen, sheep and pigs. Barns full of hay were taken on the water for miles. Sunken Island was literally covered with haystacks, cattle, sleepers, fences, telegraph poles, gates, boards, and numberless other articles, used by farmers on the marsh ... In the morning all was quiet but rather foggy; the farmers looked towards their marshes in silent amazement.

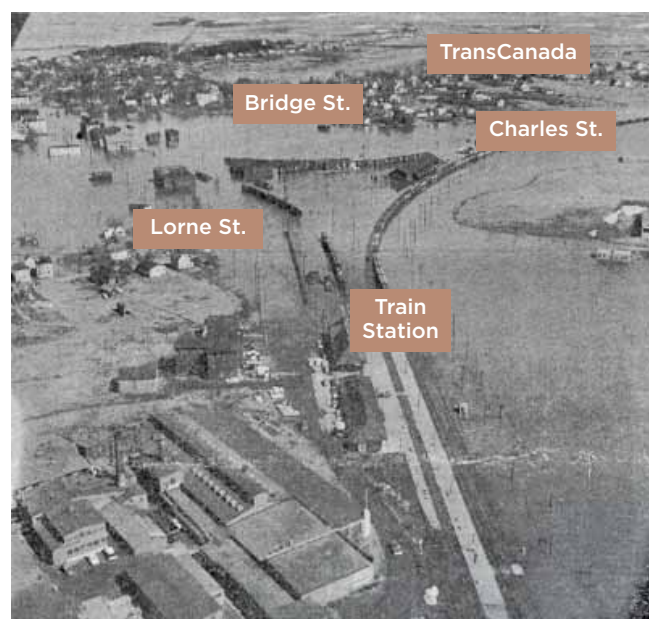
Source: W. K. Bowser diary in the Mount Allison Archives

Barns and even small schooners were driven up on high land and dykes were torn down in all directions, necessitating a heavy expense. Farmers lost nearly all their hay which was in stack (there being few barns on the marsh at that time) along with cattle and sheep pasturing on the marshlands. One particular incident happened in which a mare and her nursing colt floated on a haystack bottom across the Bay of Fundy to Rockport, alive and well. With extra work and expense, the farmers got the dykes rebuilt and gathered enough hay to get through the winter and stock came out well.

Source: http://heritage.tantramar.com/WFNewsletter_10.html

1962 Freshwater Flood

A more recent storm occurred on April 3, 1962. After heavy rains, Sackville was impacted by severe fresh water flooding. The height of the flood was estimated to be 8.0 m. Lorne Street in Sackville was completely flooded from the CN Station to Bridge Street. At Black's Hardware Store (now Bowser's Construction Ltd.) the water was over a metre deep.



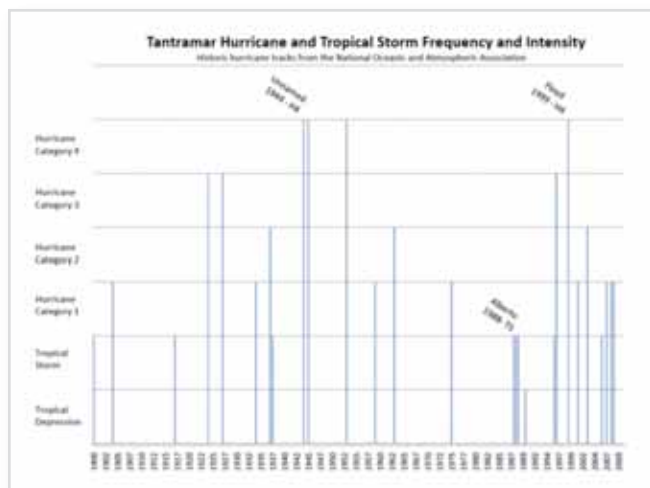
The freshwater flood of 1962 in Sackville shows extensive flooding.

Source: The "Moncton Daily Times", Vol 85, April 4, 1962.
Accessed from the Mt Allison University Archives



The 1962 freshwater flood inundated low lying areas of Sackville, including Lorne, Bridge and Charles Streets.

Source: Oct, 1991. NB Dept. of Environment and Local Government



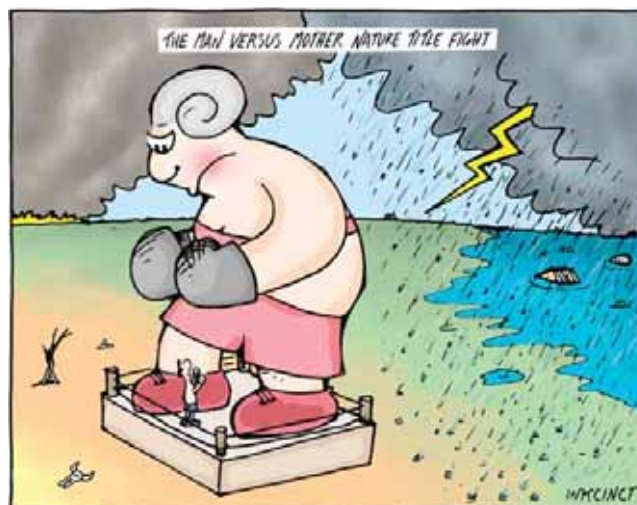
Storms are becoming more frequent and more intense.

Source: Lieske and Bornemann 2012

This graph shows the frequency and intensity of hurricanes and tropical storms to hit the Tantramar area since 1900. In the last decade there have been several serious storm events in the region. Storm surges often accompany these events and can cause considerable damage. For example, two storms hit Port Elgin in 2010 with extensive damage estimated to be around \$900,000.

What is a 100-year storm?

A 100-year storm (1:100) is severe and will cause major flooding but it is not a storm that occurs every 100 years. It is a storm that has a 1% chance of occurring each year. So it is rare but it could occur every year. Similarly, a 10-year storm (1:10) is less severe and has a 10% chance of occurring each year. A 5-year storm is much more likely to occur each year, but could also occur several times a year. Climate change is causing more severe storms to happen more often.



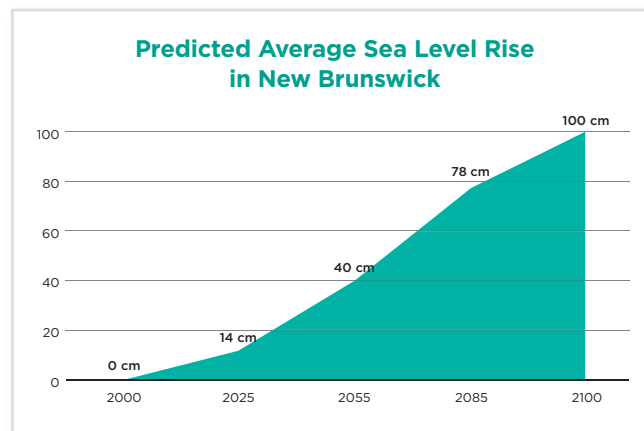
Source: 2011-032 ©INKCINCT Cartoons www.inkcinct.com

Sea Level Rise

Sea levels are rising because of:

- Melting polar ice caps and glaciers
- Expansion of warmer water molecules in the oceans
- Coastal lands are slowly sinking

Coastal lands are sinking because land in the middle of the continent is still in a process of rebounding from glaciers that retreated after the last ice age approximately 10,000 years ago. This has gone on for thousands of years, and is not related to today's climate change, but this very slow continental movement will worsen the impact of storm surges and sea level rise for coastal communities.



Source: Lee and Daigle, 2012

How Much Will Sea Level Rise in New Brunswick?

Scientists' best prediction is that by 2025 sea level is expected to rise by around 14 cm compared to what it was in 2000. By 2055 it will be about 40 cm higher and by the end of the century it is predicted to be 100 cm (1 metre) higher.

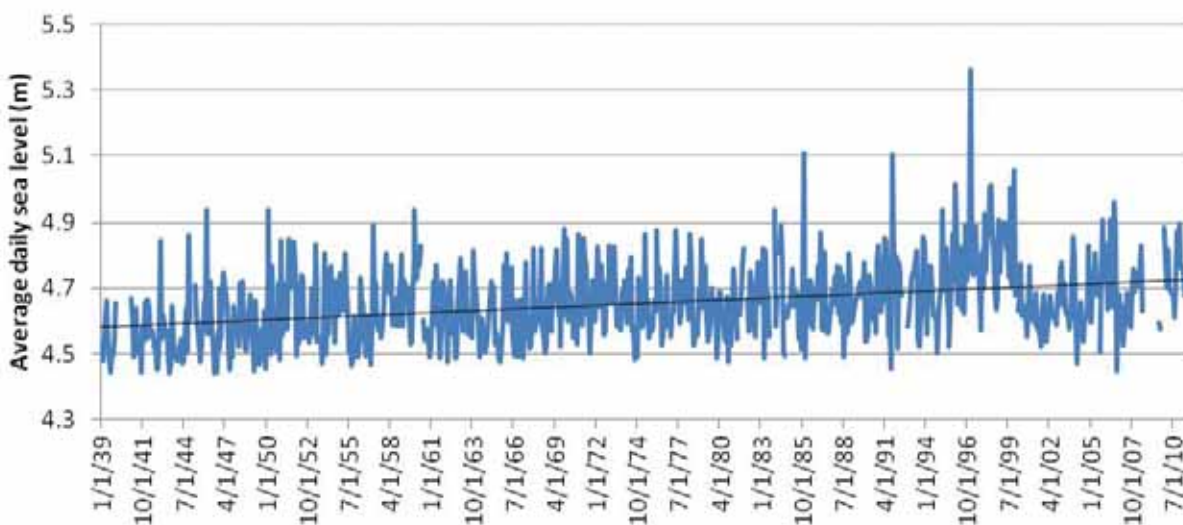
Source: Daigle, 2011 & New Brunswick Climate Change Secretariat, 2012a

What is a storm surge?

Storm surges are usually caused by low pressure and are an increase in the tide level compared to what was predicted. New Brunswick coasts most often feel the impacts of storm surges during powerful late fall and winter storms, and from hurricanes. Storm surges are worst when they coincide with high tides. Because of sea level rise, worst-case flood levels could happen much more often.

Like rising global temperatures, sea levels have been rising for a long time too. The graph below shows how the ocean level has been rising at Saint John since 1939 (when measurements began).

Maximum monthly sea level – Saint John (1939-2011)



The sea is rising around New Brunswick.

Source: Lieske and Bornemann, 2012

Find out more about sea level rise, check out these studies:

Sea-Level Rise and Flooding Estimates for New Brunswick Coastal Sections

By Réal Daigle (2012)

<http://atlanticadaptation.ca/node/285>

**Sea-Level Rise Estimates for NB Municipalities
Le Goulet, Saint John, Richibucto, Sackville,
Shippagan, Caraquet**

By Réal Daigle (2011) <http://atlanticadaptation.ca/node/203>

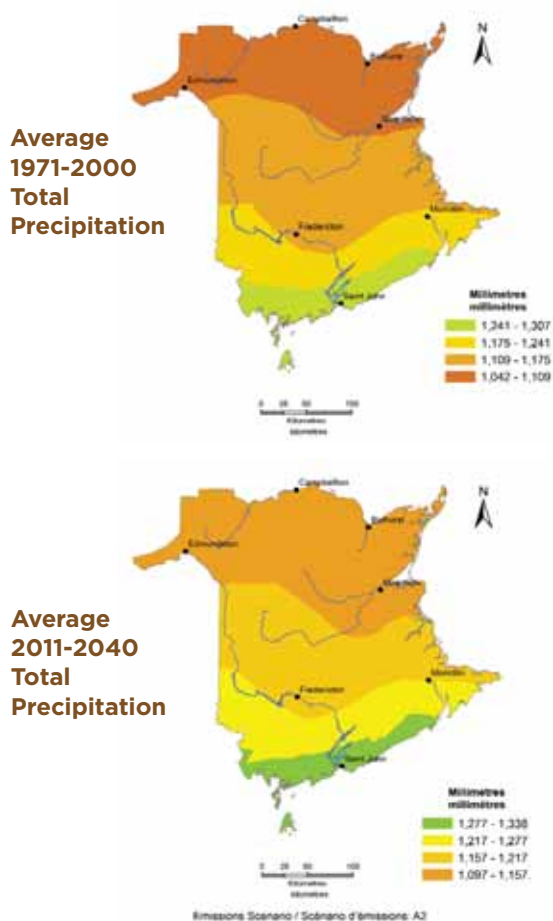
**Sea Level Rise and Flooding: What they Mean
for New Brunswick's Coastal Communities**

Lee, Caroline and Daigle, Réal (2012)

<http://atlanticadaptation.ca/reports>

Changing Precipitation Patterns

Changes to climate will affect precipitation patterns around the world. While other areas are expected to get drier, in New Brunswick we can expect an increase in total annual precipitation. This increase in annual rain, snow and freezing rain is anticipated to fall in fewer, but more intense events, which may lead to flooding and erosion. The maps below show the total annual precipitation between 1971 and 2000 and the potential average for the future.



