CLIMATE CHANGE VULNERABILITY ASSESSMENT

VICTORIA, PRINCE EDWARD ISLAND

NOVA SCOTIA

New Nouveau Brunswick

Newfoundland Labrador

Prince Edward Island CANADA

Natural Resources Canada Ressources naturelles Canada

Canada

ACKNOWLEDGEMENTS

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STORIES OF WEATHER AND CHANGE

Victoria and area residents share memorable climate-related events from the past

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Mr. Jimmy Boulter (Figure 1) recalls:

Figure 1 - Jimmy Boulter, Victoria resident (photo credit: D. Jardine).

- ***coastal erosion along the Victoria Provincial Park shoreline.*** *He recalls that the home of Mr. Gordon MacDonald, which now rests on the beach, was once 30.5 m (100 feet) from the beach and that the first road between Victoria and Hampton ran south of this house. There was a sharp turn in the road just east of the MacDonald house (Figure 2) and the road ran by an old well and separator building. The road then extended northward until it met the main road to Hampton. He remembers a flashing light with a diamond background, which was located where the road turned northward. He also recalls that the MacDonalds built a breastwork (wooden wall) along the shore to try to stop erosion. Eventually, this road washed away and another one was constructed through the middle of what is now Victoria Provincial Park. Finally, a third road was built to Hampton when the current causeway was completed in the mid-1960s.*
- ***coastal erosion at Paul's Bluff****, just west of Victoria****.*** *He recalls a grove of trees at the end of the point. The area has now succumbed to erosion.*
- ***changes to the harbour channel*** *over the years. He recalls that boaters were once able to use the outer and inner range lights to enter the harbour. With sedimentation over the years, the channel has narrowed and shifted. Now, boat operators must follow the buoys to safely enter the harbour.*
- ***a hurricane in the early 1950s****, after which a former resident of Victoria told him that she had to clean salt spray off the windows of her home in Crapaud—approximately 3 km (almost 2 miles) inland.*

Figure 2 - Foundation of former MacDonald house now on the beach (photo credit: D. Jardine).

Mrs. Lillian Elliott recalls:

Figure 3 - High water mark at windowsill in Lillian Elliott's home (photo credit: D. Jardine).

- ***a storm surge in January 2000****, when water reached the window sill of her living room (Figure 3). All of her electrical appliances (fridge, stove, furnace, and water heater) needed to be replaced—as did her bed—after the water level reached the top of her mattress.*
- ***Hurricane Juan on September 29, 2003****, when she awoke at 3:00 am to find her home flooded. Once again, the water reached the mattress of her bed, and her appliances were destroyed. According to Mrs. Elliott, her only consolation was that "at least the water was warm."*
- ***a storm surge in December 2009,*** *when the flooding of her home occurred within minutes. As with the previous two floods, water entered her home both from the waterfront to the south and from Water Street to the north. By the time she was able to put on her rubber boots, the rising water rendered them useless. Yet again, all her appliances, furnace, and mattress needed to be replaced.*
- ***a storm surge in January 2010****, when water once more flooded her home, this time through holes in the sea wall. In addition to the usual damage to her appliances and mattress, high winds caused extensive damage to her roof, shed, and fence. As with the previous three storms, there was further warping of her floor and floor supports.*
- ***coastal erosion****, which has caused the shoreline to move closer to her home. She recalls that there was once about 8 m (25 feet) of land beyond the current location of the sea wall, which she believes was built over 30 years ago.*
- ***sediment deposition****, caused by the nearby causeway (to Hampton), which has changed the shoreline. She recalls that in the past one needed to descend a ladder from the Elliott property to the beach in order to go swimming.*
- ***a lobster cannery****, once located in the lot immediately to the east of her home (adjacent to the wharf). Effluent from the lobster holding tank ran to the shore and caused erosion to the sea wall. It is now badly eroded at this spot.*

Figure 4 - Ansel Ferguson pointing towards location of former bridge (photo credit: D. Jardine).

Mr. Ansel Ferguson recalls:

- ***three bridges from Victoria to Hampton*** *in his lifetime. He remembers that the first bridge was quite low. Horses were afraid to cross it when there was a strong southerly wind because the waves would splash over the bridge. The old bridge used to line up on an angle with Nelson Street, and the channel from the Westmoreland River was some distance west of where the current channel is located (Figure 4).*

- ***changes in the amount of coastal erosion*** *in the area. He believes that 2011 was the worst year for shoreline erosion that he has ever seen. In some areas, near the Hampton end of the causeway road, over 1 m (3 feet) of sod was lost. Most affected are low-lying areas near the Hampton end of the road, where the cliff face is sandstone. He recalls the former house of Mr. Gordon MacDonald (Figure 2), and that the old road used to be on the shore side of the buildings. When he was a boy he played ball between this house and the shore, where there used to be a lovely rose bush. This has all been lost due to erosion. The former roadway would now be about 34 m (110 feet) from the existing bank.*

Mr. George Ferguson recalls:

- *that* ***sea level and tides have been rising*** *over the past 20 years. During this time, he believes that the sea level has risen by at least 30 cm (1 foot). During large tides and surges, some of the boats nearly end up on top of the wharf.*
- *that* ***shoreline erosion*** *has been severe at Victoria Provincial Park, as well as east of the park at Hampton. He believes that at least 2 m (6 feet) of shoreline have been lost over the last few years.*
- ***changes in sea ice*** *over the years. He recalls that 20 or 30 years ago fishermen in Victoria used to have trouble getting out to set lobster traps at the start of the season. Often, they waited until after May 15th. In the past 4 or 5 years, there has been virtually no ice in the Victoria harbour. There have been no delays to the start of the lobster season in the past 10 years.*
- ***a decreased amount of herring in the area*** *over the last 4 or 5 years. He believes this may have something to do with more frequent storms.*
- ***sedimentation in the harbour****, which he believes is the result of the relocation of the Victoria–Hampton bridge.*

Mr. Vince Keough recalls:

- ***how Water Street has risen*** *(Figure 5). At one time there were two steps leading up to the entrance to 25 Water Street. Now, one goes down five steps to the entrance. This change has increased the home's vulnerability to run-off flooding from Water Street.*
- ***an increase in storm activity, a decrease in sea ice, and a gradual rise in sea level*** *in recent years.*
- ***shoreline erosion at Victoria Provincial Park****, east of Victoria on the way to Hampton. Recent storms, in particular, have resulted in a dramatic recession of the cliffs.*

Figure 5 - Main Street has been raised and is now higher than homes on the south side of the street (photo credit: P. Nishimura).

Ms. Heather McBeath recalls:

- ***changes in the amount of sea ice****, which she thinks is decreasing. She further believes that winters are not as cold as they were in the past.*

Mr. Bernard Shapiro recalls:

- ***a storm surge*** *in January 2010, which moved their storage shed approximately 1 metre (3 to 4 feet).*
- ***changes in the amount of sea ice*** *during the 9 years that he has lived in Victoria. He recalls that when he first arrived in 2002, the Northumberland Strait was frozen solid during the winter months. He has noticed that over the past two or three years, there has been very little ice and no solid pack ice in the Strait.*

Mr. Donald Wood recalls:

- ***the old foundation of Mr. Gordon MacDonald's home****, which was on land when he was a boy, but now rests on the beach (Figure 2).*
- ***colder temperatures in the past****, when there was more sea ice in the harbour. He recalls one Christmas Day in the late 1980s, when his grandfather made a point of taking a photograph of green grass with no snow—at that time a very unusual sight.*
- ***a change in the type of rainfall events****. He believes that heavy rains and strong runoff are more common than they used to be.*

Mr. John Thompson recalls:

- ***the worst storm surge*** *he has seen in his lifetime was the January 2, 2010, event. During this storm, the wind switched to south or southeast and drove the water from the Northumberland Strait toward their cottage. The storm also occurred during a lunar high tide, which further contributed to the situation. Chunks of shale and sandstone, ranging in size from 2.5 cm (1 inch) up to that of dinner plates, were deposited above the cliff along the new shoreline. He also found driftwood 91 metres (100 yards) back from the shore in low-lying areas. The area around their cottage was impacted and left their deck hanging over the cliff. Before this storm they could drive their lawnmower between the deck and the cliff. After this event, the new shoreline was under their deck. The stairs to the beach were also moved by this storm surge. The surge undermined the nearby cliff and, as a result, they moved their cottage back 9 metres (30 feet) from the shore. The January 2, 2010, storm surge took more land than they had lost in the previous 10 years. John estimates that they lost almost 4 metres (12 to 13 feet) of bank during the storm.*

EXECUTIVE SUMMARY

The community of Victoria has worked, in partnership with the Prince Edward Island Department of Environment, Labour and Justice, to assess climate change risk and vulnerability. The purpose of this assessment was to identify and discuss the impacts of a changing climate on the community, and to consider possible means to lessen these effects (develop adaptation strategies for the future). Coastal hazards (storms, erosion, and flooding) were the focus of this assessment.

