RESEARCH REPORT

RESIDENTIAL DEVELOPMENT IN COASTAL COMMUNITIES: ADDRESSING CLIMATE CHANGE THROUGH SUSTAINABLE COASTAL PLANNING

EXTERNAL RESEARCH PROGRAM

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Residential Development in Coastal Communities: Addressing Climate Change Through Sustainable Coastal Planning

Case Study Analysis

Prepared By
Paul Jordan, MCIP
Research Associate
Rural and Small Town Programme, Mount Allison University
144 Main Street, Sackville, NB
E4L 1E9
Phone (506) 364-2386 email: pjordan@mta.ca

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Table of Contents

Residential Development in Coastal Communities: Addressing Climate Change Through Sustainable Coastal Planning

Abstract

The Beaubassin coastal area of southeastern New Brunswick has a long coastal development history. It has become one of the premier places to live and play in New Brunswick. In recent years, a number of storm surges have impacted dramatically on people's coastal homes, cottages and properties. Scientists have determined that sea-level rise is occurring due to climate change and the impacts are being felt all along the coasts of not only New Brunswick but all of Canada. This project looks at the issue of sea-level rise and coastal residential development.

The study reviews residential development patterns and explores unsustainable land use practices of coastal communities. It looks at ways in which property owners are currently adapting to sea-level rise, storm surges and coastal flooding. The project recommends ways in which both communities and property owners can adapt to sea-level rise and storm surges in a sustainable way.

Executive Summary

The gentle lapping of the waves on the sand, warm sunshine and soft breezes make the coast a popular place to live. In the Beaubassin coastal area of southeastern New Brunswick coastal development has a long history. It has become one of the premier places to live in Atlantic Canada. In the past number of years the coast has also become a dangerous and expensive place to live. Storm surges have flooded people home's and cottages. Scientists have determined that sea-level rise is occurring due to climate change and the impacts are being felt all along the coasts of not only New Brunswick but all of Canada.

In the Beaubassin area past land use practices have created an ad hoc unsustainable settlement pattern which is increasing sea-level rise and storm surge issues. These practices include:

- inadequate size properties
- salt water intrusion in wells
- improperly sized roads and streets
- unserviceable roads and streets
- improperly functioning sewage systems
- homes threatened by coastal erosion
- homes built in salt marshes and wetlands
- home built in sand dunes and other coastal features

In January 2000 and October 2001 major storm surges occurred, hitting the southern coast of New Brunswick. The surges caused millions of dollars of damage and caught the attention of provincial and municipal planners and officials.

In response to rising sea-level and coastal flooding homeowners have been adapting. Some of the adaptive techniques include:

- building homes on pilings and stilts
- building retaining walls along the coast
- remediating sand dunes and salt marshes
- moving their homes
- building up the land on their properties
- building homes on blocks

Since 1981 there have been substantial changes in land use policies to improve the sustainable development of the Beaubassin coastal area. The development of local land use policies such as Municipal Plans and Rural Plans has improved local development practices. At the provincial level the establishment of the Clean Water Act, the proposed Wetlands Policy and proposed Coastal Areas Protection Policy have improved the situation. Unsustainable development is still occurring due to the fact many of these policies have not been adopted as law and are still proposed or in draft form.

Many of the efforts taking place to adapt to climate change are occurring at the individual homeowner level. There is little or no community wide effort. It is recommended that a Community Sea-level Rise Mitigation Program be put in place. There are portions of the coast where mitigation measures are required sooner or have a higher level of importance to the community such as a built up urban area or a provincial park. Such a program would use scientific data to determine the extents of the impact of sea-level rise, areas prone to coastal flooding, develop appropriate policy and local homeowner actions. Similar programs are in place in coastal communities and states in the United States. Policy makers and homeowners have realized that changes are taking place and their valuable properties need to be protected. With accurate scientific data and good planning people's properties and homes can be protected from climate change and sea-level rise.

Sommaire

Le doux clapotis des vagues sur le sable, la chaleur du soleil et la brise de mer font de la côte un endroit privilégié. Les aménagements côtiers de la région de Beaubassin dans le sud-est du Nouveau-Brunswick possèdent une longue histoire. Cette région est devenue l'un des endroits les plus recherchés ou vivre dans le Canada Atlantique. Depuis un certain nombre d'années, il est coûteux et dangereux d'y vivre, car des ondes de tempête ont inondé les maisons et les chalets. Les scientifiques ont déterminé que l'augmentation du niveau de la mer est le résultat des changements climatiques et que ceux-ci ont des répercussions tant sur les côtes du Nouveau-Brunswick que celles de l'ensemble du Canada.

Dans la région de Beaubassin, les pratiques passées d'aménagement, de nature non durable et incontrôlée, ont créé un schéma de peuplement qui se répercute négativement sur le niveau de la mer et sur les ondes de tempête. Ces pratiques comprennent :

- terrains de taille inappropriée
- intrusion d'eau salée dans les puits
- chemins et rues de dimension inadéquate
- rues et chemins inutilisables
- réseaux d'égout défectueux
- habitations menacées par l'érosion côtière
- construction d'habitations dans des marais salés et des terres humides
- habitations construites sur des dunes de sable et d'autres caractéristiques des côtes

En janvier 2000 et en octobre 2001, des ondes de tempêtes frappaient la côte sud du Nouveau-Brunswick et causaient des dommages évalués à plusieurs millions de dollars, ce qui n'a pas manqué d'alerter les urbanistes et les représentants municipaux.