Total annual precipitation is expected to increase but fall in fewer, but more intense events.

These maps can be downloaded free of charge from New Brunswick Climate Futures at www.acasamaps.com

Predicted Impacts

Climate change in Tantramar means four things:

- 1 Dyke Breaches and Flooding
- 2 Transportation Challenges
- 3 Economic Damage
- 4 Opportunities and Challenges for Agriculture
- 5 Health Issues

Dyke Breaches and Flooding

Tantramar is a unique area, home to the world's largest tides, vast expanses of open marshland, and a network of dykes that span 33 km. It was Acadian settlers who arrived in the region in the 1670s and soon after began to dyke and drain the marshes, seeing the agricultural potential in their fertile soils. The Acadians built aboiteaus, a valve or flap, in the dykes to allow water to drain from the fields at low tide but prevent saltwater from entering at high tide. They were also used to drain the land after high tides and storms had forced the seas to overtop the dykes. Historically the dykes were built and managed to protect agricultural use of the marshes only.

Today the New Brunswick Department of Agriculture, Aquaculture and Fisheries continues to manage the dykes. It is important to realize that while part of the Town of Sackville is located on dyked lands and the town is partially protected by the dykes, the defence of Sackville against floods is not what the dykes are currently being managed for.



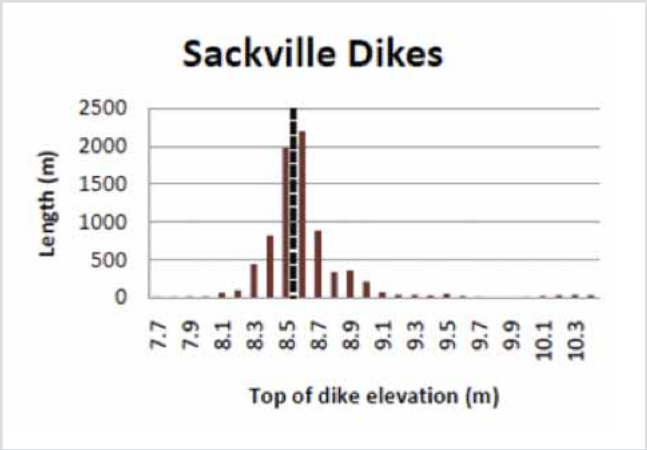
A stretch of dyke along the Bay of Fundy.

Source: Janet Crawford

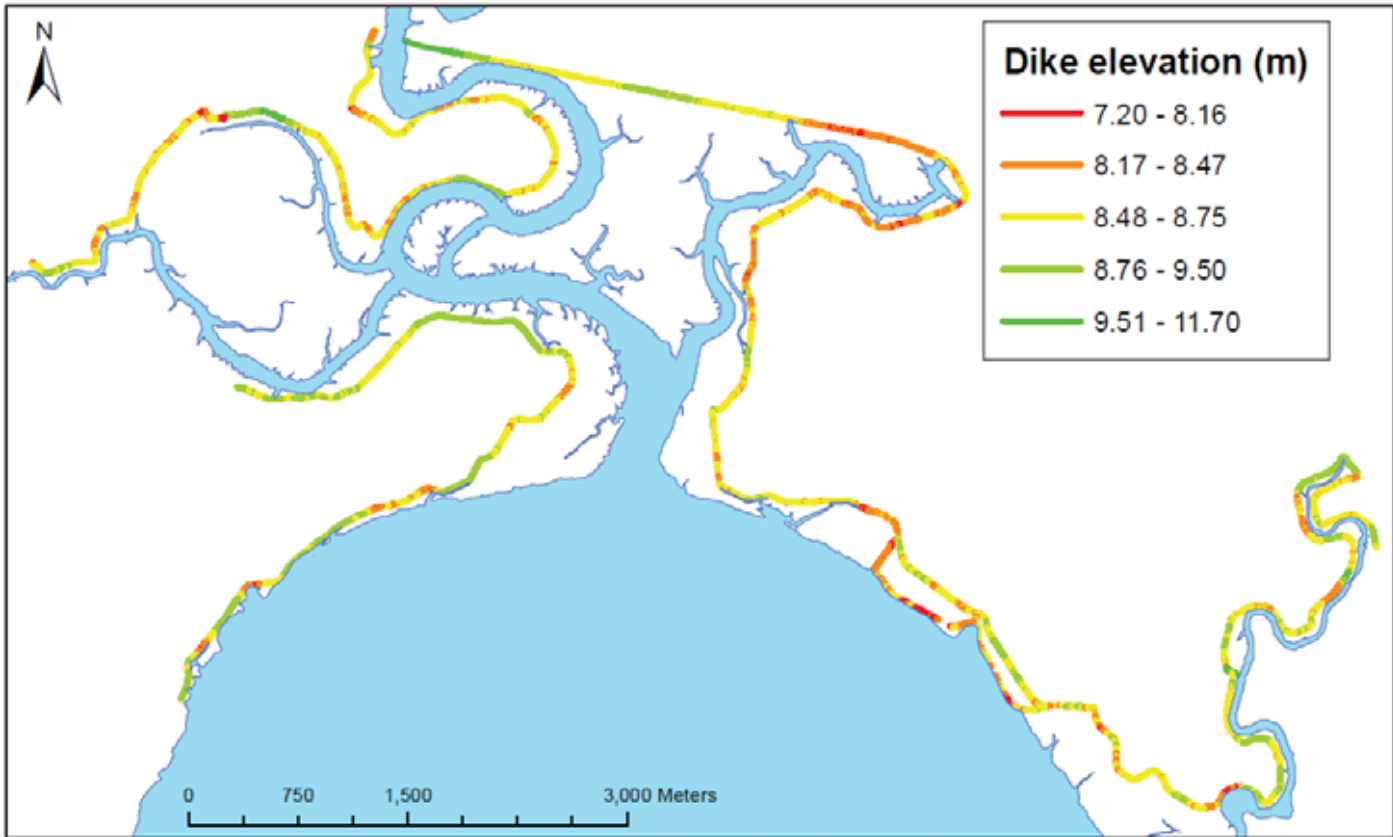
Sackville

The current average height of the dykes around Sackville is 8.6 metres. The diagram at right shows the range of dyke elevations.

Below we can see how high each section of dyke was in 2012. The orange and red sections are lowest (and could easily be overtopped by storm surges), while the green shades are tallest. The longest stretch of lower dykes is also the CN rail line, running beside the Trans-Canada Highway approaching Aulac. There are also sections of lower dykes around the town of Sackville.



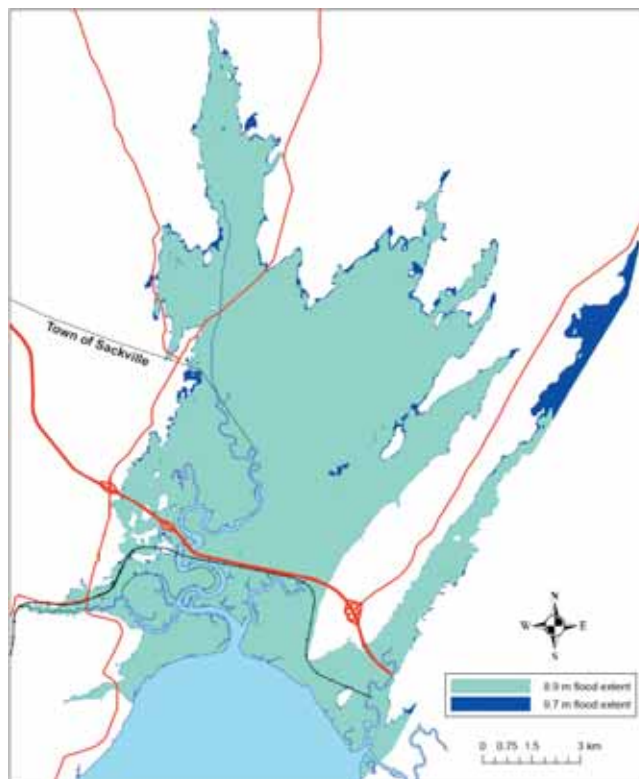
The average height of dykes around Sackville is 8.6 m.
Source: Lieske and Bornemann, 2011



The location of dykes and their heights. Red indicates lower; green indicates higher.
Source: Lieske and Bornemann, 2012

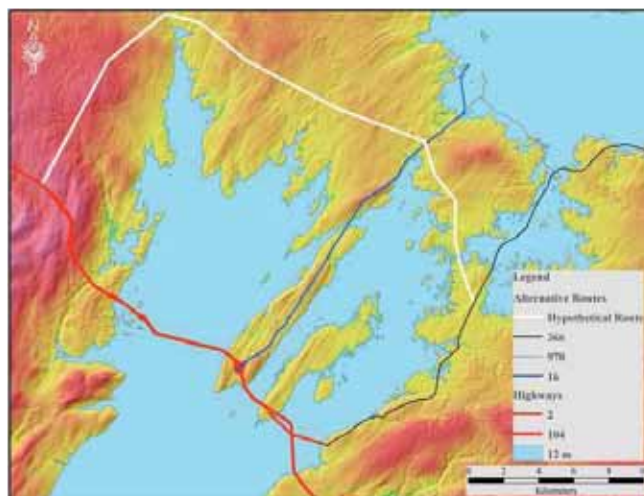
The dykes were built to protect agricultural lands, which can withstand periodic flooding. So the dykes can limit impacts from increases in sea level, but they are not high enough to protect the region from mildly severe storms, such as those that have a 10% chance of occurring in any one year (or a 1:10 year storm). The current scenarios estimate that a 1:10 year storm would see sea levels of 8.9 m (see maps above right and also on page 10). Because the average height of the dykes is 8.6 m, a storm of this strength could overtop 89% of the dykes and flood roughly 20% of the town of Sackville (population 5,500). This extent of flooding translates into 156 buildings and 1,049 properties being affected. Major and secondary highways could be flooded as well as the town's sewage lagoon, which shares its seaward wall with part of the dyke system. Agricultural lands will be flooded and some parts of Sackville with higher elevations may become islands, surrounded by flood water.

Many different climate change scenarios are being studied. A current 1:100 year storm that impacts Sackville could see a 9.8 m flood and extensive damage (see the map on page 11). Both of the current 1:10 and 1:100 year storm events could happen anytime. If or when sea levels reach 12 m due to storm surges and severe weather events, Nova Scotia could become an island (see map below right). The existing highway routes are mapped below along with a hypothetical connector route along the highest terrain (white line).



This map above and the map on page 10 show the estimated current extent of flooding from an 8.9 m flood in Sackville.