Climate change refers to a shift in average weather over time. While climate has been changing throughout the history of the planet, the warming of the atmosphere is now occurring at a much faster rate due to increased human activity around the globe. Climate change is expected to bring warmer temperatures, more rainfall, rising seas, and more intense storms.

Residents of Victoria have a long history of dealing with coastal storms, erosion, and flooding. In recent years, they have noticed more frequent and intense storms. Erosion has been significant in many places, including the shoreline in front of Victoria Provincial Park, along Water Street, and west of Victoria (Paul's Bluff). Sea level also appears to be rising. Residents have seen boats almost on top of the wharf during the highest tides of the year. At least four storm surges during the last decade have caused flooding and property damage. Little sea ice has been seen in recent years.

Sea level rise and extreme storm surge levels are both expected to become more severe. Sea level is expected to rise by 1 metre (3 feet) by the end of this century. Storm surges will ride on top of rising seas, causing even more extensive flooding. These changes will have impacts on the causeway, wharf, roadways, and other important infrastructure.

Toward the end of this century, average annual temperatures are expected to rise by 3 °C (above 1980 levels). A longer growing season and a reduction in sea ice are a few of the changes likely to impact local crop production and erosion rates. This will make the coastline even more vulnerable, as there will be less sea ice to protect it from waves. More erosion is likely (perhaps 1.5 to 2 times the current rate). Over the same time period, annual precipitation is expected to rise by 7%, with more rain and less snow. Intense rainfall events are likely to further increase run-off in the area and reduce water quality in the nearby Westmoreland River.

Climate change will undoubtedly have impacts on local residents, businesses, and infrastructure but planning now can help to minimize damage in the future. Victoria should consider adaptation options, including the development of an Emergency Management Plan that addresses climate change, restriction of coastal development, increased coastal monitoring, and assessment of community infrastructure.

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KEY TERMS

ADAPTATION is action taken to prepare for climate change. Specifically, it seeks to minimize the impacts of climate change. This is different from **mitigation**, which focuses on reducing greenhouse gas emissions in an effort to slow or limit climate change.

ADAPTATION PLANNING refers to the process whereby a community identifies ways in which it might be impacted by climate change, and how it develops a plan to minimize those impacts.

CLIMATE refers to the "average" weather over a long period of time. Aspects of climate include temperature, precipitation, wind speed and direction, sunshine, fog, and frequency of extreme events.

CLIMATE CHANGE refers to the process by which the average weather becomes different over time. Climate has changed naturally over the course of history, but human activity (e.g., industry, cars) has now caused it to change much more quickly and more severely than ever before. Some of the changes occurring in Atlantic Canada include warmer and wetter summers and winters, rising sea level, and more intense and more frequent extreme weather events (e.g., windstorms, hurricanes, storm surge).

COASTAL EROSION is the wearing away or reduction of coastal land, primarily due to wave action along the shore. Coastal erosion causes the shoreline to move further inland.

COASTAL HAZARDS are naturally occurring events that can pose a threat to the health or life of people, property, and/or the environment in coastal areas. Hazards include coastal storms, coastal flooding, and coastal erosion.

FLOODING refers to the overflow of water onto land. **Inland flooding** usually results from faulty infrastructure or sudden and/or heavy precipitation. **Coastal flooding** usually results from high tides and storm events. Storm surges, in particular, can lead to devastating flooding along the coast.

PRECIPITATION refers to rain, snow, and hail that fall from the atmosphere.

SALTWATER INTRUSION refers to the process by which saltwater from the ocean moves into (infiltrates) fresh groundwater sources along the coast.

STORM SURGE is a series of strong coastal waves that are pushed onshore by high winds during a storm.

VULNERABILITY is the state of being exposed or subject to climate change impacts such as inland flooding or coastal hazards (e.g., storms, flooding, erosion).

WEATHER is the state of the atmosphere (e.g., temperature, precipitation, wind) at a specific time and location.

1. BACKGROUND

Figure 6 - Victoria, Prince Edward Island (photo credit: D. Jardine).

Victoria is a coastal community located along the south shore of Prince Edward Island, about halfway between Summerside and Charlottetown (Figure 6). Established in 1819 and incorporated in 1951, the village is small, covering just one and one-half square kilometres. Victoria has a vibrant arts community, is a popular tourist destination (Figure 7), and is home to 31 Heritage Places (28 Registered, 3 Designated).

Victoria has 104 year-round residents. Many of these people live along or close to the shore. In the summer months, Victoria's population roughly doubles with the arrival of seasonal residents, students returning home, and tourists.

Victoria sits at the mouth of the Westmoreland River, making it rich with both coastal and freshwater habitat. The Westmoreland River contains a variety of fish, including smallmouth bass and walleye. The wetlands bordering its enclosed bay provide valuable and productive wildlife habitat.

Figure 7 - Local and visiting kayakers and swimmers near the Victoria waterfront (top). Fishing boat rests at the dock while children swim in the background (photo credit: P. Nishimura).

As a coastal community, fishing and tourism play major roles in Victoria's economy. A small group of lobster fishermen work out of Victoria, and a sizeable shell fishery also operates within the bay. Two companies—Halibut PEI Inc. (Morning Star Fisheries Ltd.) and Novartis Animal Health Inc.—currently conduct aquaculture operations in Victoria. Halibut PEI Inc. farms halibut just east of Victoria Bridge, while Novartis Animal Health Inc. conducts research and development (R&D) west of the village.

Victoria's wharf and the Victoria Provincial Park are popular destinations for residents and tourists alike. Victoria's waterfront and historic charm, its Playhouse theatre, and outdoor recreational opportunities attract many visitors over the summer months.

Farming and property development also contribute to the local economy.

A. What is a Vulnerability Assessment?

A vulnerability assessment is a process whereby a community identifies areas of exposure to possible impacts of climate change (for more information, see Appendix 1). Such impacts could include an increase in storm frequency and intensity, sea level rise, coastal erosion, and coastal flooding.

The goals of this process were to:

- develop climate change community awareness
- identify climate change issues that will affect the community
- share knowledge of similar issues and damage from previous weather events
- discuss future impacts and damage from climate change events
- identify possible solutions and adaptation strategies

B. Why Does Victoria Need a Vulnerability Assessment?

Climate change will affect the community of Victoria. Coastal flooding and erosion will be more common in the future. This could damage infrastructure (for example, buildings, roads, power lines, and water and sewage systems), property, heritage sites, and environmentally sensitive areas. In some cases, these impacts could jeopardize public safety.

A vulnerability assessment encourages a community to think about what kind of changes can be expected, which ones are of most concern, and what it can do about them now to minimize damage in the future. Consideration of these issues will help the community's decision-makers to plan for potential emergencies and to assess current infrastructure. Vulnerability assessments can also be the first step in adaptation planning. This will involve the development of a plan to identify and make the changes necessary to minimize future negative impacts.

Many rural communities in Prince Edward Island do not have the resources (e.g., people, money) to properly assess their vulnerability to climate change. With financial assistance from Natural Resources Canada's Regional Adaptation Collaborative (RAC), the PEI Department of Environment, Labour and Justice is developing tools to help communities plan for climate change. These tools, including maps and climate change scenarios, are being prepared to help communities conduct vulnerability assessments.

Victoria, along with three other communities, is evaluating this process to determine how it can be used elsewhere across Prince Edward Island.

C. How Did Victoria Complete a Vulnerability Assessment?

Members of the community of Victoria, along with representatives of the PEI Department of Environment, Labour and Justice, formed a committee to conduct the vulnerability assessment. Representatives included:

Ms. Hilary Price	Chief Administrative Officer
Mr. Ben Smith	Councillor (Chair)
Mr. Bruce Gough	Councillor
Mr. Henry Dunsmore	Councillor
Mr. Stephen Hunter	Councillor
Ms. Brenda Boudreau	Resident and Community Archivist
Mr. Richard Boulter	Resident
Mr. Peter Bower	Resident and member of Westmoreland River Watershed group
Ms. Janet Lawzor	Resident
Mr. Don Jardine	PEI Coordinator, Regional Adaptation Collaborative
Mr. Peter Nishimura	PEI Department of Environment, Labour and Justice
Mr. Glen Robertson	PEI Department of Environment, Labour and Justice

Several meetings were held to conduct the vulnerability assessment:

Introduction to Community Council	May 25, 2011
Part I – Getting Started	June 27, 2011
Part II – Coastal Hazards	July 14, 2011
Part II – Coastal Hazards (cont'd)	July 28, 2011
Part III – Presentation of Draft Report	October 19, 2011

Supplemental information was also gathered, typically through interviews conducted by Don Jardine with the following residents of Victoria and surrounding areas:

Mr. Alan Marshall, Victoria	May 31, 2011
Ms. Lillian Elliott, Victoria	June 16, 2011
Mr. Vince Keough, Victoria	July 13, 2011
Mr. Bernard Shapiro, Victoria	July 13, 2011
Ms. Heather McBeath, Victoria	July 15, 2011
Mr. Ansel Ferguson, Hampton	July 22, 2011
Mr. George Ferguson, Victoria	July 22, 2011
Mr. Donald Wood, Victoria	July 22, 2011
Mr. Mark Rutten, Tryon East	August 1, 2011

Mr. Jimmy Boulter, Victoria	August 3, 2011
Mr. & Mrs. John Thompson, Victoria	September 8, 2011

2. COASTAL HAZARDS

The community vulnerability assessment of Victoria focused on coastal hazards. This focus was selected by the community of Victoria based on their coastal location and past experience.