En réponse au phénomène de la hausse du niveau de la mer et des inondations côtières, les propriétaires tentent de s'y adapter. Voici certaines des techniques qu'ils ont employées pour parer aux phénomènes :

- construction des maisons sur pilotis et poteaux
- mise en place de murs de soutènement le long de la côte
- biorestauration des dunes de sable et des marais salés
- déménagement des maisons
- mise en place de remblais sur les propriétés
- construction des maisons sur des caissons

Depuis 1981, on a sensiblement modifié les politiques d'utilisation des sols afin de rendre l'aménagement de la région côtière de Beaubassin davantage durable. L'élaboration de politiques locales en matière d'utilisation des sols, comme les plans d'aménagement urbains et ruraux, ont amélioré les pratiques d'aménagement locales. À l'échelon provincial, les pratiques se sont également améliorées en raison de la mise en place de la Loi sur l'assainissement de l'eau, de

même que de lignes de conduite proposées en matière de terres humides et de protection des régions côtières. Le développement non durable se poursuit néanmoins du fait que les politiques, étant à l'état d'ébauche et de proposition, n'ont pas force de loi.

Un bon nombre des initiatives d'adaptation aux changements climatiques s'effectuent par les propriétaires-occupants : il existe peu ou pas d'initiatives collectives. On recommande que soit mis en place un programme de mesures d'atténuation de la hausse du niveau de la mer. Certaines parties de la côte requièrent que les mesures y soient implantées plus rapidement et d'autres possèdent une importance plus grande aux yeux de la collectivité, comme dans le cas d'une zone urbaine bâtie ou un parc provincial. Dans un tel programme, on emploierait des données scientifiques pour déterminer l'étendue des répercussions résultant de la hausse du niveau de la mer, cerner les zones sujettes aux inondations côtières et élaborer des initiatives appropriées en matière d'orientations et de plans pour les propriétaires. Des programmes similaires ont été mis en place dans des collectivités et des États côtiers américains. Les décideurs et les propriétaires se sont aperçus qu'il se produit des changements et que les propriétés de grande valeur méritent qu'on les protège. Des données scientifiques fiables et une planification appropriée permettront aux propriétaires de mettre leur maison à l'abri des changements climatiques et de la hausse du niveau de la mer.

CMHC SCHL

National Office
700 Montreal Road
Ottawa ON K1A 0P7
Telephone: (613) 748-2000

Bureau national
700 chemin de Montréal
Ottawa ON K1A 0P7
Téléphone : (613) 748-2000

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1.0 Introduction

Coastal zones are dynamic landscapes, ever changing with the changing of the tide. It is well known that climate change is occurring throughout Canada and the world. Coastal areas are seeing the dramatic impacts of the changing climate. Climate change effects the construction of housing in coastal zones, through increased coastal erosion, migration of salt marshes inland, and increased coastal flooding. Housing, along with other forms of human development, tends to be static and inflexible, thus conflicting with the dynamic nature of the coastal zone. " Our historic approach to natural hazards has been of resisting and armouring against them. In the United States, this is especially evident in coastal areas, where the strategy is to construct sea-walls, jetties, and other structures to resist the forces of nature rather than trying to understand them and live within their limits" (Beatly and Manning, 1997, page 99). Humans sometimes do not work within the limits the environment places upon them, but rather modify nature to meet their needs. Usually these modifications result in "engineered' or "technological" solutions.

The question becomes: *How do we develop housing in a sustainable fashion in such a dynamic location and environment?* The answer is to plan for an ever-changing natural environment. The challenge for this research inquiry is to understand how this might happen, particularly through changes in policies and planning practices. For thousands of years, humans have attempted to live along the coast, building their homes and wharves, only to find that one day the sea has invaded their home and washed it out to sea. In places such as Holland, whole communities are protected from the invading sea by engineered structures.

In Canada, we have the luxury of hundreds of thousands of kilometres of coast line. Much of it is still undeveloped. We have an opportunity to develop coastal communities in a sustainable form. Unfortunately there are some homes built along the coast which will eventually be damaged by the pounding of the sea and will not be saved. The opportunity, however, still remains to design future communities that adapt to the changing nature of the landscape.

In this report a detailed analysis of a case study is provided to further our understanding of issues, and to explore potential solutions. The report begins with a review of the historical land use development trends of the coastal communities within the Beaubassin case study area and ends with recommendations and potential solutions to existing issues. The analysis draws on a review of existing literature about the case study area, a review of past and present land use development practices, a review of existing provincial and local policies impacting upon residential development and coastal development, and key informant interviews. **Appendix A** includes a list of the key informants.

> "Planning for sustainable communities is not simply a matter of avoiding a few wetlands, or saving a few acres of open space, or putting in place a few non-point best-management practices. Rather, it requires considering ecological limits and environmental impacts at every step of community development and in every aspect of community design, from the energy efficiency of buildings to the regional transportation system..." (Beatley and Manning, 1997, page 28).

As Beatley and Manning state there is more to good coastal community planning than just a few simple principles. Sustainable coastal planning requires a comprehensive and long-term approach examining policies, programs and actions at all levels including the individual homeowner.

2.0 The Beaubassin Case Study

The Beaubassin Planning Commission District is located along the coast of the Northumberland Strait in southeastern New Brunswick, **(Figure 1)**. There has been on-going residential coastal development for many years in this location. **Figure 2** shows the limits of the study area, from Shediac Bridge to Shemogue, and includes the coastal communities between these two points. Although many other coastal communities in Atlantic Canada have similar histories and development practices in the area, the geographic location of this area makes it a useful case study. Within the last three years coastal residents of the Beaubassin area have seen an increase in the number of storms and severe storm surges, causing dramatic results on residential development. Some of this is the result of what some may call “freak” weather, but some of it is also due to poor land use planning and coastal planning practices.

2.1 Historical Development

Historically, the Beaubassin area has been a popular location for human settlement, beginning with the First Nations People and eventually the French and English from Europe in the early 1600's. The Mic Mac people were attracted to the area due to the abundance of fish, and shellfish from the ocean (Brun, LeBlanc and Robichaud, 1988, page 15). The French settlers established the first permanent homes along the shore in the 1600's. A combination of farming, fishing and forestry became the primary economic engine for the area. The establishment of the railway line to Pointe du Chêne and the highway between Moncton and Shediac have facilitated the movement of coastal settlers to the area (Belliveau, 1977, page 139).