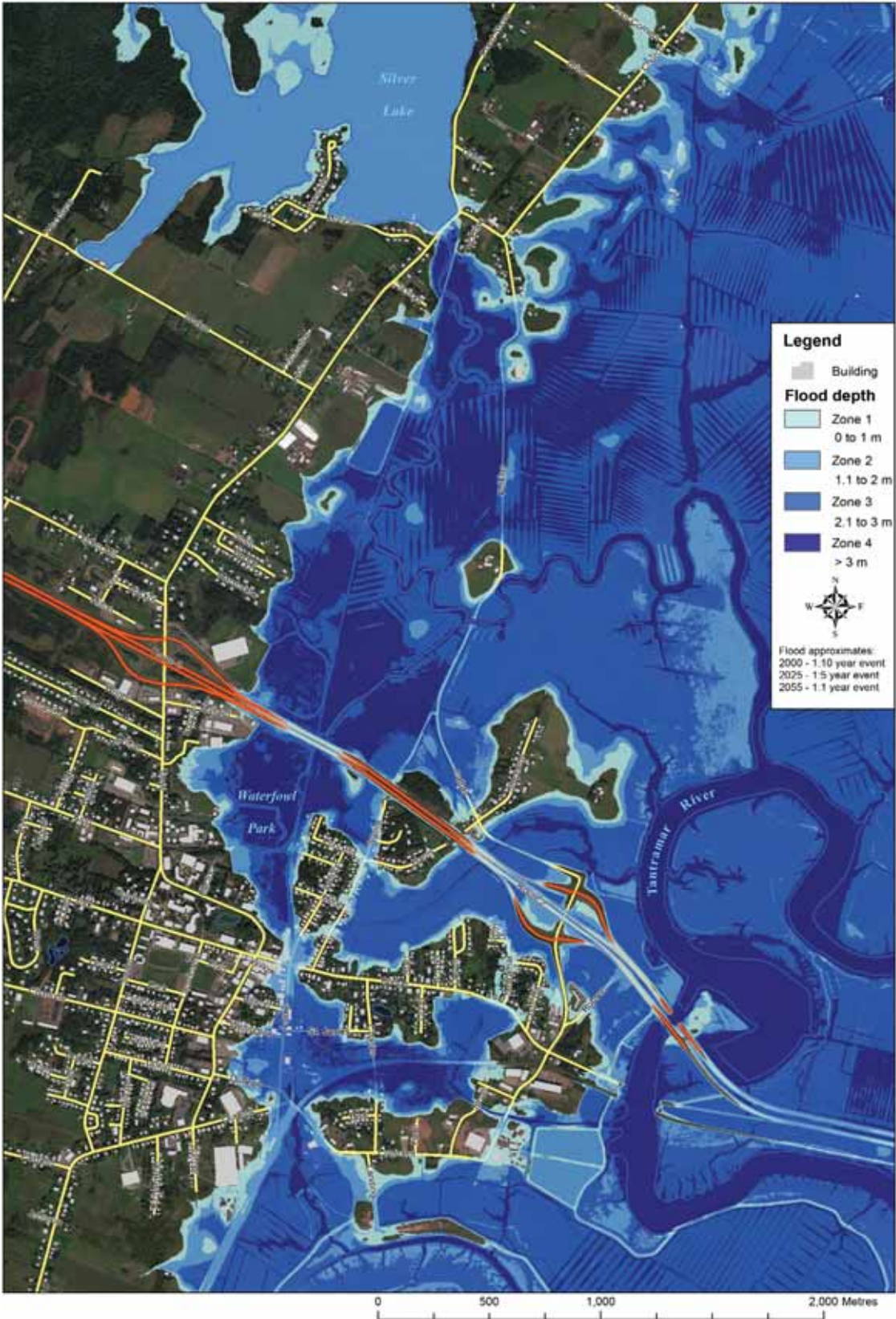
Source: Lieske and Bornemann, 2011 & 2012



A 12 m storm surge could make Nova Scotia an island. The white line shows a possible route along the highest points of land.

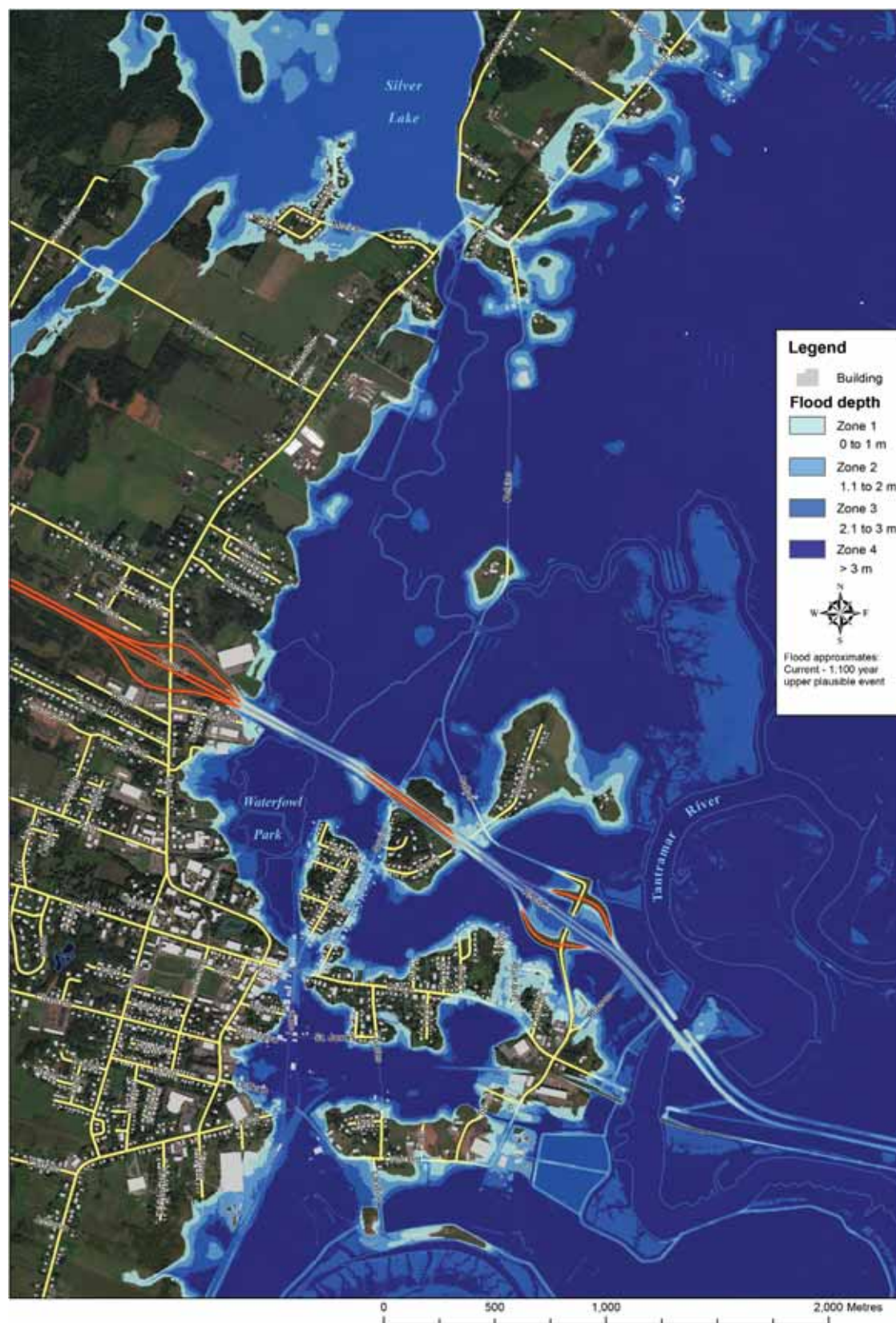
Source: Webster et al., revised Dec 2012

Current 1:10 Year Storm Event and Flood Risk for Sackville



Source: J. Bornemann, South East Regional Service Commission.

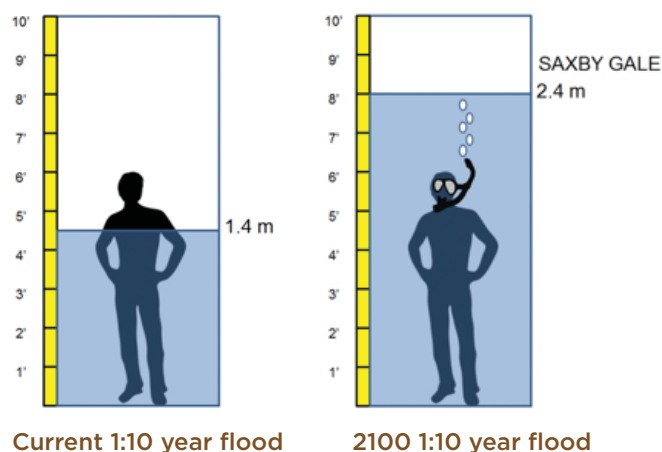
Current 1:100 Year Storm Event and Flood Risk for Sackville



Source: J. Bornemann, South East Regional Service Commission.

Adapting to Climate Change

If a 1:10 year storm occurred in the near future and dykes around Sackville are overtopped, there could be as much as 1.4 m of water at the corner of Lorne and Bridge Streets in downtown Sackville. Fast-forward to the end of the century, when there will be much higher sea levels and the same storm could overtop the dykes and fill the corner with 2.4 m of water (similar to levels seen during the Saxby Gale). If adaptation measures are not taken, future residents of Sackville will need scuba gear to get around down town!



Flood Levels at the corner of Lorne St. and Bridge St., Sackville, NB.

Source: Lieske and Bornemann, 2012



Sabine Dietz

Did you know?

When the dykes were originally built, their creation meant the loss of 85% (or 365 km²) of pre-colonial area salt marsh around the Bay of Fundy.

Removing certain portions of dyke (where they are not protecting infrastructure, buildings or active agriculture) and allowing the land to return to salt marsh is one climate change adaptation option that local groups such as Mount Allison University have been studying for many years.

Salt marshes have a natural ability to shift with rising sea levels, absorb and disperse intense wave energy, decrease erosion, and create a natural buffer area between sea and land. They are also effective carbon sinks, taking in excess carbon dioxide.

Source: Marlin et al., 2007

Information about the dykes and flooding were taken from these studies:

**Coastal Dykelands in the Tantramar Area:
Impacts of Climate Change on Dyke Erosion and Flood Risk**
By David Lieske and James Bornemann, James (2011, 2012)
<http://atlanticadaptation.ca/node/283>

**Tantramar Dyke Risk Project:
The Use of Visualizations to Inspire Action**
By Lori Ann Roness and David Lieske (2012)
<http://atlanticadaptation.ca/node/283>

**An Evaluation of Flood Risk to Infrastructure
Across the Chignecto Isthmus**
By Tim Webster, Malinee Kongwongtha and Nathan Crowell
(Revised Dec 2012) <http://atlanticadaptation.ca/>

Port Elgin

Sackville is certainly not the only community in the Tantramar Region at risk of climate change-induced flooding. Port Elgin, a village of just over 400 people, experienced two damaging flood events in 2010 as the photos here show. On January 2, 2010 the village experienced flooding from a nor'easter. The storm, measured as a 1:25 year event, moved cottages off their foundations and led to a state of emergency being called. \$900,000 worth of damages were estimated. Later that same year another nor'easter battered the small community and a storm surge caused coastal flooding.

The map on page 14 shows the extent of flooding for a sea level rise scenario in Port Elgin. A current 1:10 year storm event could affect 17 buildings and 109 parcels of land. Toward the end of the century, when higher sea levels are considered, the same storm event could flood 68 buildings and 198 parcels.