Coastal hazards are naturally occurring events that can pose a threat to the health or safety of people, property, and/or the environment in coastal areas. Types of coastal hazards include storms, flooding, and erosion (Figure 8).

Figure 8 - A storm surge in December 2010 resulted in flooding of this children's playground in North Rustico (photo credit: D. Jardine).

Coastal storms can cause high winds, heavy precipitation, storm surges, and erosion. Flying debris, movement of unsecured equipment, and flooding of streets and basements are only some of the dangers to coastal residents. Power outages and leaking roofs also threaten homeowners, particularly those who make up the more vulnerable segments of the population (e.g., elderly, disabled). In many cases, the costs of repair and replacement fall to the resident, whose financial resources may be limited.

Storm surges and sea level rise can also cause **coastal flooding**. Storm surges often deposit debris, like ice, seaweed, sand, and rocks, onto the land. This can damage structures and make roads impassable. Flood waters can also enter homes and businesses, and cut people off from essential services.

Coastal erosion poses a distinct threat to property along the coast. Wave action wears away the shoreline, gradually reducing shore frontage on coastal properties. Extreme weather events, such as coastal storms, are particularly devastating. They can result in dramatic erosion that far exceeds that typically seen over the course of a year. Substantial erosion can place coastal properties at risk, undermine structures, and jeopardize water and sewage systems. It can reduce both the aesthetic and market values of coastal lots. Erosion also has the potential to increase vulnerability of drinking water wells to saltwater intrusion, as saline groundwater moves further inland.

3. RECENT COASTAL HAZARDS IN VICTORIA

The community of Victoria has a long history of vulnerability to coastal storms, erosion, and flooding. Coastal hazards have had—and continue to have—impacts on Victoria's infrastructure, people, economy, and environment. People living in Victoria and the surrounding area identified many areas impacted by storms and weather events (Figure 9).

A. Coastal Storms

Residents report storms seems to be "more frequent" in recent years, are often associated with the hurricane season (approximately June to September), and are common in December and January. Some of these events are listed in Table 1.

Table 1 - Historical records of coastal storms causing extensive damage in Victoria

Date	Type of Storm	Damages due to	Damage Caused
Dec 21, 2010	Nor'easter	coastal flooding, erosion	bank erosion at Park[1]
Jan 2, 2010	Nor'easter	coastal flooding, erosion	bank erosion, flooding on Water St., lower part of Nelson St., Rovis Lane[2]
Dec 21, 2009		coastal flooding	flooding on Water St.[3]
Sep 29, 2003	Hurricane Juan	coastal flooding, erosion	bank erosion, flooding on Water St.[4]
Jan 21, 2000	Great Atlantic Storm	coastal flooding, erosion	bank erosion, flooding on wharf and Water St.[4]
Sep 11, 1954	Hurricane Edna	high winds and waves	tree damage, boats sank[5]
Sep 11, 1953	Hurricane Carol	high winds	trees uprooted[5]
Aug 20-21, 1950	Hurricane Able	rain, high winds	heavy runoff[5]

Coastal storms may temporarily displace wildlife. Residents have reported a recent decline in cliff swallows (likely bank swallows). Bank swallows are adversely affected by a reduction in bank height (from sea level rise and coastal erosion) as well as by the construction of coastal protection structures.[6]

Heavy rainfall events, such as those experienced during coastal storms, carry sediment and occasionally clog the estuary. This can diminish the quality of fish habitat and wetlands. One stream running through the marshland along the west bank of the Westmoreland River has experienced farm run-off and was previously blocked by sedimentation. Heavy rainfall can also mobilize pesticides and contaminate local streams. Together these can contribute to fish kills. The Westmoreland River experienced fish kills in 1990, 1994, 1999, and 2002.

[1] Richard Boulter and Alan Marshall, personal communication
[2] Lillian Elliott and Bernard Shapiro, personal communication
[3] Lillian Elliott, personal communication
[4] Lillian Elliott and Gerard Keough, personal communication
[5] Jimmy Boulter, personal communication; Environment Canada Hurricane records
[6] Rosemary Curley, Species-at-Risk Biologist, PEI Agriculture and Forestry

Figure 9 - Areas impacted by storms, erosion, flooding and saltwater intrusion as identified by residents of Victoria and surrounding areas.

B. Coastal Erosion

Coastal erosion has become a significant concern in Victoria. Residents have noted that most parts of Victoria's shoreline are vulnerable to erosion. Some have recalled that the harbour seems much wider than it was 50 or 60 years ago. As well, the rate of shoreline erosion seems to have increased in recent years.

According to residents, four areas within the community have experienced significant erosion (Figure 9). These include the:

- **south shore, west of Victoria Bridge**. This also includes the sea wall below 25 and 27 Water Street, as well as all points west.
- **south shore, east of Victoria Bridge and below Victoria Provincial Park.** This area has been severely eroded, threatening the park's bathhouse and playground area. It is suspected that the removal of seaweed from this beach—for aesthetic reasons—has resulted in the reduced build-up of sand dunes. This has left it more vulnerable to erosion. Shoreline erosion is a problem along the causeway road from Victoria to Hampton.
- **west shore of the Westmoreland River**. While the river banks used to be steep, they now approach the water at a much more gradual slope, with no overhang. This change in slope has made the shoreline more susceptible to storm surges, particularly when a storm is accompanied by a north-westerly wind.
- **north-facing shore of the Westmoreland River** (on the north side of the Causeway Road). This area has also experienced erosion along its banks.

Erosion rates, recently updated for Prince Edward Island, confirm some of the changes residents have been seeing along the coastline (Figure 10). Since 1968, the south shore west of Victoria's wharf has eroded at a low rate (<0.2 metres/year), though this rate appears to have increased in recent years. Erosion rates are much higher (from 0.2 metres/year to 0.8 metres/year) along the south shore below the Causeway Road and in some areas north of the Causeway Road. Again, slightly higher erosion rates have been seen in the last 10 years compared to the last 40 years, particularly below Victoria Provincial Park (Figure 11). Erosion also appears to be increasing along the north shore of the Causeway Road. The marshland along the west shore of the Westmoreland River has changed, but not because of erosion. This area is likely experiencing flooding due to sea level rise. Thus, it has been identified as "anomalous" in Figures 10 and 11.

Erosion is also being monitored at Victoria Provincial Park by a resident using a manual measure (the distance between the bathhouse and the shoreline) (Figure 12). According to these measurements, the erosion rate here is about 120 cm/year (4 feet/year) over the last 9 years.

Figure 10 - Coastal change in the Victoria area, determined by comparing aerial photos from 1968 and 2010.