The general settlement pattern characteristic to the Province of New Brunswick has been defined by a concentration along the coastline and interior waterways. Today waterfront properties tend to carry higher real estate values (Natural Resources and Energy and Environment and Local Government, 2001, page 5). The settlement pattern in the Beaubassin area is consistent with that of the general New Brunswick pattern.

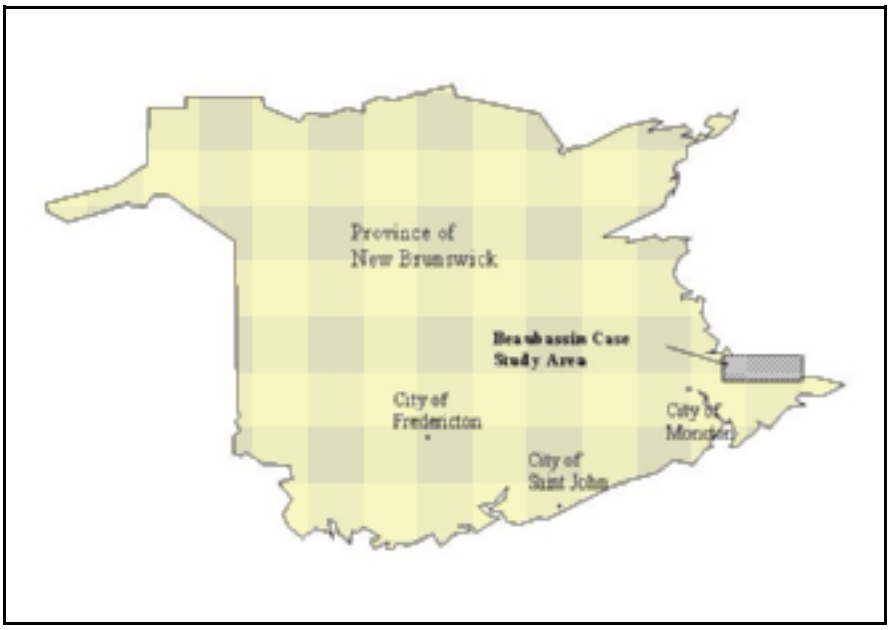

Figure 1 - Location of Beaubassin Case Study Area

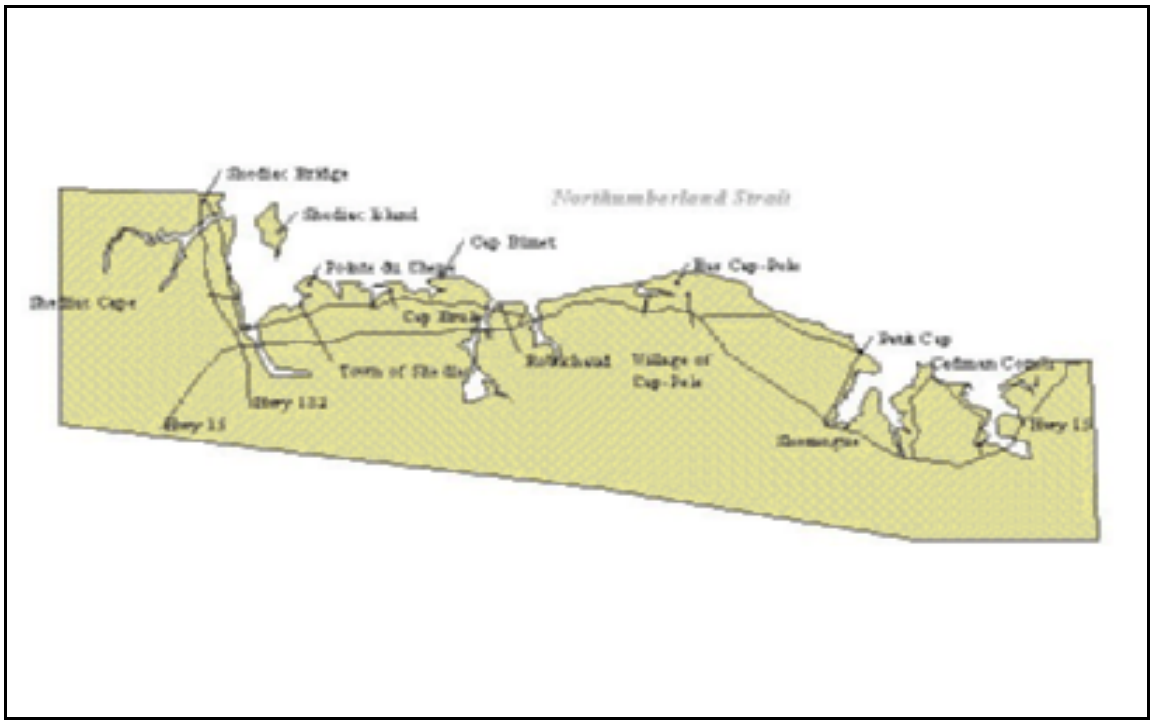

Figure 2 - Coastal Communities of the Beaubassin Case Study

2.2 Traditional Subdivision Pattern

The original or traditional land subdivision is based on land grants given by both the French and English governments in the early 16th and 17th centuries. **Figure 3** shows a land subdivision pattern, introduced in the early 1800's and based on the long-lot system found in Quebec used by French settlers (homes and buildings were intentionally left off this map to show what the subdivision pattern would look like). This pattern permitted both road and water access for all property owners. When this settlement pattern was established, farming was the predominant land use in this area. With a farm-based economy, it is not essential that housing be placed close to the sea-shore. Therefore, housing was found closer to the road. It is important to note that the houses and buildings were established first, then a road was put in place to connect the homes.