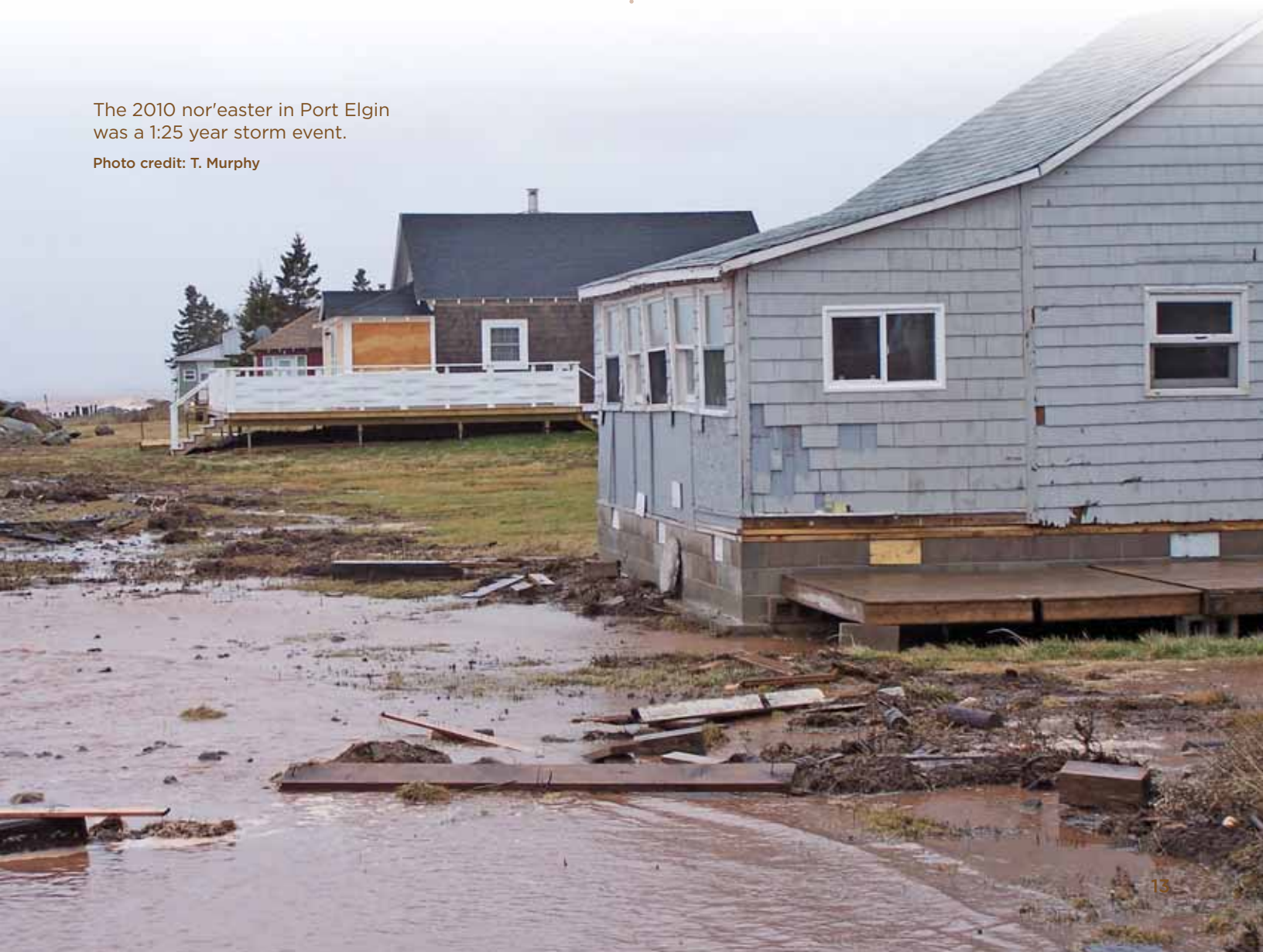


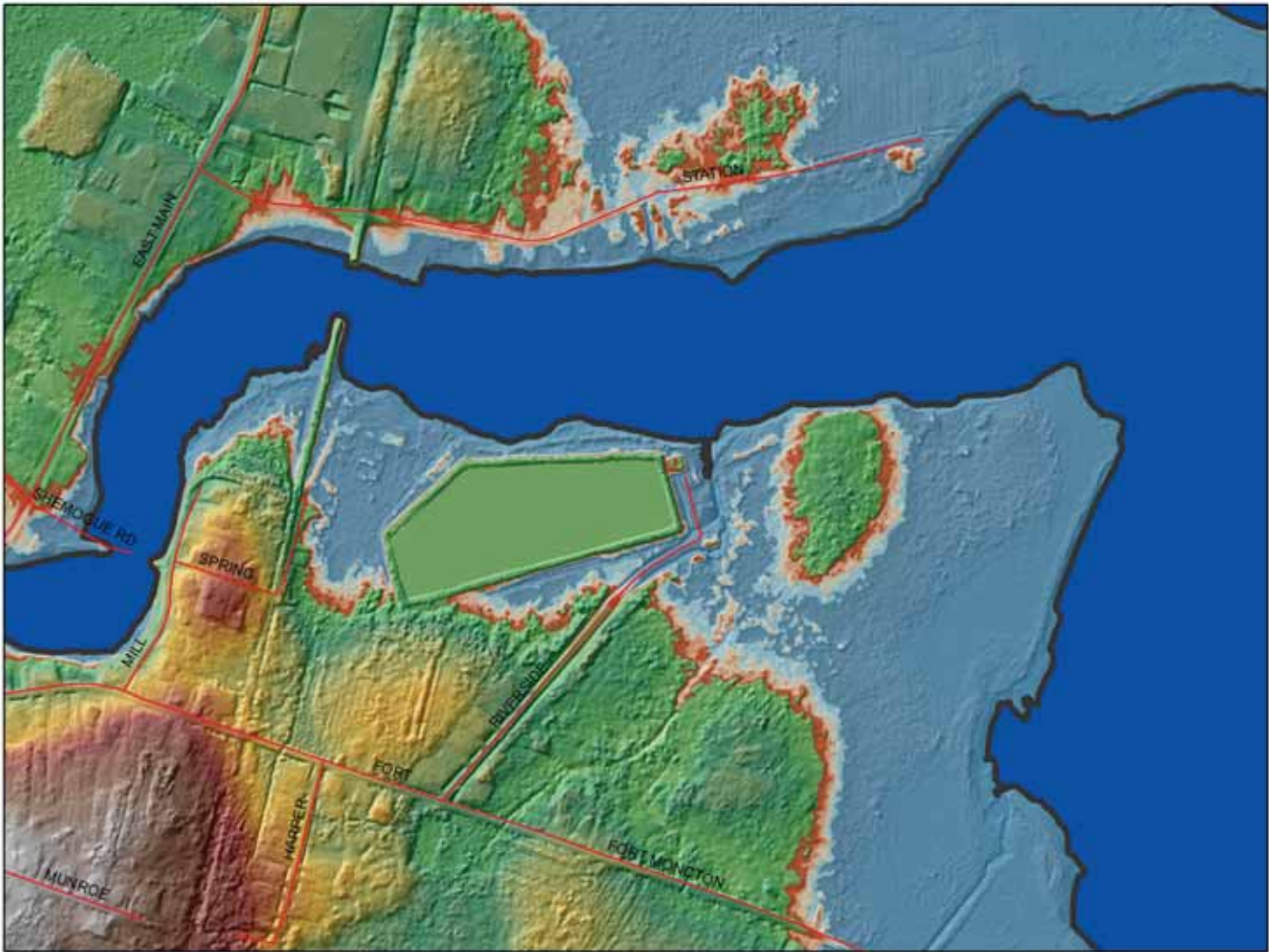
2010 Storm in Port Elgin.

Source: Jellett, 2011

The 2010 nor'easter in Port Elgin was a 1:25 year storm event.

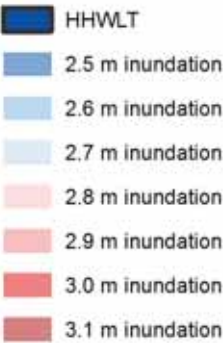
Photo credit: T. Murphy





A current 1:10 year storm event scenario for Port Elgin shows significant flooding.

Source: R. McLean, DOELG



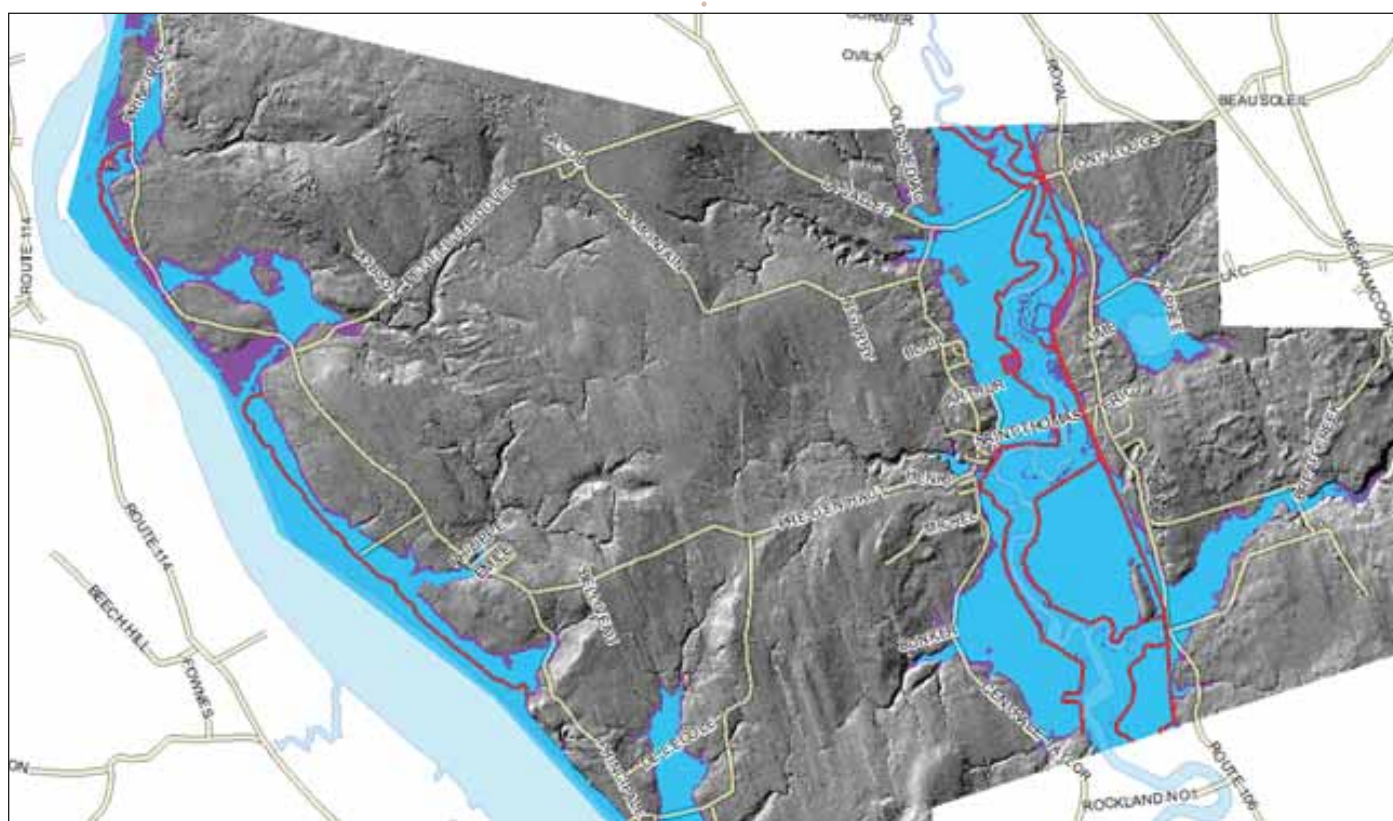
Memramcook

Memramcook, with a population just over 4600 residents, is also vulnerable to flooding due to sea level rise, storm surges, dyke breaches, and also because of damaged culverts. For example, the map below shows the potential extent of coastal flooding for current (in blue) and future (in purple for the year 2100) 100 year flood events. The red lines show the current location of dykes.



Memramcook.

Source: www.nbculturalcoast.com



Current (blue) and future (purple) 100 year flood events for Memramcook. Flood depths equal 7.58 m and 8.6 m respectively.

Source: James Bornemann, South East Regional Service Commission

Adapting to Climate Change

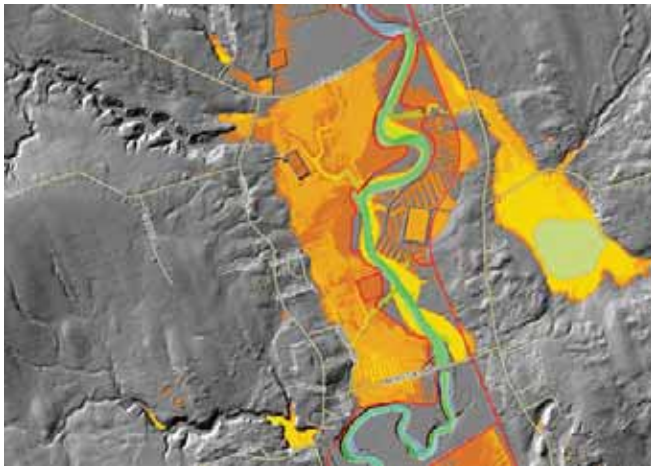
A number of culverts in Memramcook are damaged, blocked or partially blocked with rocks, debris, leaves, sediment, etc. as shown in these photos.



Damaged and partially blocked culverts in Memramcook could lead to flooding.

Source: James Bornemann

The map below shows areas of potential flooding that could result from clogged culverts and closed aboiteaus. Areas with the darkest shades of orange represent the areas that could experience the deepest flooding. The lighter yellow shades are shallower areas of flooding.



Flooding estimate due to clogged culverts and closed aboiteaus in Memramcook, 2012.

Source: James Bornemann, South East Regional Service Commission

Dorchester

Dorchester has experienced flooding in the past, such as with the Saxby Gale (below is an account of the aftermath of the gale). However, studies concerning storm surges, sea level rise and wet area mapping have yet to be completed for the village of 1,167 residents.