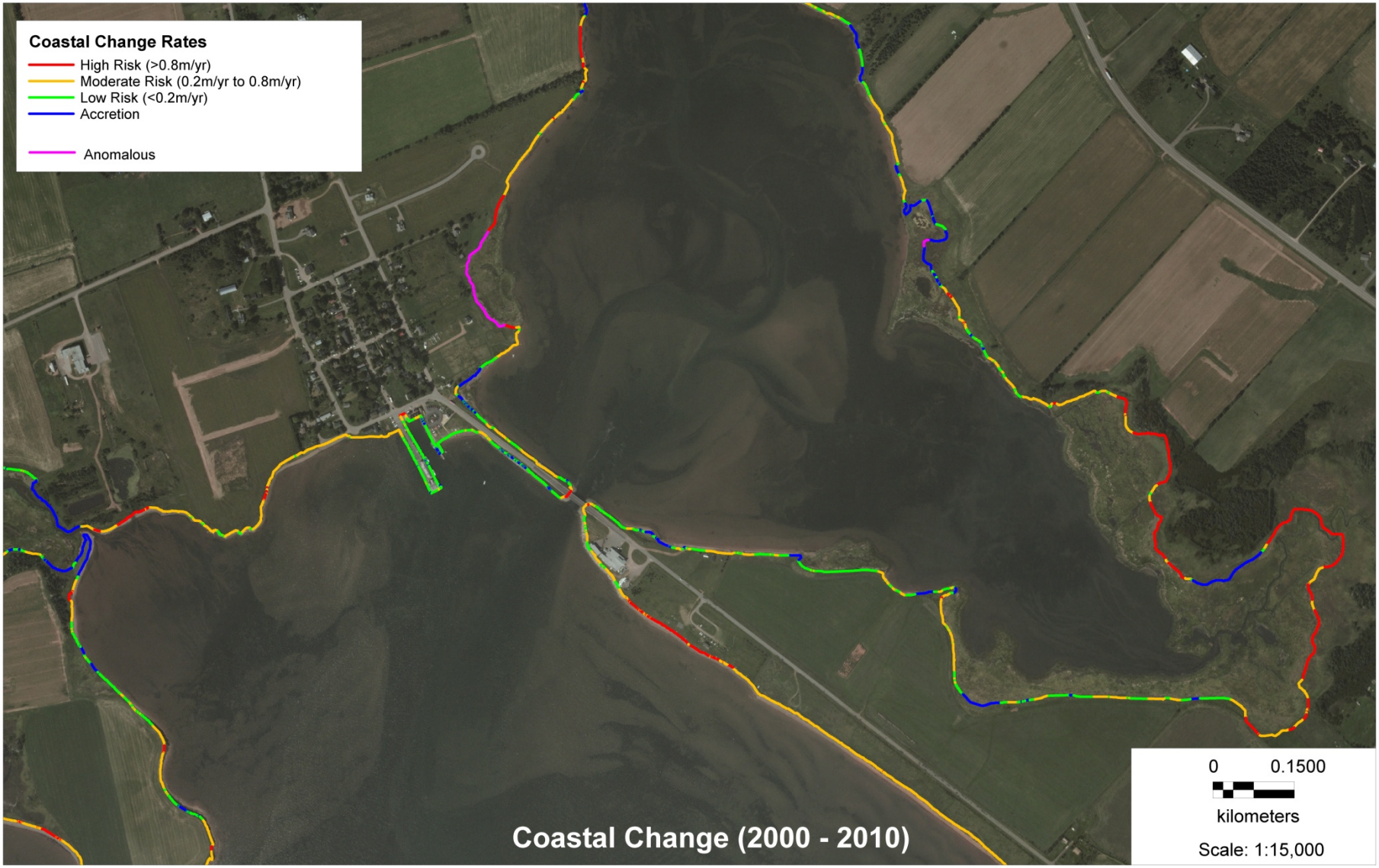

Figure 11 - Coastal change in the Victoria area, determined by comparing aerial photos from 2000 and 2010.

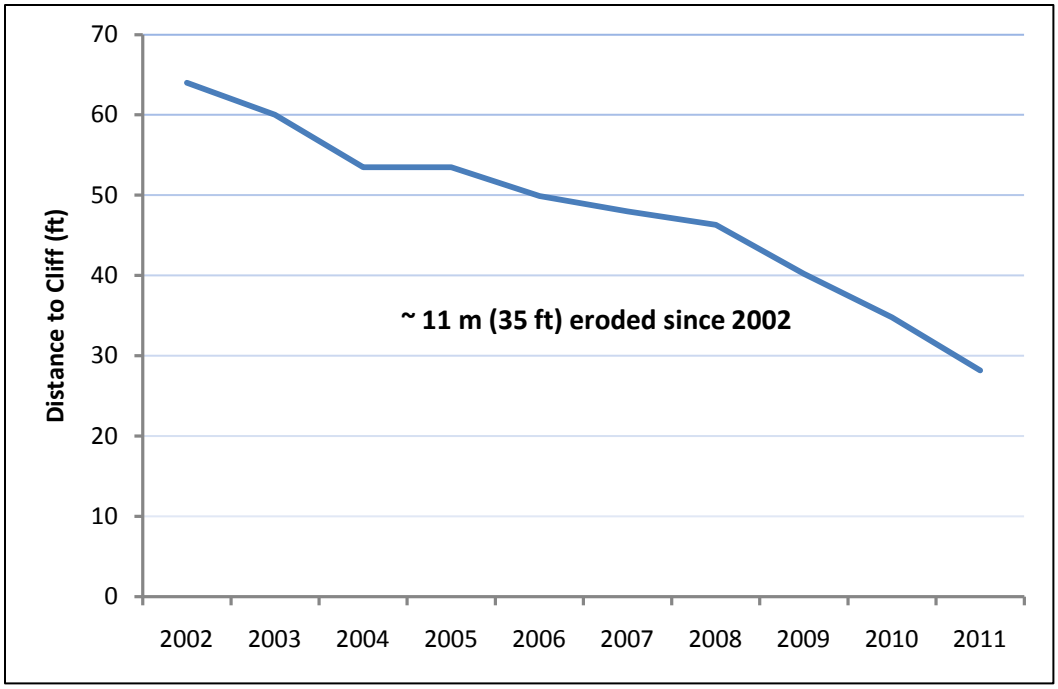

Figure 12 - Shoreline erosion monitoring at Victoria Provincial Park bath house (SE Corner) (courtesy of Alan Marshall).

Residents report that local roads, as well as the Victoria Bridge, are currently in good condition and, to date, have not been impacted significantly by erosion. However, erosion has taken place along the south shore of the harbour, immediately west of the bridge and at the western extent of Water Street. Gabions were installed at both of these locations; however, erosion has persisted (Figure 13). Wave action (particularly during storms) has resulted in overtopping and flanking of the gabions, such that erosion continues to threaten the portion of road that the gabions were designed to protect.

Figure 13 - Shoreline protection (gabion baskets) installed below the Causeway Road, west of Victoria Bridge (left) and at the western extent of Water Street (right) (photo credit: D. Jardine).

So far, coastal erosion does not appear to have affected Victoria's local economy. Damage to waterfront homes and businesses has not overburdened affected residents and entrepreneurs. Halibut PEI Inc. has invested in shoreline protection along its waterfront, and currently has plans to expand its operations. Novartis Animal Health Inc. is also in the process of expanding its facilities. Dunrovin Estates Subdivision invested in a shoreline protection system in 2011. Other waterfront property development continues.

Coastal erosion in Victoria could be happening for several reasons. Sea level rise, a decrease in winter frost, and a decrease in harbour and Northumberland Strait ice during the winter months are all suspected by the community as playing a role. Residents have observed that while coastal erosion has acted gradually in some places, its most dramatic effects have been observed following storm activity.

C. Coastal Flooding

Coastal flooding has become a hazard for the community of Victoria. It is especially severe when storm surges are accompanied by a southerly or south-westerly wind. Flooding in Victoria tends to happen in the same low-lying areas during storm events. The south shore of the village, particularly from the western edge of the wharf to the southern tip of Rovis Beach Lane, is especially susceptible to coastal flooding (Figure 14).

Low-lying land is also found on the north side of Water Street. Homes located along Water Street have been flooded numerous times during extreme weather events, with storms in January 2000, September 2003 (Hurricane Juan), and January 2010 being the most significant in recent memory. The extent of flooding from the January 21, 2000, storm surge, based on several high water marks recorded during this event, is shown in Figure 15.

Extensive flooding is particularly well-known at 25 Water Street. Built in 1873, this is a provincially registered heritage home (known as "The Seagull"). Storm surges have repeatedly threatened the safety of its elderly occupant. Sea level rise, a degraded sea wall, increased storm intensity, and the elevation of Water Street are all suspected reasons for this property's vulnerability (Figure 14).

Figure 14 - Storm surge at 25 and 27 Water Street easily breached the degraded sea wall during a storm on Dec 6, 2010 (photo credits: P. Nishimura and K. Boulter).