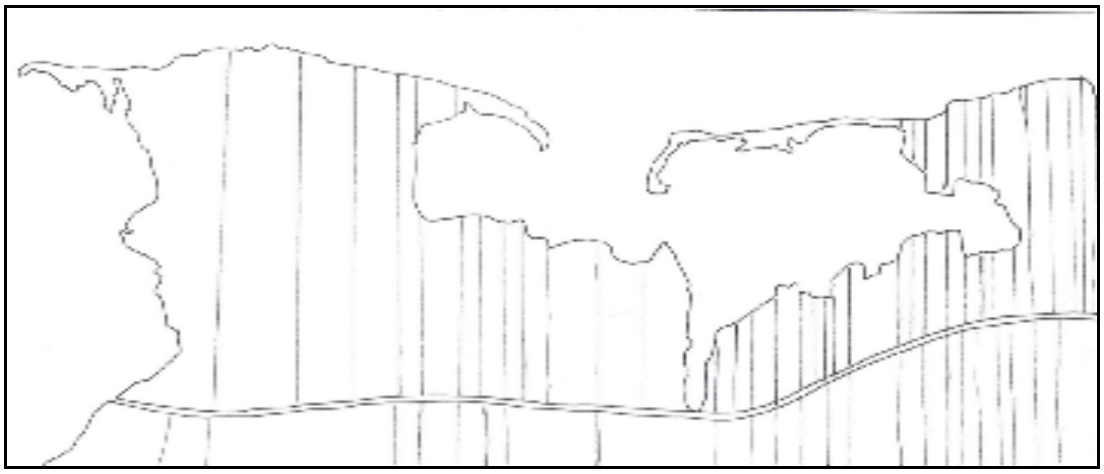

Figure 3 - Long-Lot Subdivision Pattern in the Cap Brûlé and Cap Bimet area
Base map source: Beaubassin Planning District Commission

Figure 4 shows the same area as in the previous figure, in 1805. At this time land was divided into a long-lot system with houses located along the primary road (the black squares and dots indicate the location of houses on this map). Housing is located away from the coast as well as the marshlands. The map below also shows where two roads were built, each extending from the primary road to the coast. During this period the local economy was based on agriculture and fishing. Families were dependent upon their crops and live-stock, and supplemented their diets with fish and other foods from the sea. The two roads leading to the coast provided the main routes to opening the coast to new settlement. These two roads served as the conduit for the coastal development in the 20th century.

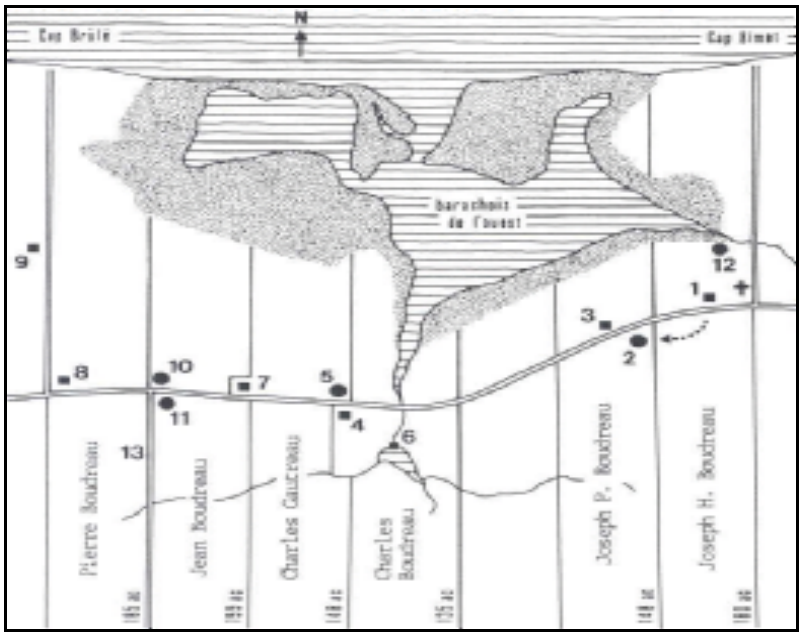

Figure 4 - Development in the Cap Brûlé and Cap Bimet area in 1805
Map from Brun, R., B. LeBlanc, and Robichaud, page 101, 1988

There is much to be said about the settlement pattern of the French settlers in 1805. The homes and buildings were located at a significant distance from the eroding coastline, the salt marsh had room to function properly (storing water, and protecting homes from floods) and there was room to migrate inland. Infrastructure such as roads were not built through the salt marsh, therefore not impeding its natural migration.

Figure 5 represents the Town of Shediac in 1862 and shows the settlement pattern at this time (black dots represent houses and buildings). The homes and structures were located on the higher ground away from the coastline. Some homes were built along the primary road and along a number of small or secondary streets. Such a settlement pattern points to the possibility that the original settlers may have been well aware of the dangers of building too close to the water. A number of roads provided access to the coast, as fishing was a part of the local economy of this time. The lack automobiles during this time may have influenced the number of formal roads and streets.