Accounts of the Saxby Gale, 1869 in Dorchester

At Dorchester the rise of the waters was eight feet, and they carried away all the fences, bridges, barns, hay, cattle, horses, sheep, and a large amount of dyking. The schooners *Ida May* and *Independence*, lashed to a wharf, were all carried a short distance above Smith & McKelvie's quarry on the upland, where they still remain. A considerable amount of property was lost in the station. A new piano of Mr. Trites' was nearly destroyed, and his family were much alarmed. An engine-cleaner at his work in the engine house was surprised by the waters, but climbed up on the rafters and remained there until next day.

Source: "The storm" From *The Borderer*. Sackville, N.B., October 14, 1869



Johnson's Mills, outside Dorchester.

Source: A. Marlin

Transportation

The New Brunswick/Nova Scotia Transport Corridor is a part of the Atlantic Canada Gateway and Trade Corridor – a system of major ports, international airports, key border crossings, and road and rail connections between Atlantic Canada and North America's major markets. A variety of commodities pass through the corridor such as gasoline and fuel, petroleum, wood pulp, machinery, automobiles, and various food products. The largest users of transportation in the area are manufacturing, forestry and logging, wholesale and retail trade.

For trade to be efficient it depends on accessible and reliable rail and road networks. In fact, the CN rail line moves 97% of all international traffic through the corridor, and right past Memramcook, Dorchester and Sackville. The Trans-Canada Highway is the second most important transportation route in the region.

Did you know?

\$43 billion worth of goods involved in international trade move through Atlantic Canada annually.

Source: Yevdokimov, 2012

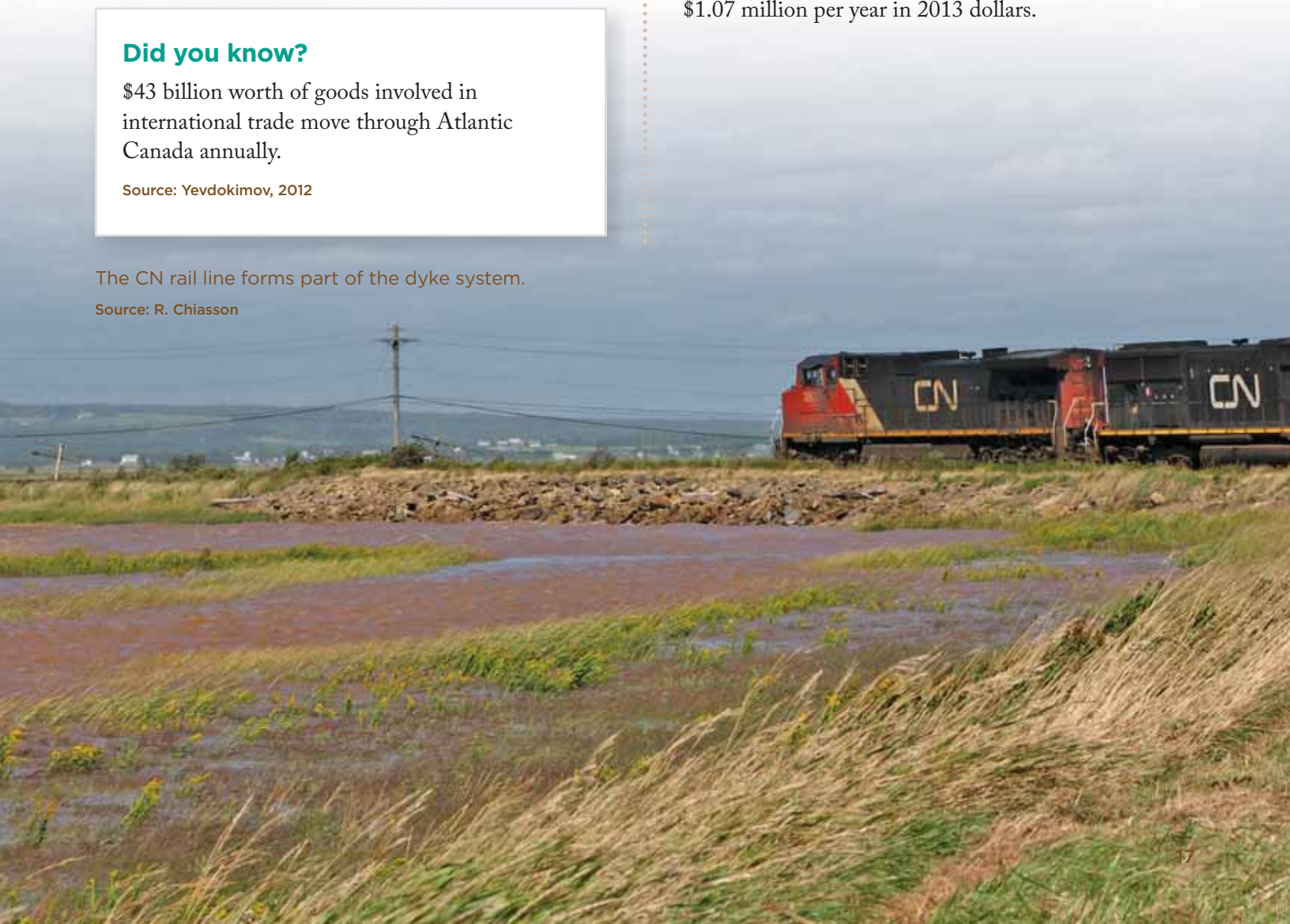
The CN rail line forms part of the dyke system.

Source: R. Chiasson

Climate change is predicted to affect the New Brunswick/Nova Scotia Transport Corridor in five important economic ways:

- 1 Damage to roads, highways, etc.
- 2 Disruption in transportation operations
- 3 Travel time loss (due to traffic interruptions/ delays caused by storms, floods, etc.)
- 4 Increase in costs of transportation accidents and derailments (property damage, hospital care, traffic delay, emergency response and out-of-pocket expenses by the victims)
- 5 Loss of labour income and profits in related sectors (the transportation network is a central part of the regional economy and climate change will affect all its users directly and indirectly including agriculture, forestry and the general public)

Climate change impacts (flooding, extreme weather events, general worsening of weather conditions) are estimated to cause a disruption in transportation operations to a total value of just over \$1.07 million per year in 2013 dollars.





Flooding will impact transportation routes.

Map source: J. Bornemann, South East Regional Service Commission

The overall annual economic loss from the cumulative effects of climate change impacts on the New Brunswick/Nova Scotia Transportation Corridor is estimated to be over \$11.8 million per year (in 2013 dollars).

It may be necessary to invest in mitigation measures during the next 11 years to a value of anywhere between \$11.9 million and \$20.3 million to avoid those losses. These numbers depend on economic growth, oil prices, and a loss in transportation volume due to climate change impacts.

Information on impacts to transportation came from the following studies.

Economic Consequences of the Climate Change Impacts on the NB/NS Transport Corridor
By Yuri Yevdokimov (March 2013)
<http://atlanticadaptation.ca/>

Economic Evaluation of Climate Change Impacts on New Brunswick-Nova Scotia Transport Corridor
By Yuri Yevdokimov (2012)
<http://atlanticadaptation.ca/node/284>

The Economic Cost of Future Flood Damages

The potential economic damage associated with increased flood risk has been calculated for the Sackville region. This information is important as it will affect how communities decide to adapt to climate change.

Past floods have certainly resulted in huge economic costs for the Town of Sackville and more recently the Village of Port Elgin. In the days following the April 1962 fresh water flood in Sackville damage estimates ranged from several thousand to one million dollars. Several weeks later the estimated cost of damage was refined to a total of \$197,000. In today's dollars that would equal over \$1.4 million!

More recent damage in Port Elgin totalled \$900,000 from a single storm surge event in January 2010.



Newspaper coverage of Sackville's 1962 flood.

Source: Moncton Daily Times, April 4, 1962

To calculate the economic cost of damages from future flood events the following has been considered for the Town of Sackville:

- 5 different climate scenarios
- Depth of flood waters and duration of flood
- Assets at risk (eg. residential, commercial and public properties, contents of properties, agricultural crops, and vehicles, as well as less tangible aspects such as human illness, clean-up costs, business disruption, temporary displacement, emotional stress, etc.)
- Market value of vehicles, types of vehicles owned
- Types of crops grown on agricultural land and their market values
- Probability of storms and floods happening in each month and which crops would be impacted in each month
- Potential adaptive strategies (a stakeholder group discussed what people might do to adapt and how to prepare and offset the costs of damages ahead of time)



STILL FLOODED — Shown above are two scenes in the town of Sackville which is still under water following the flooding which reached its peak Tuesday. The town is now facing the hazards of open sewage and a contaminated water supply. The top photo shows Lorne Street near the CNR Station looking towards Bridge Street while the bottom photo shows the interior of Black's Hardware Store.

Lorne St. businesses and stores experienced significant flooding in 1962 as documented in the "Moncton Daily Times", Vol 85, April 6, 1962.

Accessed from the Mount Allison University Archives

Economic costs were calculated for the following agreed upon adaptation strategies:

- 1 Doing nothing
- 2 Raising the height of the dykes
- 3 Moving infrastructure outside high risk areas
- 4 Mixed Strategy (both raising dykes and relocating)

Each of these adaptation scenarios were examined and were compared to determine the rough cost of damages that might be avoided by using each strategy.

The Cost of Doing Nothing

If the Town of Sackville does nothing new to adapt to climate change the expected annual cost could be nearly \$1.5 million. As climate change intensifies, these costs are expected to increase to nearly \$1.7 million by 2025, just over \$2.1 million by 2055, and over \$3.1 million per year by 2085. Over the next 100 years, if the climate futures occur as forecasted, the total present value of the expected annual damages is \$59.3 million.

Raising the Dykes

Discussion with local dyke experts suggested that a dyke top-up strategy could be reasonably implemented over a five-year period, subject to available funding. Proposed cost for dyke top-up is a little over \$1.2 million including a new dyke behind the CN rail line.

It is important to note that the structure of the dykes prevents them from being topped up continuously. Because of the way Acadian settlers built the dykes over 200 years ago they can only support being raised to a certain height, and then no more. The option of raising the dykes is not as simple as topping them up over and over again.

Relocation

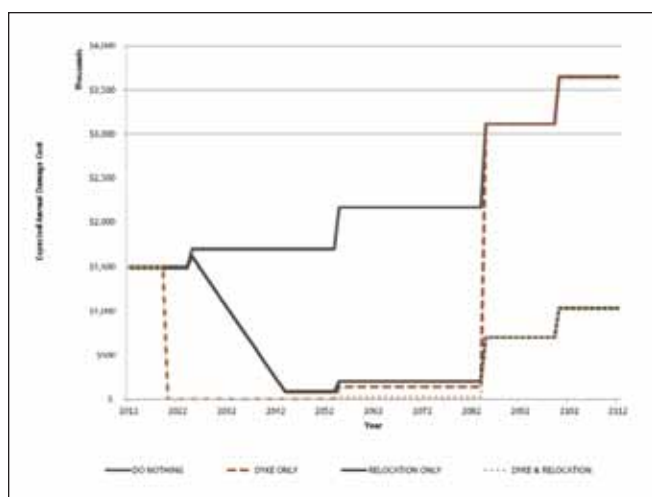
A relocation strategy involves moving infrastructure out of high risk areas. The strategy would require some policy research and development to determine the most effective and efficient way to relocate high risk assets. A number of policy mechanisms could be explored ranging from direct purchase of land by government to using tax or other incentive mechanisms to encourage individuals to relocate from high

Adapting to Climate Change

risk areas to low risk areas. Depending on the type of mechanism used, the costs could vary significantly. The researchers assume that land purchase would be used (at fair market value) which would cost roughly \$19.7 million. However, this would be implemented over an assumed 20 year implementation period between 2025 and 2045. Therefore, the present value of these costs, assuming land purchase is implemented evenly over the 20 year period, would be \$10.3 million.

Mixed Strategy

Costs associated with the mixed scenario would be the sum of both relocation and dyke top-up scenarios.



Expected costs of doing nothing versus adapting to climate change.

Source: Wilson et al., 2012

In summary, for the Tantramar Region, and Sackville in particular, despite the costs involved in adaptation options, the price of not doing anything, especially when we now know what climate change has in store for us, is so much higher, as depicted in the graph above.