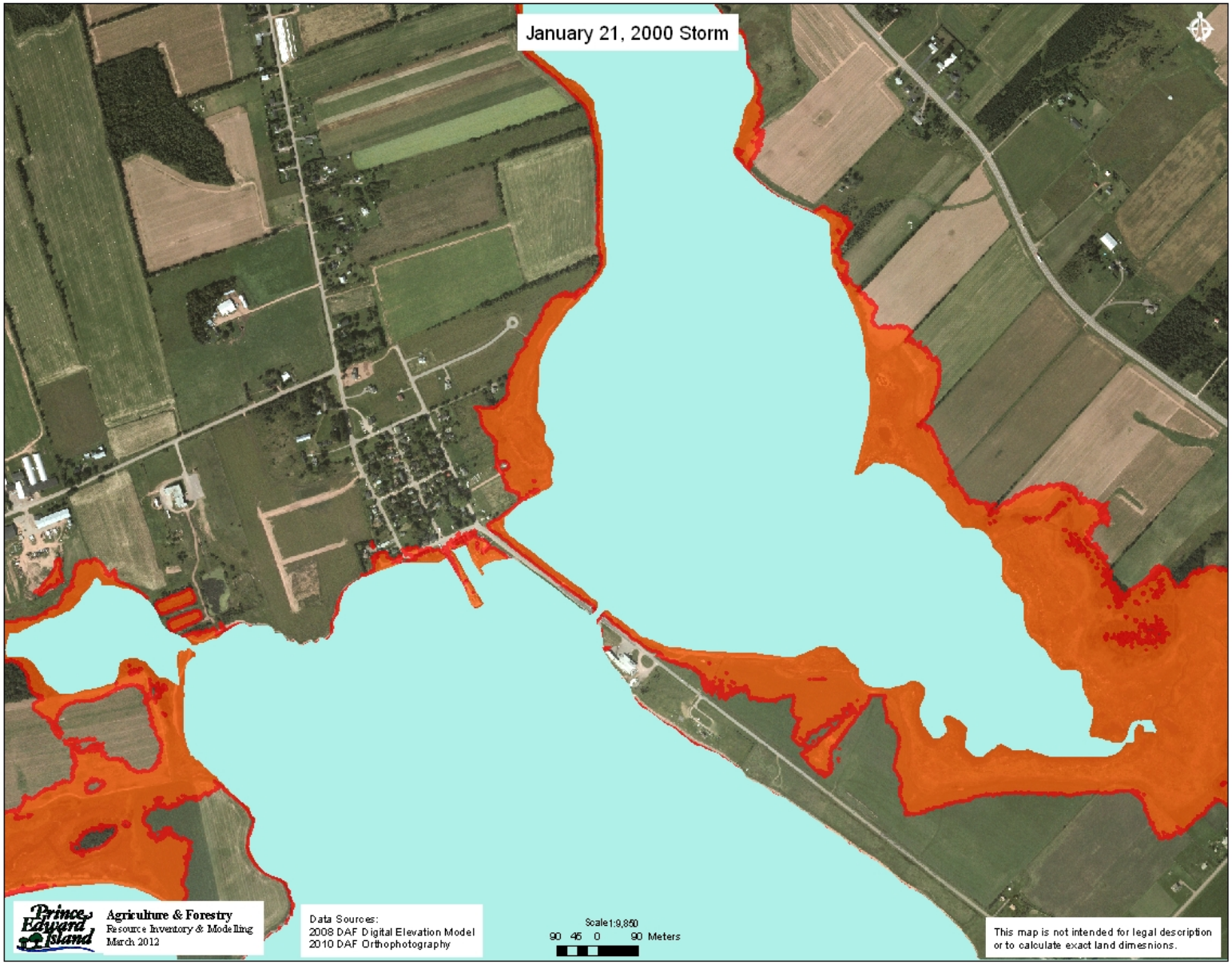

Figure 15 – Estimated coastal flooding during the January 21, 2000 storm reached the 2.3 metre land elevation in Victoria (all areas shaded red).

Basement flooding has also occurred on the north side of the road, at 22 Water Street—another provincially registered heritage building. A storage shed located at 1 Nelson Street was moved over 1 metre (over 3 feet) during a storm in January 2010. Much of the flooding that occurs in the area of Water Street can be attributed to a severely eroded segment of sea wall close to the wharf (Figure 16). The eroded area, found at the base of 27 Water Street, offers free passage for storm surge to access the empty property and, eventually, Water Street.

Figure 16 - An eroded segment of sea wall below 27 Water Street allows free passage for storm surge to flood the area (photo credit: D. Jardine).

Water level during coastal storms has sometimes reached the top of the wharf. A gas tank was carried off the wharf during a recent storm. Flooding also tends to occur near one of the community's other landmarks, the Victoria Range Light at the corner of Russell Street and Water Street.

The threat of sewage back-up has been virtually eliminated with the installation of a new wastewater treatment system in 2008. However, a lift station for the treatment facility has periodically been threatened by storm surges. Water has reached the top of the lift station, which is not designed to withstand submersion. Village council members have expressed concern that sea water could corrode the interior, thereby compromising the system and resulting in a great expense.

Storm surges also occur along the west shore of the Westmoreland River, particularly when a coastal storm is accompanied by a northeasterly wind. While no infrastructure or residences are present along the immediate shoreline, the marshland does become flooded.

Generally, culverts within the community are adequate, although some culverts in the Nelson Street and Rovis Beach Lane areas have been found to be partially plugged or in poor condition. This has resulted in localized flooding during heavy rains.

4. CLIMATE CHANGE SCENARIOS FOR VICTORIA

Climate is changing around the world. This will impact different regions and communities in varying ways. Communities must adapt to these changes if they are to minimize negative impacts upon their residents, infrastructure, economy, and environment. Planning for these changes becomes easier when one can imagine what the future climate could look like.

Global climate models (20) were used to generate future scenarios for eight Island locations. Such scenarios represent reasonable descriptions of future climate. For this vulnerability assessment, information for the Summerside area was used. (See Appendix 2 for more information on the data and explanations of the climate indices.)

A. Temperature

According to climate scenarios, the community of Victoria is likely to experience warmer weather in coming years (Table 2). By the 2080s, average temperatures will be warmer year round (3 – 4 °C from 1980s levels). There will also be more hot days (maximum temperature > 30 °C) and fewer cold days (maximum temperature < -10 °C).

The growing season will be longer (by 40 days). This could increase the incidence of agricultural run-off and sedimentation into the Westmoreland River. With more days above freezing temperatures, Victoria's harbour will continue to experience less sea ice. Both the decrease in sea ice and reduced freeze-thaw cycles over the winter could lead to an increase in coastal erosion at that time of the year.

B. Precipitation

Precipitation (rain and snow) will increase slightly (Table 3). Victoria is likely to experience more days with rain and fewer days with snow. Increasing temperatures will mean that more precipitation during the winter will fall as rain. Short period rainfall is expected to become more intense, increasing the vulnerability of locations already prone to inland flooding. More intense short period rainfall is also likely to increase the amount of agricultural run-off and sedimentation.

C. Sea Level Rise and Storm Surge

Sea level will continue to rise in Victoria, increasing by 100 cm or 1 metre (almost 3 feet) by the end of this century (Table 4). Rising seas will permanently flood land that is less than 1 metre above the highest tide levels (provided it is not protected by a higher sea wall or other structure). Flooding caused by storm surges will be temporary, but still capable of causing damage.

Table 2 - Climate change temperature (°C) scenarios for Victoria [Climate Station Summerside A (ID: 8300700) @ 46.44N 63.83W]

Parameter	1980s	2020s	2050s	2080s
Temperature - Annual	6	7 ± 1	8 ± 1	9 ± 1
Winter	-6	-5 ± 1	-3 ± 1	-2 ± 1
Spring	3	4 ± 1	5 ± 1	7 ± 1
Summer	18	19 ± 1	20 ± 1	21 ± 1
Fall	8	9 ± <1	10 ± 1	12 ± 1
Heating Degree Days	4,621	4,255	3,865	3,472
Cooling Degree Days	111	170	255	360
Hot Days (Tmax > 30)	1	3	6	13
Very Hot Days (Tmax > 35)	0	0	0	0
Cold Days (Tmax < -10)	10	8	4	3
Very Cold Days (Tmax < -20)	0	0	0	0
Growing Degree Days > 5	1,718	1,923	2,172	2,457
Growing Degree Days > 10	889	1,041	1,228	1,438
Growing Season Length (days)	184	196	205	225
Corn Heat Units (CHU)	2,186	2,441	2,728	3,066
Corn Season Length (days)	159	169	176	191
Freeze Free Season (days)	171	189	207	222
Freeze Thaw Cycles - Annual	86	82	73	67
Winter	32	35	37	39
Spring	36	33	26	20
Summer	0	0	0	0
Fall	18	14	10	7

Table 3 - Climate change precipitation (mm) scenarios for Victoria [Climate Station Summerside A (ID: 8300700) @ 46.44N 63.83W]

Parameter	1980s	2020s	2050s	2080s
Precipitation – Annual	1,078	1,111 ± 25	1,131 ± 32	1,167 ± 46
Winter	280	296 ± 11	308 ± 17	324 ± 25
Spring	258	267 ± 10	274 ± 15	288 ± 19
Summer	257	263 ± 11	264 ± 16	263 ± 24
Fall	283	286 ± 12	289 ± 14	297 ± 20
Days with Rain	131	145	152	160
Days with Snow	64	60	50	43
Water Surplus	613	623	622	639
Water Deficit	41	45	55	67
Δ Intensity of Short Period Rainfall %	0	5	9	16

Rising sea levels will increase the frequency and severity of coastal flooding in Victoria. Storm surges will ride on top of higher seas, causing even more extensive flooding. For example, the extent of flooding experienced during a 1-in-100 yr storm surge will happen during a 1-in-10 yr storm surge by mid-century. By the end of this century, a 1-in-100 yr storm could reach coastal property that is less than 4 metres (13 feet) in elevation. Flooding scenarios for 2050 and 2100 are shown in Figures 17 and 18, respectively.

Table 4 - Sea level rise (cm) scenarios for Victoria (Canadian Hydrographic Services site - Summerside)

Year	Total Sea Level Rise (cm)
2025	14 ± 3
2055	40 ± 15
2085	78 ± 36
2100	100 ± 48

5. PROJECTED FUTURE IMPACTS IN VICTORIA

Victoria will continue to be impacted by coastal storms, erosion, and flooding. The nature of these coastal hazards, however, is likely to change. Coastal erosion and flooding during storms will continue to occur in future years, but in the context of a changing climate they will gradually occur with greater severity and increased frequency. This means that for communities like Victoria, the impacts of these hazards—on the local infrastructure, residents, economy, and environment—will be more intense and more experienced more often.