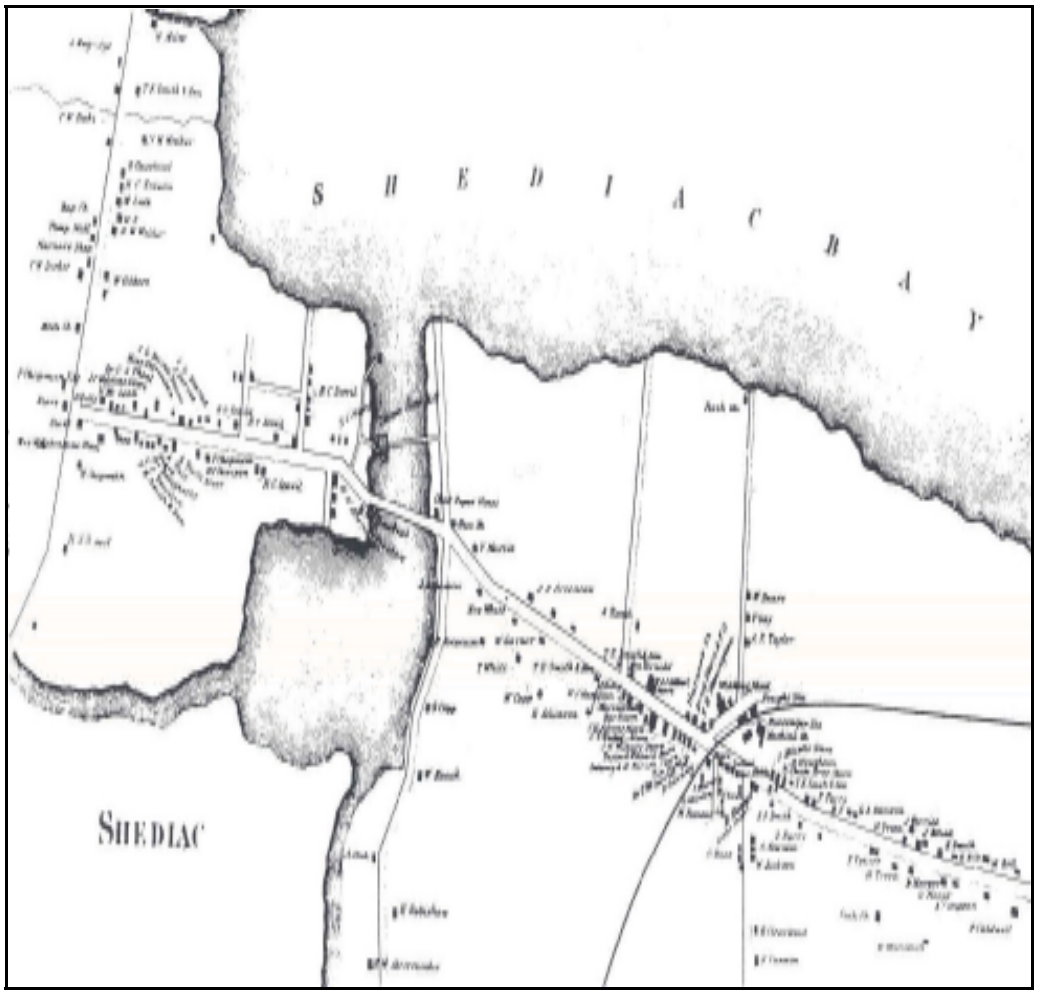

Figure 5 - Town of Shediac Development Pattern in 1862
Map source: Brun, R., B. LeBlanc and A. Robichaud, page 80, 1988

2.3 Pre-Planning Subdivision Pattern

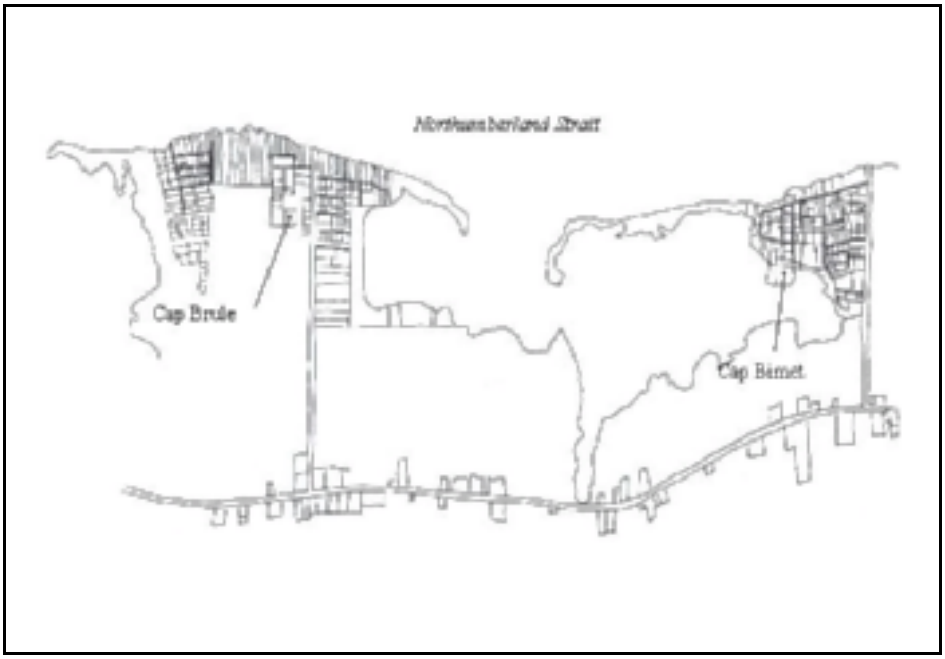

Figure 6 - Pre-Planning Subdivision Pattern prior to 1981.
Adopted from Service New Brunswick base map 1996

Prior to formal coastal land use planning (before 1981), subdivision and land development tended to be ad hoc and informal. **Figure 6** shows that lots were very small which contributes to the very high density. Streets were very narrow (single lane in some cases). There was an emerging grid pattern, but some street patterns were irregular. Lots were pushed against the coast, and settlement was clustered primarily on head lands. Some linear strip development occurring along the primary road can be detected. Access in and out of the settlement clusters was by one main street only. The evidence shows that unplanned development had been permitted to encroach upon the salt marsh.

The long-lot system previously found in this area was subject to a new pattern of ad hoc land subdivision pattern thrust upon it by people wanting ocean front property. The smaller lots would have been subdivided from the much larger farming lots. As farming lost its role as the primary driver of the local economy, roads were built from the main road to the shore. This opened up the coast to development. Since the property had been cleared for farming, the building of cottages was unconstrained.