Information about economic damages came from the following study:

Forecasting Economic Damages from Storm Surge Flooding: A Case Study in the Tantramar Region of New Brunswick.

By Jeff Wilson, Ryan Trenholm, Ryan, James Bornemann and David Lieske (2012)

<http://atlanticadaptation.ca/node/307>

Agriculture

The Tantramar area has been involved in agriculture since the 1670s when Acadian settlers first arrived in the area and began dyking the marshes to use the fertile soil. Since these early days agricultural activities have been impacted by floods and storms, most notably the 1869 Saxby Gale (see excerpt below). In addition, there have been other floods over the years such as one in 1917 which filled the marshes with water as shown in the photos on the next page.

Excerpt from “The storm”

Featured in *The Borderer*, Sackville, N.B., October 14, 1869

It has been estimated that not over 2,000 tons of hay have been destroyed. This loss, great as it is, to our hard working farming people, will not be so severely felt now as the loss of the English grass next season, for there can be no doubt that wherever the salt water has touched English grass lands, their productiveness has been destroyed for one season at least. As the fencing has been entirely swept away, renewing it will be a heavy item. Thus the loss in hay to many is most ruinous, and the high price of labor will make the re-erection of dykes the most expensive and burdensome. The marsh proprietors have decided, we understand, not to erect any dykes this fall. In this they are quite wise, for the great majority of marshes will, we are satisfied, feel vastly the benefit of a winter's run of tides, and heavy crops in the future will tell of the rejuvenating effects of this flood. Indeed, our farmers, as a rule, are most unreasonably afraid of a dash of salt water and mud, considering it is to them alone that we owe the fertility of our marshes.

“Clearly adaptation and mitigation will need to be made around the globe, and Sackville is no exception.”

Mel Jellet, Department of Geography and Environmental Studies, Mount Allison University



1917 Flood on Tantramar Marshes.

Accessed from the Mount Allison University Archives

Much of the agricultural land in the Sackville area is in low-lying dyked land in the direct path of storm surges and sea level rise. Apart from potential flooding, there is a long list of impacts and stresses that climate change is predicted to bring to agriculture around the world:

- Limited availability of water
- Loss of biodiversity
- Air pollution
- Reduced resilience
- Soil erosion
- Increased salt content in irrigated areas
- Over-extraction of ground water
- Growing susceptibility to disease

In Sackville there are 80 farm operators comprising a total area of 8,436 ha and worth a total of \$26,127,037 (based on total farm capital). See the agricultural land use map on the next page for the location and types of farms.



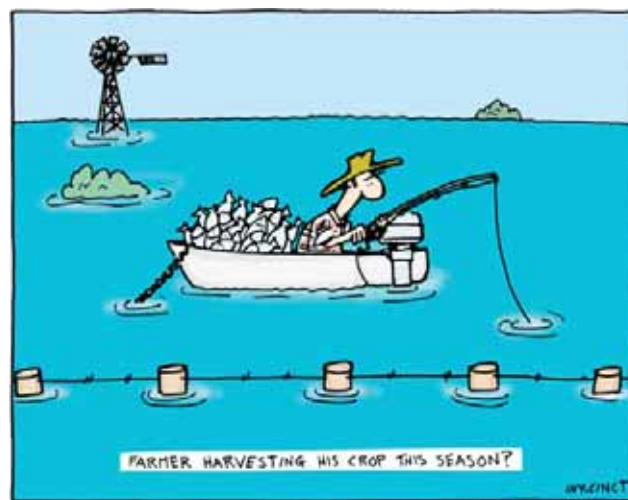
The Tantramar Marshes.

Source: http://en.wikipedia.org/wiki/Tantramar_Marshes

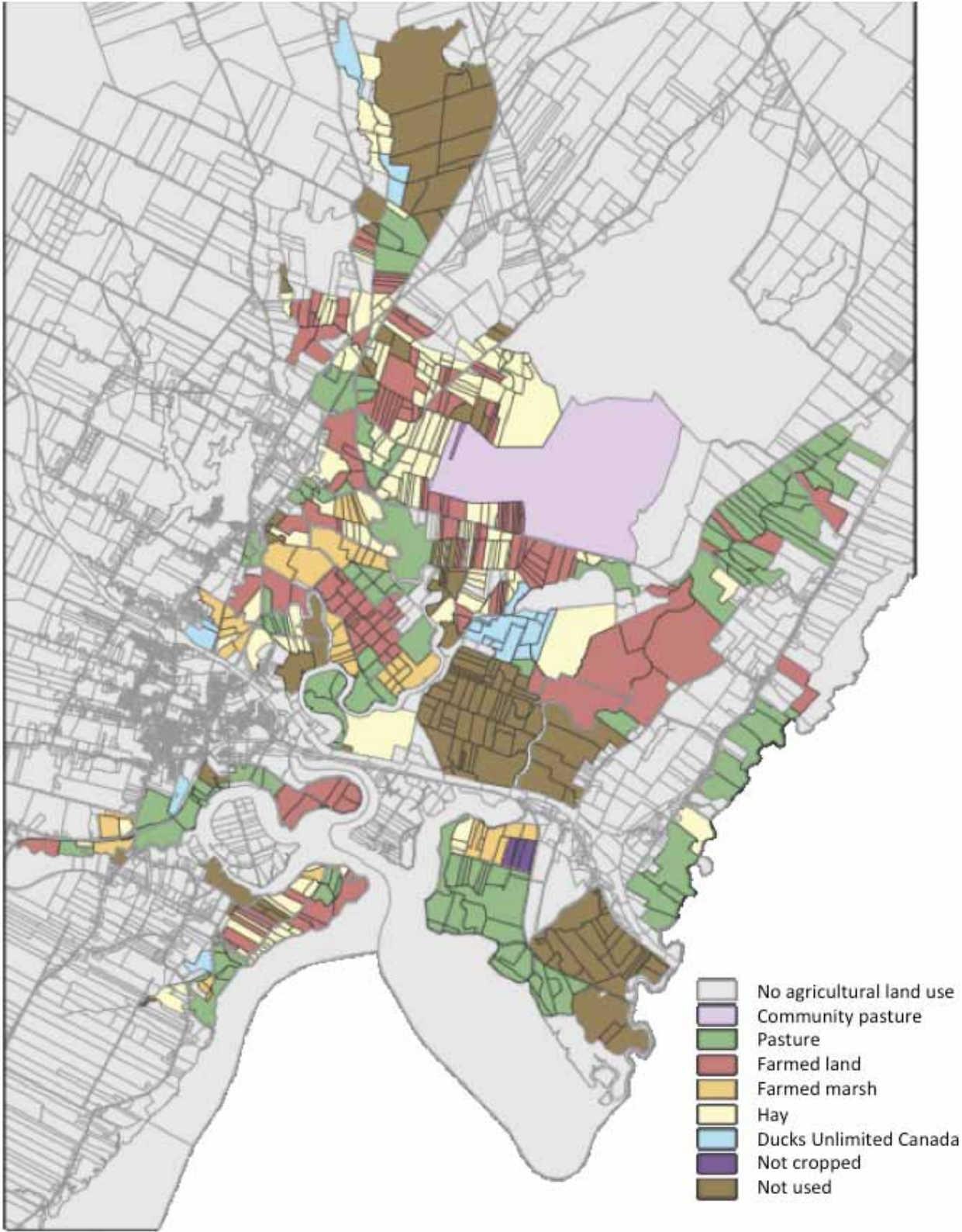
There are pros and cons for agricultural production in the Tantramar Region when it comes to climate change.

Climate Change Related Opportunities for Tantramar Farms

- Opportunity to grow a wider range of crops
- A longer growing season
- Grow higher yielding crops



Source: 2010-517 ©INKCINCT Cartoons www.inkcinct.com



Agricultural Land Use in Westmorland County

Source: Bornemann, 2011 in Jellett, 2011

Climate Change Challenges for Tantramar Farms

- Faster growing weeds
- Introduction of new invasive weeds and pests
- Heat stress will affect milk production in cows
- Sea level rise and storm surges could flood fields with salt water for days
- Increased use of fertilizer, herbicides and pesticides because of increased temperatures and periods of drought
- More frequent droughts during the growing season make irrigation essential for most high-value crops
- An increasing number of storms producing heavy rainfall may delay spring planting and damage crops and soils
- Investment in new farm equipment and storage facilities as shifts are made to grow new crops
- Adaptation strategies to combat climate change can be costly

What is the risk of floods on farmlands around Sackville?

A 7 m flood would roughly affect 35% of the agricultural land in and around the town of Sackville. This number jumps dramatically with a 9 m flood event, where dykes would be overtopped and close to 93% of farm land would be flooded.

Source: Jellett, 2012

Information in this section is based on the following study:

Agricultural Adaptation Strategy for the Tantramar Region
By Mel Jellett (2011) <http://atlanticadaptation.ca/node/282>

Health Issues

Residents of Tantramar may experience health impacts due to climate change. In particular, the Town of Sackville's sewage treatment ponds share a wall with the dyke. If a storm surge overtops or breaches the dykes and floods the sewage ponds, raw sewage could spill onto the streets of Sackville creating a severe health emergency. Sewage could also back up into houses in the town. Flooding could also disperse chemicals and fuel stored on commercial and residential properties anywhere in Tantramar.

Furthermore, studies are being conducted to understand the impacts of climate change on the distribution of Lyme disease-carrying ticks. The distribution of these ticks has changed in certain parts of Canada, including New Brunswick. Warmer temperatures could bring more ticks, as well as other pests and diseases to our region.

Dr. Vett Lloyd, Associate Professor in Biology at Mount Allison University, is currently studying the distribution of ticks and rate of Lyme Disease in southeast New Brunswick. Residents are urged to collect ticks they find on themselves or their dogs and submit them to Dr. Lloyd. For more information please contact vlloyd@mta.ca or 364-2509.



Deer ticks could become increasingly common in our region.

Photo source: myhealth.alberta.ca

Part Two



What can be done? Ideas and Suggestions for Preparing and Adapting

The following pages list many ideas for those involved in climate change adaptation planning as well as for the general public and farmers.



Source: 2011-152 ©INKINCINCT Cartoons www.inkcinct.com

Municipal Governments

Municipal governments (elected officials and staff) have a crucial leadership role to play in adapting to and preparing for climate change and flooding in the Tantramar Region. Here are some things that municipal leaders should do:

- Create a community adaptation plan
- Change land use zoning to minimize residential, commercial and municipal exposure to flood risks (eg. do not let new development take place in flood zones)
- Lobby government to increase the height of dykes as well as offer incentives for the use of renewable energy sources, and other climate change mitigation
- Relocate highly vulnerable residents and businesses (using a voluntary, long-term process including tax incentives, planning policies, land use plans, etc.)
- Move community assets out of flood prone areas (eg. Sackville sewage pond)
- Build storm surge barriers
- Support the removal of certain dykes for salt marsh restoration
- Develop a “green corridor” where wetland areas are allowed to develop to naturally absorb flood water and wave energy
- Regularly update residents with the latest climate change research and plans

- Create warning systems to alert residents of imminent flooding
- Take legal responsibility (municipalities could have legal responsibilities for damages incurred from flooding if failing to take reasonable measures to prepare for it, such as protecting water, wastewater, or other municipal infrastructure)

“One of the keys to success for communities, in the thousands of years that humans have created them, is our ability to learn, adapt and survive. For many of us who have been working on climate change and community development for a long time, the experiences are very encouraging. We discover that our communities already have many resources to build upon: inspiring local leaders; traditional wisdom, history and stories that guide us; and, a resiliency of spirit that maintains hope.”