A. Coastal Erosion

Coastal erosion rates are likely to increase in Victoria. Some experts expect erosion to increase to 1.5 to 2 times the current rates over the next 100 years.[7] Storms, sea level rise, and warming winter temperatures will be most influential in this regard. Sea level rise will increase the intensity of coastal erosion along the shoreline. Higher water levels mean larger waves. Larger waves can cause more erosion than smaller waves. Higher rates of erosion will prompt the need for further consideration of retreat or protection options in some areas.

[7] Forbes, D. L., and Manson, G.K. 2001. Coastal Impacts of Climate Change and Sea-level Rise on Prince Edward Island. [Supporting Document 9 (Coastal geology and shore-zone processes) *to* **McCulloch, M., Forbes, D.L., Shaw, R.W. and A041 Scientific Team.** 2002. Coastal impacts of climate change and sea-level rise on Prince Edward Island (Forbes, D.L. & Shaw, R.W., eds). Geological Survey of Canada, Open File 4261, 62 p.]

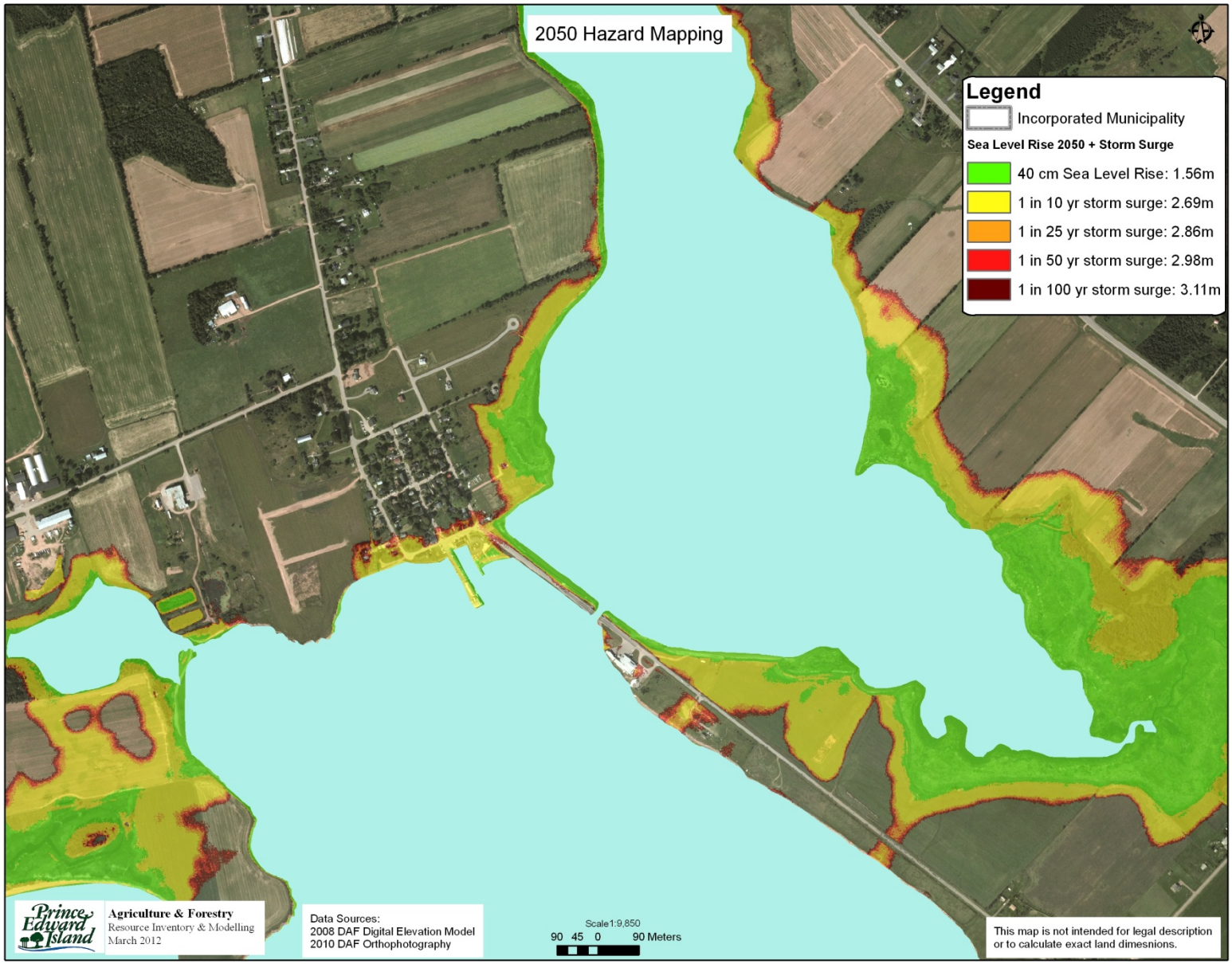

Figure 17 - Climate change flood risk scenarios for 2050. Projected flooding from sea level rise (green) plus 1-in-10 year (yellow), 1-in-25 year (orange), 1-in-50 year (red), and 1-in-100 year (dark red) storm surges are shown for the year 2050.

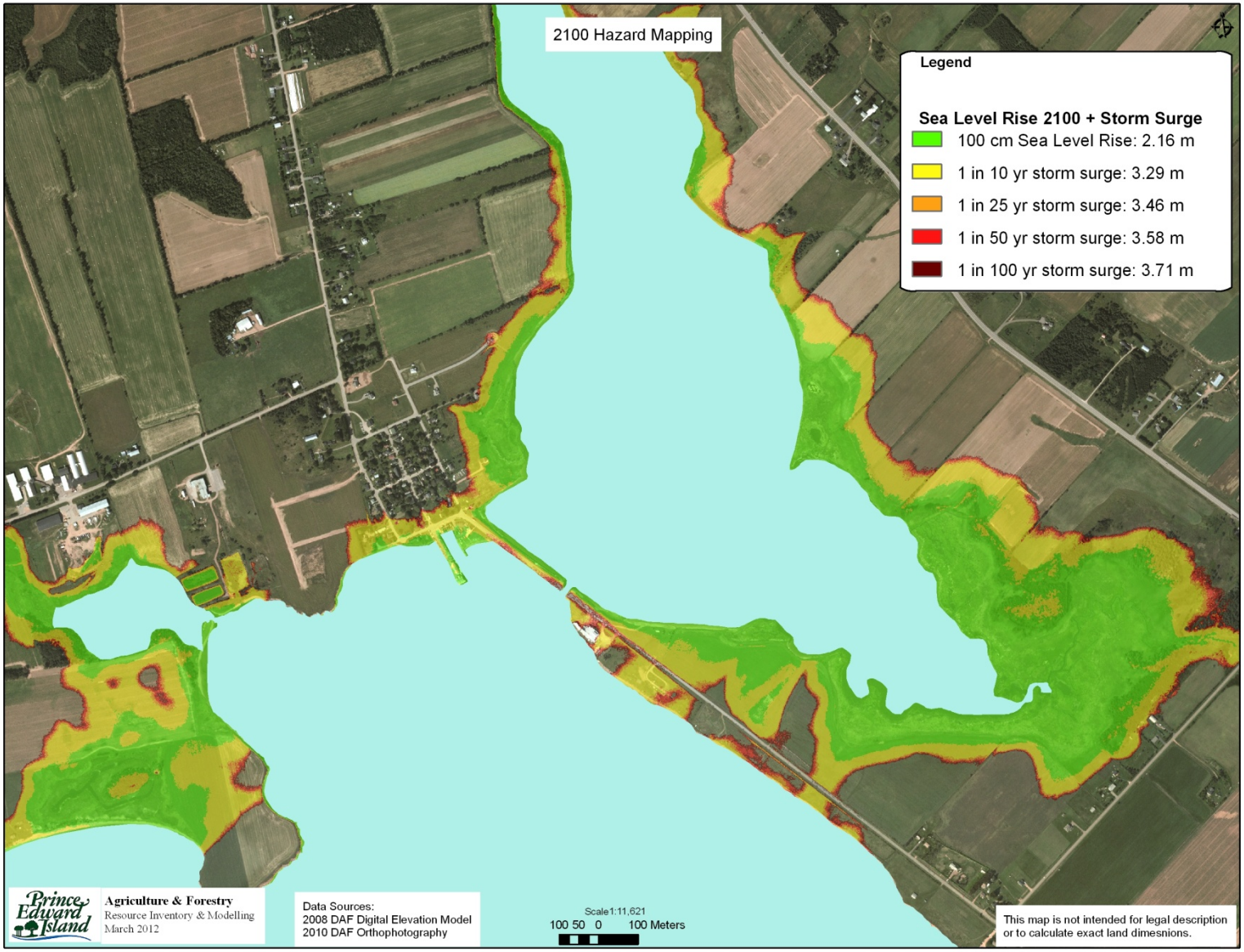

Figure 18 - Climate change flood risk scenarios for 2100. Projected flooding from sea level rise (green) plus 1-in-10 year (yellow), 1-in-25 year (orange), 1-in-50 year (red), and 1-in-100 year (dark red) storm surges are shown for the year 2100.