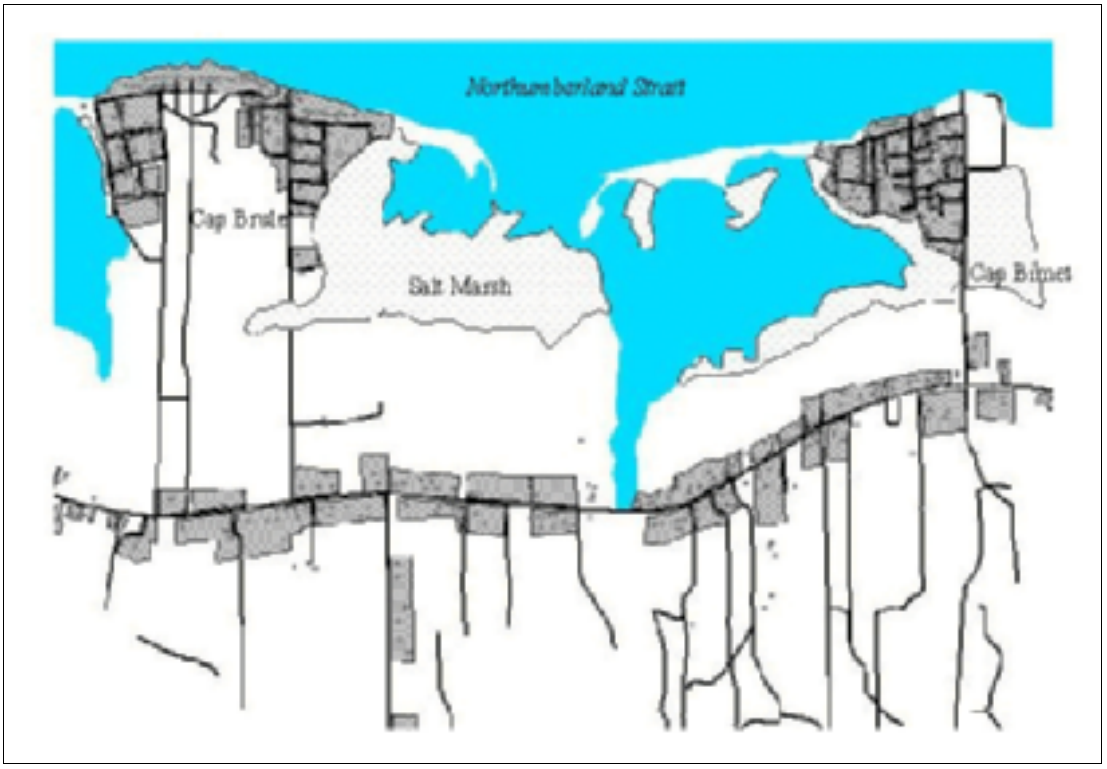

Figure 7 - Coastal Residential Development Trend as of 1996
Adopted from Service New Brunswick base map 1996

Figure 7 shows current residential development in 1996 (in dark grey). Intensive development has occurred on the headlands. This development is encroaching on the salt marshes (light grey pattern). Some linear development is also located along the primary road.

2.4 Post-Planning Subdivision Pattern

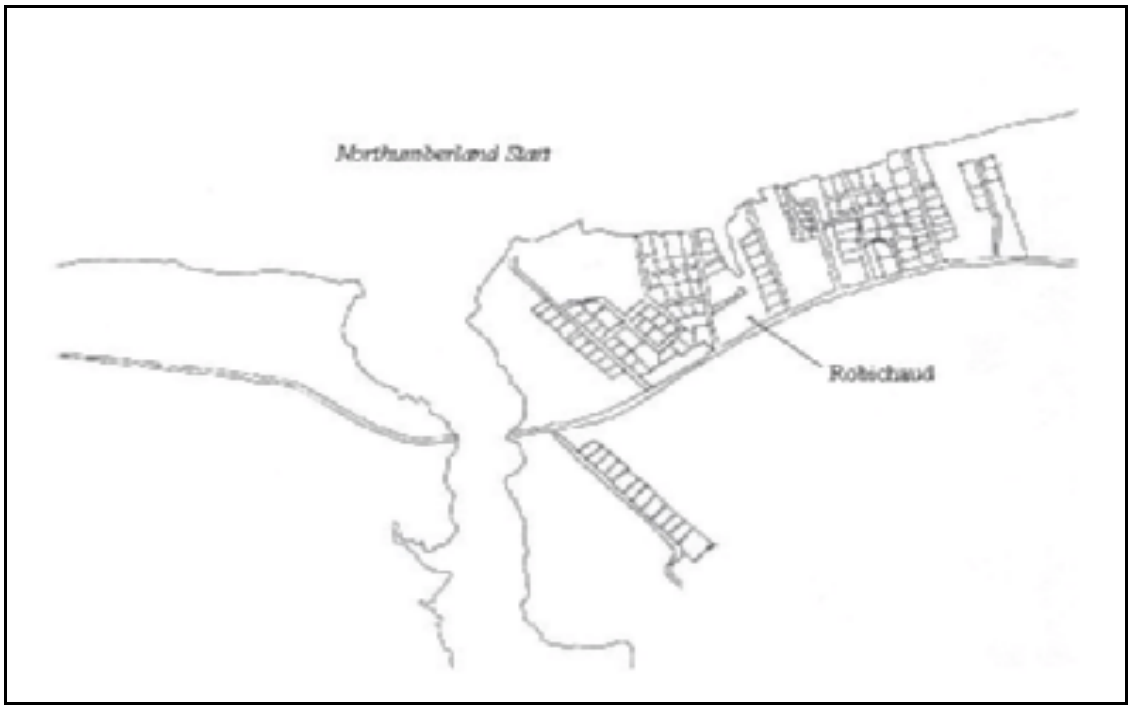

Figure 8 - Post-Planning Subdivision Pattern in Robichaud
Adopted from Service New Brunswick base map 1996

In 1981 formal land use planning was introduced to the Beaubassin region, with the establishment of the Beaubassin Planning District Commission. Since that time, there have been significant changes in the way land is subdivided and developed in the coastal communities as compared to the period before 1981. Planning officials began enforcing provincial subdivision and land use regulations. These new standards influenced the development pattern, requiring that building lots meet a minimum standard, ensuring that roads meet specific criteria, and ensuring that appropriate construction materials for housing are used. **Figure 8** is an example of a new pattern of development along the Beaubassin coast. When compared with pre-planning period subdivisions, the new pattern of subdivision planning reflects a movement away from the grid pattern to a more curvilinear street pattern, with larger lots. There is more access to the primary street. Other major differences are: a form that is less compact, lower density and larger lots to accommodate larger homes. Over the years provincial health regulations regarding on-site septic systems and wells have become stronger with specific conditions and approved systems being required.