Margaret Tusz-King, Sackville Town Councillor

Information for municipal governments came from:

Forecasting Economic Damages from Storm Surge Flooding:

A Case Study in the Tantramar Region of New Brunswick

Wilson, Jeff; Trenholm, Ryan; Bornemann, James; Lieske David (2012) <http://atlanticadaptation.ca/node/307>

Tantramar Dyke Risk Project:

The Use of Visualizations to Inspire Action

Roness, Lori Ann and Lieske, David. (2012) <http://atlanticadaptation.ca/node/306>

Sea Level Rise and Flooding: What They Mean for New Brunswick's Coastal Communities

Climate Change Secretariat, New Brunswick Department of Environment and Local Government (2012a) <http://atlanticadaptation.ca/node/328>

Community Leaders

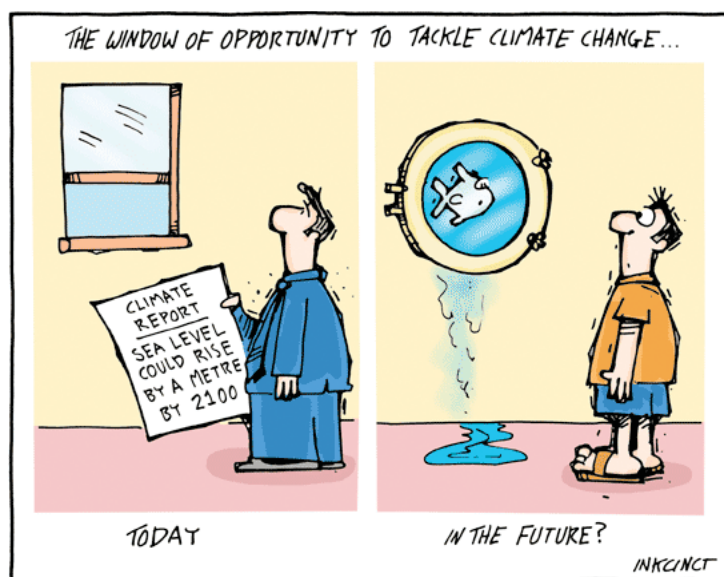
Community leaders in the Tantramar Region are individuals and organizations who lead change. They can be local experts, environmental groups, other non-governmental organizations, and leaders or representatives in the Local Service Districts. Many of these leaders are already taking action on climate change adaptation in our region. Here are some of the things they are currently doing and could do in the future:

- Bring stakeholders together to create a coordinated adaptation plan for Tantramar (a plan was developed in January 2013 and a working group has been established).
- Lobby governments (local, provincial and federal) to make climate change adaptation a priority for Tantramar.
- Lobby governments (local, provincial and federal) to offer incentives for the use of renewable energy sources, and other climate change mitigation.
- Regularly update residents with the latest climate change research and projects they, as leaders and experts, are working on.
- Raise awareness and educate the public through a variety of avenues such as Sackville's Climate Change Week in March 2013.



Community leaders and experts working on climate change adaptation.

Source: D. Lieske



Source: 2011-322 ©INKCINCT Cartoons www.inkcinct.com

Planners

Planners also have an important role to play in enabling municipalities and residents to adapt to climate change. Below is a list of tools, actions and ideas for planners in New Brunswick to use to prepare for climate change.

Regional Service Commissions

- The newly created Commissions are responsible for the development of a regional plan, the aim of which is to better coordinate and manage development of land use within each of the 12 commission regions. More specifically, the Regional Plans will focus on strategies that foster sustainable development practices, that encourage coordinated development between communities, that influence and guide the location of significant infrastructure (e.g. major roadways, facilities, trails), and that enhance coordination of commercial/industrial development.
- The Tantramar Region is now part of the South East Regional Planning Commission.

Future Regional Plan

- A regional plan for the South East Regional Planning Commission (including Sackville, Port Elgin, Dorchester, Memramcook and rural areas in between) is set to be developed between 2014 and 2018.
- A Regional Plan can be used to develop a shared infrastructure strategy within a region containing several nearby municipalities. These strategies can help to make water, transportation and energy infrastructure systems more efficient and cost-effective.
- A Regional Plan can be used to control growth across a large region and ensure that urban growth is occurring in ideal areas while also ensuring that other areas are being protected from development.
- As part of a Land Use Strategy, Regional Plans can identify agricultural lands, which should be protected from development and the sprawl of nearby urban centres.

Municipal Plans

- An appropriate location for a municipality to clearly state that minimizing and/or modifying development in flood prone areas is a priority.
- Municipal plans for Sackville (2009), Dorchester (2012) and Port Elgin (2001) can be found here: <http://www.tantramarplanning.ca/partners.html>.

Rural Plans

- The equivalent of a municipal plan for less populated areas.
- Rural Plans exist in some of the province's rural areas; however, these are not adopted in any kind of systematic way throughout the province.
- A rural plan for Tantramar can be found at <http://www.tantramarplanning.ca/partners/unincorporated.html>.
- Memramcook's Rural Plan can be found at: <http://www.cabbbpc.ca/en/village-of-memramcook-maps>.

Zoning By-laws

(found in both Municipal and Rural Plans)

- Create "Flood Risk Zones" which are subject to flood proofing designs (height requirements, setback requirements, etc.) and including these in a zoning bylaw can help minimize damages caused by flooding, storms and rising sea levels to buildings in flood prone areas. Zoning by-laws can also include maintaining a certain percentage of vegetation cover on newly developed land; reducing asphalt and other sealed surfaces, and planting trees.

Building By-laws

(found in both Municipal and Rural Plans)

- Building by-laws that stipulate the use of green energy and other technologies can be one climate change mitigation option.

Subdivision By-laws

- By restricting the types of subdivisions that can be made in coastal areas we can prevent future development in vulnerable areas.

The Coastal Areas Protection Policy for New Brunswick

- This is a guide for implementing development practices in coastal regions.

Information for planners was based on the following study:

Planning for Sustainability in New Brunswick

Fox, Michael and Daigle, Marcel (2012)

<http://atlanticadaptation.ca/node/286>

Dyke Managers

The dykes that surround Sackville and border the Bay of Fundy throughout the Tantramar Region are managed by the New Brunswick Department of Agriculture, Aquaculture and Fisheries. They have a limited budget to maintain and improve the dyke system. Below are adaptation options that dyke managers are currently working on.

- Build the dykes higher to combat breaches and over-topping by storm surges
- Vegetate exposed sections of the dyke to decrease erosion and reinforce weak spots
- Prioritize particular sections of dyke to protect critical properties and assets



A span of dykes in Tantramar.

Source: Mel Jellett

"In an area like Sackville, where mitigation, in terms of dyke repair is still possible, the reduction of potential damage should be a top priority."

Mel Jellett, Mount Allison University

EMO Coordinators

Emergency Measures Organizations (EMOs) across Tantramar continue to work on response plans to climate change related disasters such as flooding. They have important roles to play in helping the region respond to direct impacts of climate change.

They currently:

- Offer emergency response services
- Update emergency response plans regularly to adjust to updated information and forecasts
- Plan hypothetical emergency exercises on a variety of climate change related crisis such as floods, hurricanes, etc. with the use of sand tables, table top activities, and field exercises
- Educate the public about emergency response plans, and communicating steps they can take to protect their own property
- Are available to answer questions and concerns from residents
- Provide materials to help residents plan for emergencies (such as what to put in a 72 Hour Emergency kit)
- Are training to use the Sentinel Incident Management Suite which includes emergency preparedness software, an integrated command console, and a web-based public warning system (using email, text messaging and phone broadcasting). Find out more at <http://www.sentinel systems.ca/>.



Did you know?

You can buy a Red Cross 72 Hour Emergency Kit on their website at <https://shop.redcross.ca>.



Source: 23/02 2007-116 ©INKCINCT Cartoons www.inkcinct.com

Residents

This section has some examples of actions that residents can take to adapt to a changing climate, such as how to flood-proof your house, what to put in an emergency kit, what to do in the event of an emergency and other ideas.

Did you know?

Even if your home is not in the flood plain, you may still be impacted by a flood!

- Flooded or washed out roads may make it hard to get around and slow emergency response.
- Damage to municipal buildings and vital services.
- Undrinkable water supply (because of increased risk of saltwater and other types of contamination, as well as damage to pipes and other infrastructure).
- Risk of contamination with wastewater and agricultural chemicals released from flooding.
- Power outages.

Make sure you have a Family Flood Plan. You can find templates online at places like <http://focusonfloods.org/flood-plans> or <http://www.ready.gov/make-a-plan>.

Flood-Proofing your Home

Find out if your property is at risk from flooding and if so, take the following steps now to protect it from damage:

- Avoid carpets in basements or ground floors. Ceramic tiles are more resilient.
- Raise electrical sockets to at least 1 m above floor level.
- Raise electrical panel above flood line.
- Fit non-return valves to floor drains (also called back-flow valves).
- Flood proof lower walls with liquid membranes, polymer/cement coatings, asphalt or sheet membranes, etc.
- Improve the flood resistance of your windows and doors (ensuring the seal is tight, fix cracks, etc).
- Ensure the land around your home slopes down and away from your house.
- Position eave troughs and downspouts away from your house.
- Build rain gardens to catch runoff and let it absorb into the ground naturally and away from your foundation.
- Have materials to build temporary defenses on hand so you are ready for a flood (sand bags, plywood, plastic sheeting, sand, nails, hammer, shovel, bricks, blocks of wood, a saw, etc.).
- Store important documents and sentimental items upstairs (e.g. certificates, diplomas, birth certificates, passports, wills, photographs, property ownership documents, mortgage documents) or on high shelves, possibly in a fire and water proof safe, and certainly not in the basement.
- Make an inventory of your household contents, including digital photos of the main items (useful if you have an insurance claim).
- Have a 72 Hour Emergency Kit (a suggested list is found above right)
- Have a Household Flood Emergency Plan

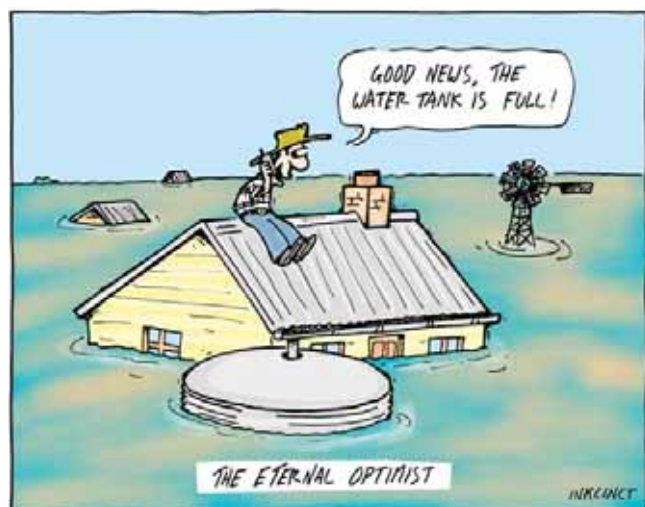
What to Have in your Flood Emergency Kit

- Copy of your address book with important phone numbers (friends and family, doctors, hospital, insurance company, etc.)
- Flashlight, wind-up radio
- Warm and waterproof clothes, rubber gloves, rubber boots
- First aid kit, multipurpose tool, whistle, keys, rain gear, and blankets or sleeping bags, towelettes, garbage bags and plastic ties for sanitation
- General emergency supplies such as a 3-day supply of water and non-perishable food, can opener, a cell phone with a charger, whistle, cash, medication, glasses, infant formula and diapers, bleach (to be used as a disinfectant with water and a medicine dropper), fire extinguisher, matches in a waterproof container, feminine and personal hygiene products, paper cups, plates and plastic utensils, towels, paper and pencil
- A list of special or sentimental items and where they are so you can move them to safety quickly if there is a flood
- A list of gas and electricity shut offs and when to turn them off
- Copies of personal documents (e.g., insurance policies, identification, bank account information, social insurance numbers, medicare numbers, stored in a waterproof container)
- A list of essentials you will have to bring if you are evacuated

Did you know?

Homeowners in Canada cannot buy insurance coverage for damages caused by overland flooding, including flooding from rivers, storm surges, tides, and sea level rise. Erosion caused by overland flooding, including coastal erosion is not covered either. Flood coverage is available for businesses and vehicles though. Check with your insurance company for more information.

Source: Insurance Bureau of Canada



Source: 2011-036 ©INKNCINCT Cartoons www.inkcinct.com

What to Do in the Event of a Flood Emergency

- Follow your Household Flood Emergency Plan
- Get out your 72 Hour Emergency Kit
- Know where and how to shut off your home's electricity, gas and water
- Move your car to higher ground, if possible
- Move other items outside to higher ground (e.g. lawn mowers, fuel, etc)
- Weigh down manhole covers so they don't come loose
- Close off flow valves from propane tanks, etc.
- Unplug outdoor electrical equipment
- Sandbag around houses and sheds
- Harvest ripened crops (depending on how much time there is!)
- Prepare to evacuate your home if necessary

Other Climate Change Impacts to Prepare For

The New Brunswick Climate Change Secretariat suggests that New Brunswickers take the following actions in preparing for climate change related impacts:

Wind Storms

- Check your house over for vulnerability to high winds and driving rain.
- Renew and repair your roof if it is in poor condition, replace loose shingles or other roofing materials.
- Renew or replace windows in poor condition.
- Repair weak or unstable brickwork especially chimneys
- Remove or prune large trees. Branches in poor condition may threaten your property if brought down in a storm.