Warming winter temperatures are likely to result in less sea ice, leaving the shoreline exposed to waves. Greater wave energy reaching the coastline during late winter storm events will increase erosion rates in vulnerable areas.

An accelerated rate of erosion is likely along Victoria's shoreline, prompting the need for further consideration of retreat or protection options. Severe erosion could threaten the viability of the causeway. Ongoing maintenance and monitoring will be important if the community is to keep this infrastructure. Victoria Provincial Park is also at risk, as erosion continues to reduce the low cliffs. This park is an important tourism attraction and recreational centre for the community. Considering only current rates of erosion, the bath house could be at the shoreline in 5 to 10 years. Maintaining this infrastructure will likely require that it be moved farther away from shore.

Private properties will also face challenges along the Victoria coastline. Wright's Point is one area showing accelerated erosion rates. This area currently provides some protection from erosion to the surrounding area. Other locations could become more vulnerable to future damage if it's eroded (as was the case in West Point, Prince County). More property owners may attempt shoreline protection projects in the future and this could influence the aesthetics of Victoria's shoreline.

Continued erosion could also affect the fresh water supply in the area closest to the shoreline. Erosion can increase the vulnerability of coastal wells to saltwater intrusion. A growing demand for water in Victoria from homes, cottages, and commercial users could speed the rate of this intrusion. Pumping rates in other places on Prince Edward Island have been shown to drive the intrusion process more than any other factor.

B. Coastal Flooding

Sea level rise represents the most significant risk for the community of Victoria. Predictably, low-lying areas along the shoreline, stretching from Rovis Beach Lane to Victoria Bridge, are the most vulnerable. Storm surges and sea level rise will continue to threaten Water Street and its supporting infrastructure. Without significant repair to the sea wall—particularly below 25 and 27 Water Street—properties will continue to experience flooding. Nelson Street could also see increased flooding and damage. The question of responsibility for repair of the sea wall is an important one. Though currently located below private property, residents claim that sea wall construction was funded by the federal Department of Fisheries and Oceans (DFO). To date, however, neither residents, nor town council, nor DFO have indicated a willingness to address this glaring source of vulnerability.

Victoria's wharf, although currently in good condition, will gradually suffer damage from repeated coastal storms and wave action. Businesses keep critical equipment on the wharf. Flooding could cause financial losses if it was to be heavily damaged. Fishing vessels and equipment, which could be washed away or destroyed, face the same risk. Losing the viability of the wharf and shore area would have major impacts throughout Victoria. Waste water collection tanks in the wharf area and a nearby lift station are also vulnerable to flooding and damage from coastal storms.

C. Other Potential Impacts

Inland farming will not be immune to the impacts of a changing climate. The change in intensity of short period rainfall, likely to increase up to 15% over the next 90 years, could have a significant impact on farms in the area. This increase in short duration, intense rainfall also has the potential to carry more sediment and nutrients into the Westmoreland River estuary. The length of the growing season is also likely to lengthen, potentially by 40 days by the end of this century. This could have a positive effect on agriculture, allowing farmers to grow crops that require a longer season or to plant new crops.

6. CLIMATE CHANGE ADAPTATION

A. Past Initiatives

The community of Victoria has already made some decisions that will better enable the community to cope with coastal hazards and climate change. Some have been successful, while others need ongoing attention to maintain their effectiveness.

Wastewater Treatment System - In the early 2000s, the community was looking to replace its failing septic system. A system that suited its size, limited resources, values, and seasonal variations was needed. Specifically, the community wanted a system that was compact, affordable, environmentally sensitive, and capable of accommodating a four-fold flow capacity increase during the summer tourist season. In 2008, a central land-based effluent dispersal (LBED) system was installed, eliminating both discharge to Victoria Harbour and sewage backup during coastal storms and flooding. In 2011, the community was awarded a Sustainable Communities Award from the Federation of Canadian Municipalities (FCM).

Shoreline Protection - Coastal erosion along the community's south shore has slowly increased the vulnerability of local homes, recreation areas, businesses, and infrastructure. Erosion control structures have been built to protect these properties. A sea wall fronting a portion of Water Street (Figure 19) was constructed more than 30 years ago. Today, it is severely eroded. Its limited height, combined with sea level rise and coastal erosion, has rendered the sea wall virtually non-effective during any coastal storm of significance.

Figure 19 - Sea wall near Water Street (photo credit: D. Jardine).

More recently, shoreline protection was installed along the south shore, immediately west of the Victoria Bridge. Gabion baskets (Figure 13) had only limited success. Wave action has actively eroded around and behind the baskets, threatening the Causeway Road only a few metres away.

Shoreline protection has also been installed below the property owned by Halibut PEI Inc. (Morning Star Fisheries Ltd.), just east of the Victoria Bridge (Figure 20). The barrier installed here—rip rap composed of discarded concrete—has thus far effectively protected the shoreline. However, its lack of uniformity and aesthetic appeal do not complement the historic charm found elsewhere along the community's waterfront.

Figure 20 - Shoreline protection (rip rap composed of discarded concrete) borders the shore below Morning Star Fisheries Ltd, east of Victoria Bridge (photo credit: D. Jardine).

Figure 21 - Shoreline protection (sandstone) installed at Dunrovin Shores subdivision, west of the Victoria harbour front (photo credit: D. Jardine).

Other attempts at shoreline protection have been made on private lots. Sandstone boulders have been installed below the Dunrovin Shores subdivision (Figure 21), just west of the Victoria harbour front, and, on a much smaller scale, on the north side of the Causeway Road. These installations are quite recent and therefore their effectiveness can only be assessed with time.

B. Adaptation Options

Vulnerability assessments identify locations, people, businesses, infrastructure, and habitat that have been or will be vulnerable to coastal hazards. Issues requiring further consideration have been identified through this process. These can be used to inform Council and other local decision-makers. The development of a formal and comprehensive climate change adaptation plan, prepared with the help of a planning professional, is the next appropriate course of action for any community. Recommendations are provided below, in no particular order. Council and the community of Victoria will need to evaluate each recommendation and prioritize their response.

1. Develop an Emergency Management Plan

Prior to, during, and after emergencies such as coastal storms and floods, elected heads of municipalities are responsible for:

- analyzing risks and hazards within their municipality/local authority and developing emergency plans to address situations that might impact life, property, and the well being of persons within the municipality/local authority;
- preparing and implementing local emergency programs using the resources available to them;
- directing and controlling all emergency operations
- requesting assistance from other municipalities/local authorities; and
- informing the provincial government (Emergency Measures Organization - EMO) about the emergency and possible requirements for assistance.[8]

The development of a comprehensive emergency management plan is integral to public safety, and should be a top priority for community leadership. The community of Victoria is aware that such a plan is needed.

The PEI Office of Public Safety can assist in the development of this plan and can provide the following resources:

- The ***Municipal Emergency Management Guide*** outlines key components and steps to help communities develop plans, create exercises, and ensure that resources have been identified before an emergency occurs.
- A ***Public Safety Officer*** is available to speak to community council members on Municipal Emergency Management, or to conduct a community presentation on Personal Preparedness.
- The ***Municipal Self Assessment Tool*** helps municipalities to identify key areas of focus and to ensure hazards are clearly understood.
- ***Emergency Planning Templates*** are available for municipalities and local businesses to create an emergency plan specific to the community or business requirements.
- The ***Guide to Business Continuity Planning*** (developed by the Government of Canada, Office of Critical Infrastructure Protection and Emergency Preparedness) assists local businesses in

[8] PEI Office of Public Safety, Municipal Responsibilities

developing strategies to deliver and resume their services, during and after an emergency, respectively.

- **Crisis Communication Planning** assists communities and businesses with outlining and delegating responsibilities in the event of a crisis, and with client and public communication.
- **Emergency Management Training** is available for municipal staff and volunteers who have a role to play within the municipal emergency plan. Topics include Basic Emergency Management, Emergency Operations Centre Management, Exercise Design, and Emergency Public Information.

2. Create a Municipal Coastal Development Setback By-law

Some coastal infrastructure, businesses, homes, and other structures in Victoria are located close to the water's edge. When they were built, they may have been well back from the shoreline. Today, however, erosion of the coastline has made many of these developments vulnerable. This is a common problem across Prince Edward Island.

Figure 22 - Coastal erosion in Souris has required this homeowner to remove a portion of his shed (photo credit: D. Jardine).

Their vulnerability, however, might also be due in part to a lack of awareness, foresight, and/or caution by the original developers and local government. Many coastal developments currently threatened by an encroaching shoreline might now be less vulnerable if developers had been able both to anticipate changes to the shoreline and to adapt the development accordingly.