Unsustainable development has occurred for many years along this coastline. Over time provincial and local land use policies have become stronger in controlling development. **Figure 9** shows the Bluff area of Pointe du Chêne in 1992, one of the many coastal communities found along the coastline of the Beaubassin study area. The top of **Figure 9** shows residential development which has taken place on the edge and within the salt marsh. Property owners have in-filled the marsh and built on it. Up until a few years ago, planners and officials have had difficulty controlling housing development in proximity to and within salt marshes. With homes and cottages placed so close to the dynamic coast and in an area prone to flooding it is conceivable that these home owners will experience the impacts of a storm surge, not to mention future sea-level rise.

Figure 9 - Residential Encroachment on Salt Marsh in Pointe du Chêne
Photo by NB Department of Natural Resources and Energy

Figure 10 - Residential Development Trends in Greater Shediac Area, 1996
Base map source: Service New Brunswick, 1996

Figure 10 shows residential development as of 1996 for a portion of the case study area, extending from Shediac Cape to Cap-Bimet, including the Town of Shediac, Pointe du Chêne and Cap-Brûlé. Residential development is clearly clustered along the coast. **Figure 10** also indicates linear residential development extending inland along roads and rivers. The areas most prone to coastal flooding due to a storm surge are the areas heavily developed. These areas are low-lying areas around rivers and salt marshes.

3.0 Physical Characteristics of the Case Study Area

The physical characteristics of a coastal community influence or impact the size, location and type of development that occurs. For example, a rocky granite landscape will be a highly stable surface to build on, but the drawback is that it is expensive to build on. Surface run off is high in this case, and erosion is slow. However, the type of geology found in the Beaubassin case study area consists primarily of sandstone and shale. These types of soils and bedrock are easy to build on. Drilling a well is simple. There is plenty of sand and clay for septic drainage. The drawback is that the bedrock and soil are highly erodible along the coast, thus increasing the risk to residential development. Associated with this type of geology are: low sandstone cliffs, rock outcrops, barrier beaches, sand dunes and salt marshes. The salt marshes and sand dunes are nature's way of protecting the land from storm surges and wave action. Much of the coast in the Beaubassin area is low lying, at or just above sea-level. **Figure 9** shows the type of physical landscape found throughout much of the case study area. It is characterized by low-lying land and

salt marshes developed behind barrier beaches. Eroding of coastal headlands provides the sand to develop the barrier beaches that protect salt marshes.

Ollerhead and Rush (2000) conducted a study on sea-level rise in a portion of the case study area and concluded that the global rise in sea-level, in combination with a sinking coast, would result in a significant rise in sea-level. It is expected to rise more than 2-4 centimetres per decade over the next 50 years. The conclusion to be drawn here is that relative sea-level will rise in the Shediac area and that this will impact on people living in this area (Ollerhead and Rush, 2000, page 3). Sea-level rise coupled with storm surges as high as 0.7m similar to the one in January 2000 can in the future have devastating results (Bérubé 2001).

The case study coast is considered to be a low energy environment meaning there is little surf pounding on the shore. Other places which are much more exposed to wave action, such as along the Atlantic shore of Nova Scotia or Newfoundland are considered to be high energy coasts. A high energy coast can have an increased impact of coastal erosion and flooding. An example is the Red Head area in Saint John, New Brunswick where a number of homes along the Bay of Fundy are about to tumble into the ocean due to erosion of the cliff on which they were built. An area like the Bay of Fundy with the highest tides in the world would be considered a high energy environment. There is much daily tide movement and action to increase the rate of erosion.

Due to the highly erodible coast, many coastal residents all along the case study area have placed large rocks in front of their properties to slow the erosion process, called coastal armouring. A study conducted on a portion of the case study area (approximately 30 km of the study area's coastline) in 2000 by Jeff Ollerhead and Rebecca Rush (2000, page 7) of Mount Allison University found that 55% was stable, 13% of the coast was extremely erosional and 15% of that coast was actually accretional (see **Figure 11** for more details). Ollerhead and Rush also found that much of the coast had been protected with coastal armouring.