Rainstorms and Freeze/Thaw Periods

- Check for poor drainage around your house, damaged or blocked culverts or cracked foundations, improve via landscaping and grading, installing drains and gullies, and diverting surface water away from house foundations.
- If you have a sump pump, check it regularly and consider a generator to maintain protection during power outages.
- Consider driveway and parking area surfaces that allow water infiltration, as opposed to asphalt.
- Build and plant rain gardens (that will naturally absorb runoff), install water barrels.

Heat and Drought

- Plant a diverse range of plants for use in landscaping, use deep-rooted perennials, and avoid those that require extra watering.
- Promote some shade of south facing window areas using annual or deciduous plants such as trees, vines, or install shade awnings, shutters, sails or blinds.
- Use lots of mulch on any cultivated areas to reduce the need for watering.

Reduced Water Supply

- Install water-saving devices such as dual or low-flush toilets, tap aerators, and low flow shower heads.
- Upgrade your washing machine to a front-loader or high-efficiency model, wash full loads only.
- Wash cars using a bucket, not a hose.

Did you know?

Preserving Natural Landscapes Helps Adapt to Climate Change

Wetlands absorb water run off, buffer floods and filter pollutants. In addition they allow rainwater to slowly seep into the ground and replenish groundwater. Forests reduce pollutants from the air and provide shade to help keep temperatures lower. Forests also slow the runoff of water, reducing soil erosion and flooding. Property owners can choose to plant trees, protect wetlands, and minimize impermeable surfaces (driveways, patios) to help slow down water run-off and reduce flooding.

Source: CPAWS, 2009

The information to help you prepare for flooding and climate change came from:

New Brunswick's Climate Change Secretariat
www2.gnb.ca/content/gnb/en/departments/elg/environment/content/climate_change.htm

Tantramar Dyke Risk Project:
The Use of Visualizations to Inspire Action
 Roness, Lori Ann and Lieske, David. (2012)
<http://atlanticadaptation.ca/node/306>

Climate Change and Natural Areas Fact Sheet #5
New Brunswick Communities in a Changing Climate
 Canadian Parks and Wilderness Society (2009)
http://cpawsnb.org/images/upload/Climate_Change_5_Communities.pdf

Farmers

Farmers in the Tantramar Region face a number of challenges, but also opportunities when facing climate change. Below is a list of ideas to address the challenges and make the most of opportunities.

Crop Rotation and Soil Conservation

- Many farmers in the region currently use some form of chemical pesticides and herbicides, which is not uncommon in conventional farming. But more and more chemicals may be needed to fight the forecasted increase in pests and disease in the future. This will result in the need for more and more fertilizer, lime, etc.
- Instead, a more adaptive farming practice is to use a crop rotation or soil conservation strategy that benefits the farmland and can also cost less than conventional practices. These might include:
 - Crop rotation
 - Winter cover crops
 - Plowing down green crops
 - Rotational grazing
 - Windbreaks or shelterbelts



Farmland adjacent to dykes.

Source: Mel Jellett

Information for farmers is based on the following study:

Agricultural Adaptation Strategy for the Tantramar Region
 By Mel Jellett (2011) <http://atlanticadaptation.ca/node/282>

Diversification

- As the climate changes, pests and disease will play an increasing role in the need for diversification on the farm.
- Crops and livestock may need to be altered in order to adapt to local climate changes.
- New infrastructure may be required to regulate temperatures in farm buildings that hold animals or food, etc.

How Farmers Can Prepare for a Flood Emergency

- Perform regular safety checks around the farm
- Prepare fencing systems to ensure animals can have access to high areas
- Install a hand pump and other measures so your livestock has access to fresh water
- Identify alternative power and water sources
- Secure items that can become floating projectiles
- Label and deal with hazardous material
- Write down important phone numbers, such as veterinarians, animal care and control, Department of Agriculture contacts

Source: Roness and Lieske, 2012

Educators

Educators, whether they are public school teachers, community leaders, camp counselors, etc., can teach children and youth about climate change, the impacts it may have, and how to prepare and adapt. Children are tomorrow's leaders and the ones who have the most to lose as climate change impacts grow in severity. Here are some ideas for teaching about climate change.

Glass Jar Greenhouse Effect

- Get two thermometers, place one on a sunny windowsill, place the other in a glass jar with the lid on and place it on the windowsill.
- Discussion: Which thermometer will read a higher temperature and why?

Visit the Dykes

- Take a class trip, summer camp outing or community carpool out to the dykes.
- Discussion: What do you see? What is behind the dyke? Where is the tide? How high are the dykes?

Visit a Saltmarsh Restoration Project

- Visit a saltmarsh restoration project in action by Fort Beausejour.
- Discussion: What do you see? What is a salt marsh? How can salt marshes adapt to climate change?

Run a Mock Town Council Meeting

- Have students assume the roles of town councillors and work through climate change adaptation planning in your community.
- Discussion: What could be impacted by a flood? How can we prepare? Should our town relocate infrastructure out of high risk flood areas? How would we do that? How do we make room for all of this in our budget?

Find more great ideas on the internet.

Check out these links!

<http://cool.greenlearning.ca/curriculum/>
<http://www.davidsuzuki.org/what-you-can-do/connecting-youth-with-nature/>
<http://www.greenteacher.com/tacc.html>

Additional Resources

Local Contacts for Further Help and Support

EOS Eco-Energy

536-4487

www.eosecoenergy.com

eos@nb.aibn.com

Town of Sackville

Town Hall 364-4930

EMO 364-4988 c.bowser@sackville.com

Fire 364-4988 c.bowser@sackville.com

RCMP 533-5151 (non-emergency) or 911

Public Health Office 364-4080

Red Cross Office 364-8813

Village of Dorchester

Village Office 379-3030 dorchester@nb.aibn.com

EMO 379-0111 macleod.kim34@gmail.com

Fire 379-3036

Police 911

Village de Memramcook

Village Office 758-4078

EMO 758-4078

Fire 758-4068

Police 911

Village of Port Elgin

Village Office 538-2120 prtelgin@nbnet.nb.ca

EMO 538-2120 shamus@nbnet.nb.ca

Fire (non-emergency) 538-7270

Police 911

South East Regional Service Commission

364-4701

james.bornemann@csrrsc7.ca

Department of Geography and Environment, Mount Allison University

364-2390

geography@mta.ca

New Brunswick Climate Change Secretariat

(506) 457-4844

elg/egl-info@gnb.ca

Useful Websites

New Brunswick Environment and Local Government Climate Change Indicators

http://www2.gnb.ca/content/gnb/en/departments/elg/environment/content/climate_change/content/climate_change_indicators.html

ACASA Website

www.atlanticadaptation.ca

The Province of New Brunswick's Climate Change Action Plan

www.gnb.ca/climatechange

Efficiency New Brunswick

www.efficiencynb.ca

The Government of Canada's Climate Change Website

www.climatechange.gc.ca

New Brunswick Coastal Areas Protection Policy

<http://www2.gnb.ca/content/gnb/en/departments/elg/publications.html>

Insurance Bureau of Canada

www.abc.ca

Institute for Catastrophic Loss Reduction

www.iclr.org

Get Prepared (Government of Canada 72 Hour Emergency Kits)

www.getprepared.gc.ca

References and Resources

Adapting to Climate Change:

Coastal Flooding Port Elgin

Atlantic Climate Adaptation Solutions
Association & Climate Change Secretariat (2012)
<http://atlanticadaptation.ca/node/82>

Sea Level Rise and Flooding: What They Mean for New Brunswick's Coastal Communities

Climate Change Secretariat, New Brunswick
Department of Environment and Local
Government (2012a)
<http://atlanticadaptation.ca/node/328>

Actions you can take to adapt to a changing climate

Climate Change Secretariat, New Brunswick
Department of Environment and Local
Government (2012b)
[http://www2.gnb.ca/content/gnb/en/departments/
elg/environment/content/climate_change/content/
changing_climate.html](http://www2.gnb.ca/content/gnb/en/departments/elg/environment/content/climate_change/content/changing_climate.html)

Sea-Level Rise and Flooding Estimates for New Brunswick Coastal Sections

Daigle, Réal (2012)
<http://atlanticadaptation.ca/node/285>

Sea-Level Rise Estimates for NB Municipalities

Le Goulet, Saint John, Richibucto, Sackville,
Shippagan, Caraquet
Daigle, Réal (2011)
<http://atlanticadaptation.ca/node/203>

Planning for Sustainability in New Brunswick

Fox, Michael and Daigle, Marcel (2012)
<http://atlanticadaptation.ca/node/286>

Agricultural Adaptation Strategy for the Tantramar Region

Jellett, Mel (2011)
<http://atlanticadaptation.ca/node/282>

Sea Level Rise and Flooding: What they Mean for New Brunswick's Coastal Communities

Lee, Caroline and Daigle, Réal (2012)
<http://atlanticadaptation.ca/reports>

Visualizations and their Role in Communicating the Risk of Coastal Flooding: A Tantramar Case Study

Lieske, David (2012)
<http://atlanticadaptation.ca/node/329>

Coastal Dykelands in the Tantramar Area: Impacts of Climate Change on Dyke Erosion and Flood Risk

Lieske, David, and Bornemann, James (2012)
<http://atlanticadaptation.ca/node/283>

Coastal Dykelands in the Tantramar Area: Impacts of Climate Change on Dyke Erosion and Flood Risk

Lieske, David, and Bornemann, James (2011)
<http://atlanticadaptation.ca/node/283>

Climate Change Adaptation in Tantramar: Action Planning Workshop

Marlin, Amanda (2013)
For a copy of the workshop report, please
contact Eos Eco-Energy at eos@nb.aibn.com

Examining Community Adaptive Capacity to Address Climate Change, Sea Level Rise, and Salt Marsh Restoration in Maritime Canada

Marlin, A.; Olsen, L.; Bruce, D.; Ollerhead, J.;
Singh, K.; Heckman, J.; Walters, B.; Meadus, D.;
Hanson, A. (2007)
[www.mta.ca/research/rstp/CCIAP_Project_A1106_
Final_Report1.pdf](http://www.mta.ca/research/rstp/CCIAP_Project_A1106_Final_Report1.pdf)

Tantramar Dykelands Risk and Vulnerability Assessment Water Levels Report

Ollerhead, Jeff (2011)
<http://atlanticadaptation.ca/node/288>

Lyme Disease Fact Sheet

Public Health Agency of Canada (July 4, 2012)
[http://www.phac-aspc.gc.ca/id-mi/
lyme-fs-eng.php](http://www.phac-aspc.gc.ca/id-mi/lyme-fs-eng.php)

Tantramar Dyke Risk Project:

The Use of Visualizations to Inspire Action

Roness, Lori Ann and Lieske, David (2012)
<http://atlanticadaptation.ca/node/306>

Insurance Issues in Atlantic Canada

Sandink, Dan (2011)
<http://atlanticadaptation.ca/node/315>

Local Government, Sustainability and Climate Change: A Resource for Elected Municipal Officials in New Brunswick

Tusz-King, Margaret (2012)
<http://atlanticadaptation.ca/node/361>

**An Evaluation of Flood Risk to Infrastructure
Across the Chignecto Isthmus**

Webster, Tim; Kongwongthai, Malinee and
Crowell, Nathan (Revised Dec 2012)
<http://atlanticadaptation.ca/node/195>

**Forecasting Economic Damages from Storm Surge
Flooding: A Case Study in the Tantramar Region of
New Brunswick.**

Wilson, Jeff; Trenholm, Ryan; Bornemann, James;
Lieske David (2012)
<http://atlanticadaptation.ca/node/307>

**Economic Evaluation of Climate Change Impacts
on New Brunswick-Nova Scotia Transport Corridor**

Yevdokimov, Yuri (2012)
<http://atlanticadaptation.ca/node/284>

**Economic Consequences of the Climate Change
Impacts on the NB/NS Transport Corridor**

Yevdokimov, Yuri (March 2013)
<http://atlanticadaptation.ca/reports>

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