Ensuring that future development is protected from erosion and sea level rise, Victoria could consider enacting coastal setback by-laws that go beyond provincial requirements. These should include both a horizontal setback (a distance from the coast that incorporates the rate of erosion) and a vertical setback (an elevation that provides protection from coastal flooding). The towns of Shediac, East Beaubassin, and West Beaubassin, in southern New Brunswick, already have such by-laws in place. The Town of Shediac, for example, seeks through its by-law to "*anticipate, prevent and attack the causes of coastal environmental degradation",* to *"only allow developments that will be able to adapt to sea-level rise and severe storm surges in zones that risk flooding"* and to ensure that *"for a new building the minimum elevation must be 4.3 m".*[9]

There may be some liability to the community for approving subdivisions and building permits in areas subject to flooding or aggressive shoreline erosion. By implementing a by-law that mandates

[9] Town of Shediac. Zoning By-Law 66(1) *SLR Zone – Sea-Level Rise*. http://www.shediac.org/pdf/zoning_by_law.pdf

coastal development setback distances beyond the minimum provincial requirements, Victoria could count itself among the growing number of maritime communities that are taking progressive, proactive measures in the interest of their constituents. They may also minimize liability claims from individuals who suffer damage in the future due to flooding and erosion events.

3. Encourage Provincial Land Use Planning Policies that Consider Climate Change

The community of Victoria (like other Island communities) has the opportunity to effect change in the area of land use policy. In the spring of 2012, the Department of Finance, Energy and Municipal Affairs will be forming a provincial task force to lead a public dialogue on the topic of land use policy on Prince Edward Island. Council and residents of Victoria will have an opportunity to discuss with government representatives their concerns surrounding land use policy, including those associated with climate change impacts.

4. Promote Responsible Agricultural Practices

Sedimentation within the Westmoreland River can be attributed to run-off from nearby dirt roads, construction sites, and farmland, particularly during heavy rainfall events. Efforts to improve agricultural practices will help to reduce the amount of sediment entering local watercourses. This will help to limit the negative impact of sedimentation on habitat and water quality. Responsible farmers are becoming better educated about the direct impacts their actions have on surrounding watercourses, and most are acting accordingly for the benefit of their community. Whenever possible, all farmers should be encouraged to take proactive measures to minimize the impact of their operations on the local environment.

The Alternative Land Use Services (ALUS) program is a voluntary program that provides financial incentives to PEI landowners and farmers who 1) remove land from agricultural production, or 2) implement beneficial management practices that protect soil and water quality or improve fish and wildlife habitat.

Financial incentives are offered to farmers who:

- plant native trees in buffer zones;
- retire sensitive land by expanding buffer zones, establish non-regulated grassed headlands, and/or take high-sloped land out of agricultural production;
- take land out of production to establish soil conservation structures; and/or
- maintain livestock fences adjacent to watercourses and wetlands.

The community of Victoria should work with the Westmoreland River Watershed Group to encourage farmers in Victoria and surrounding areas to participate in the ALUS program.

5. Increase Monitoring of Coastal Hazards

Monitoring the impacts of flooding and erosion can help Victoria to adapt and plan appropriately for future impacts.

Monitoring of high water marks is a useful way to record the extent of flooding during storm surge events. High water marks, observed during storm events, can be recorded and compared with tidal data to evaluate the severity of a given storm, and the vulnerability of coastal structures. This information can also be used to forecast possible impacts at high tide and/or in the event of sea level rise. High water marks can be recorded simply by observing the highest or most landward extent of flooding caused by a storm surge and marking it on a permanent structure. The mark could consist of something as simple as a painted line on the side of a building or a spike embedded into a telephone pole. Precise coordinates of these marks can then be gathered after the storm surge is over.

Shoreline erosion monitoring in some of the more susceptible areas would help to record the impact of a rising sea level. There are several resources available to communities who wish to conduct shoreline erosion monitoring. One such resource is available through the Southern Gulf of St. Lawrence (SGSL) Coalition on Sustainability. This group has created a program to ensure continued effort towards community-based monitoring and education on coastal erosion issues. The education component of the project focuses on informing the general public and community decision-makers about coastal erosion and how to live sustainably with this natural process. The monitoring component of the project helps to build a local capacity for informed decision making with regard to coastal erosion. A toolkit has been developed specifically for communities in the southern Gulf of St. Lawrence. In cooperation with the SGSL Coalition, shoreline erosion monitoring has been initiated in Eastern Kings, PEI.[10]

Erosion monitoring should continue in Victoria Provincial Park to provide a regular assessment of shoreline retreat in the area.

6. Create a Climate Change Adaptation Plan

Now that residents of Victoria better understand their vulnerability to climate change, a climate change adaptation plan will help to evaluate adaptation options and identify next steps for the community. A recent report by the National Round Table on the Environment and the Economy entitled, “Paying the Price: The Economic Impacts of Climate Change for Canada”, indicates that inaction now by Canadians on climate change issues will result in a greater price to be paid down the road. It is evident from this report that early action can save taxpayers money and avoid higher costs and impacts in the future.

[10] http://www.souriswl.ca/shoreline.pdf

Fortunately, there are a number of useful tools available to Victoria to help create a climate change adaptation plan. One of these has recently been produced by the Canadian Institute of Planners (CIP). Entitled "A Handbook for Small Canadian Municipalities", it lays out a six-step process for climate change adaptation planning. The Town of Stratford has produced a climate change adaptation plan using the methodology described in this handbook.

7. Assess Community Infrastructure

As mentioned earlier in this report, some of Victoria's infrastructure is already experiencing impacts from climate-related events.

Under the climate change scenarios developed for the community, the likelihood of coastal hazard events increasing in magnitude is clear. There are a number of tools available to help assess the risk to community infrastructure and to prioritize items for action. The Canadian Institute of Planners Handbook lays out a process to list, evaluate, and rank the risks. Another approach for assessing risk to public infrastructure (buildings, roads, storm water, waste water, and water supply systems) is proposed by Engineers Canada's Public Infrastructure Engineering Vulnerability Committee (PIEVC). With tools like these the community will be able to 1) identify all existing and future risks, and 2) rank them in an order of priority for planning and budget purposes. Consultation with the provincial departments of Transportation and Infrastructure Renewal and Tourism and Culture is recommended, because they own some of the vulnerable infrastructure assets in the community.

8. Consider Strategies to Reduce Vulnerability of Community Infrastructure

Decreasing the vulnerability of existing homes, businesses, roads, and other infrastructure can be challenging. Three basic strategies can be considered:

Retreat or move infrastructure to less vulnerable areas. This strategy is common in Prince Edward Island. Homes, cottages, and even barns have been moved further inland to protect them from erosion and storm surges. Sometimes roads are moved further inland or completely re-routed. This approach makes sense when property owners have adequate room to do so or when the on-going cost of storm repairs and safety concerns outweigh the costs of retreating.

Abandon property or infrastructure in vulnerable areas. Moving isn't always an option. However, abandoning a property or parcel of land can be reasonable if the land or infrastructure is not worth protecting.

Protect property or infrastructure in vulnerable areas. Protecting the coastline from erosion (armouring) is a common practice in PEI. However, good shoreline protection systems are expensive and some are unattractive. They can change the look of the shoreline, making it less

attractive for tourism and recreational purposes. They also reduce habitat for birds and other wildlife. Successful shoreline protection requires conscious and careful decision-making. Different approaches are better suited to different shorelines (see Appendix 3). Knowledge of local conditions is essential. In particular, consideration of sediment budgets (the amount of sediment brought into and leaving the system) and coastal land use is very important. Professional consultation is recommended if coastal communities are to make the best decisions possible.

Flood protection is also common in Atlantic Canada. Dykes have been used for hundreds of years to reclaim and protect coastal land. In recent years, some people have reduced flood vulnerability by building elevated structures (e.g., homes on stilts) (Figure 23).

Figure 23 - Elevated house on Harbour View Drive, Rustico Harbour (photo credit: D. Jardine).

9. Increase Climate Change Awareness and Education

An informed resident is a better prepared resident. Creating a community awareness of the impacts of coastal storms, flooding, and erosion will help residents to personally prepare for such events. Encouraging residents to gain an education—however general—in the area of climate change will inspire them to plan long term for the benefit of future generations.

A variety of low-cost options are available to communities that wish to foster greater awareness and education in the areas of climate change, coastal processes, and emergency preparedness. These include:

- **Guest speakers**—from local watershed groups, government agencies, or universities—may be invited to speak to the community. This could be an individual presentation or part of a series of related lectures (Figure 24).

- **Promotion of relevant local community / college / university courses** will help to create awareness of relevant subject areas (e.g., emergency preparedness, business continuity management, watershed health, climate change).

- **Public activities** such as open houses, networking sessions, dances, and community barbecues foster friendship and closeness among residents. Such connections increase

goodwill between neighbours, raise awareness regarding vulnerable residents, and strengthen communities in times of emergency.

- **Newsletters / fact sheets** could be produced for general distribution or inserted with applications for development permits.

Figure 24 - Grade 7 and 8 students at Gulf Shore School in North Rustico discuss climate change and recent local weather events.