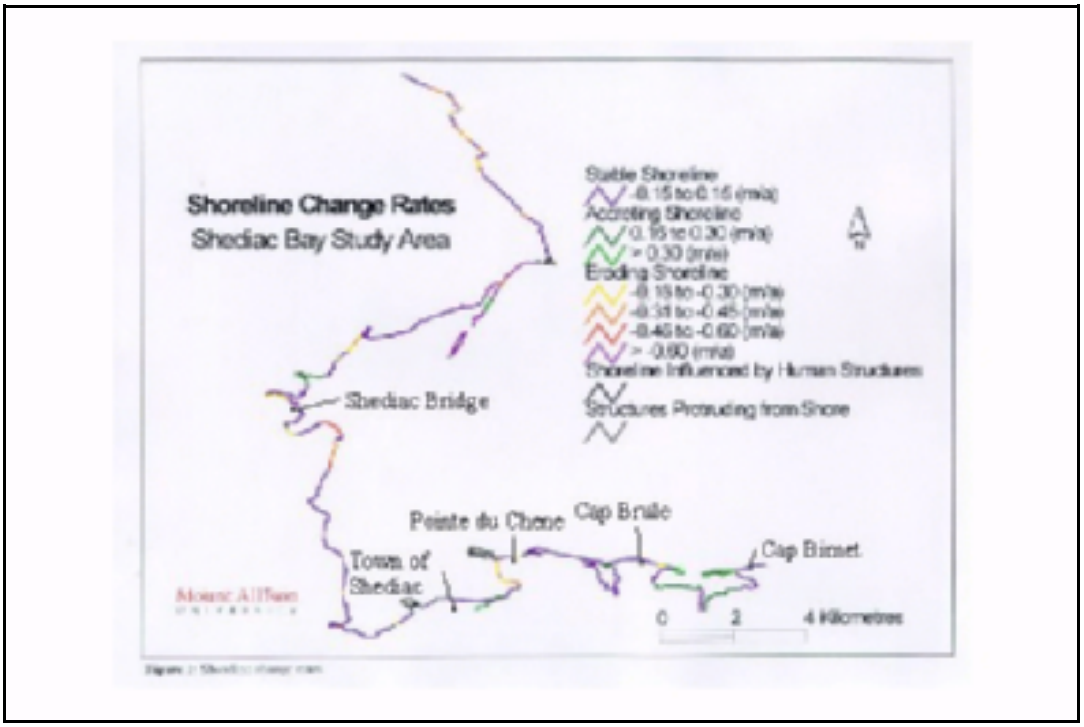

Figure 11 - Coastal Erosion Areas
Map from Ollerhead and Rush, 2000

Figure 11 indicates erosion rates for a portion of the study area. It includes the Town of Shediac, Shediac Cape, Cap-Brûlé and Cap-Bimet. The map indicates that much of the shoreline is stable. However, it is important to note that much of the inner part of the Bay has man-made structures in place to slow the erosion process.

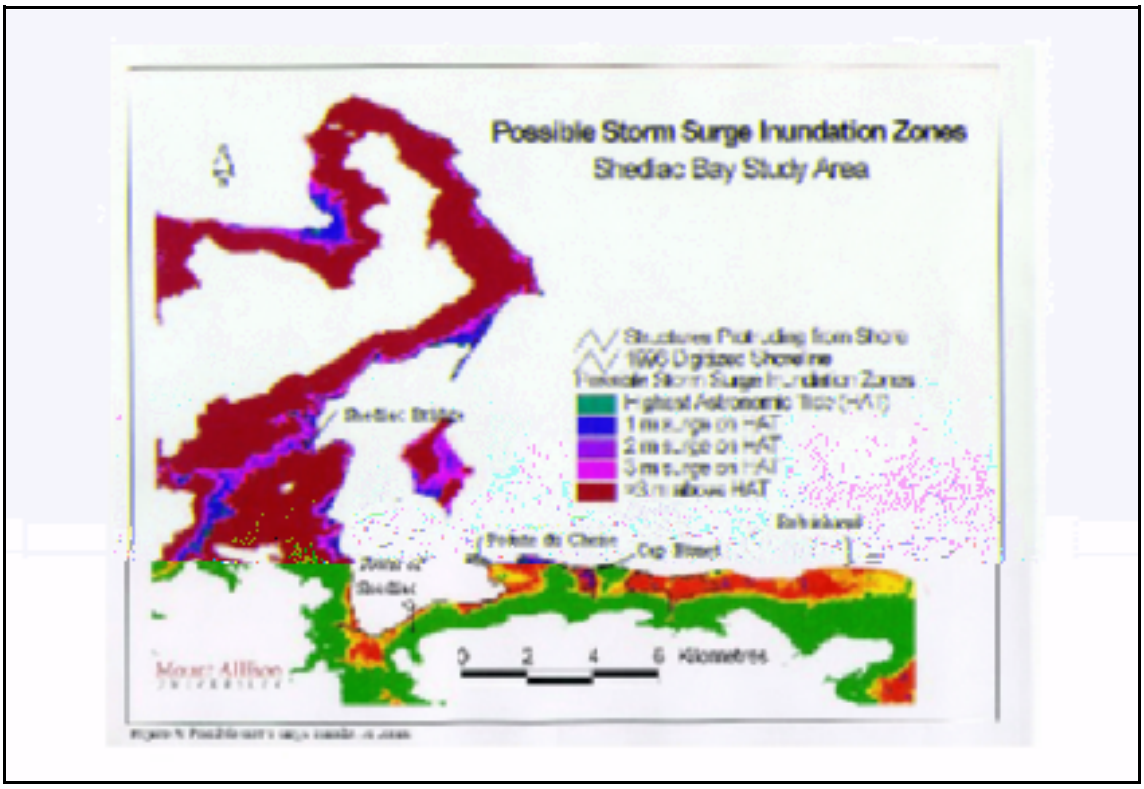

Figure 12 - Possible Storm Surge Inundation Zones
Map from Ollerhead and Rebecca Rush, 2000

Figure 12 shows areas that could possibly flood due to high tides and storm surges. The accuracy of the map is low due to the quality of the topographic information that was available at the time when the map was produced. The purple and orange areas identify coastal areas that could be in immediate danger. More detailed mapping would be required to produce land use policies and design guidelines for communities. **Figure 12** does give some indication of low-lying areas prone to flooding. The areas most likely to flood are areas adjacent to river mouths or sandy barrier spits (Ollerhead and Rush, 2000, page 9).

The conclusions made by Ollerhead and Rush (2000) are:

- the coastal zone in this study area is susceptible to coastal erosion and flooding as natural hazards based on it physical characteristics;
- the erosion patterns are consistent with what one might expect in a coastal environment of this type;
- coastal erosion is a healthy part of an evolving coastal system under a sea-level rise scenario;
- the presence of human infrastructure leads to concerns about erosion; and
- the erosion rate in this study area is not excessive (2000, page 9).

Figure 13 - Sandy Landscape at Parlee Beach Provincial Park
Photo by Paul Jordan

Figure 13 shows a portion of the physical landscape of the case study area which varies and includes wide sandy beaches, such as this example from Parlee Beach Provincial Park. Ocean currents and winter storms are impacting this popular recreational beach causing erosion. Each year authorities are forced to replenish the beach by pushing the sand back on to the beach from the ocean.

Figure 14 - Eroding Sandstone Cliffs
Photo by Paul Jordan

There are places along the coast of the study area that consist primarily of sandstone cliffs which are highly erodible. **Figure 14** is an example of eroding sandstone cliffs.

4.0 Housing Types

The types of housing found along the coastline of the case study area have changed over time. Historically, these homes were small bungalows and cottages and served as second homes for urban dwellers. They were built small, on small lots, were fairly inexpensive, and tended to be used only as a second home or cottage for part of the year. In recent years there has been a change in the types of homes being built. They are much larger, more expensive and are more likely to be permanent, year round homes.

Figure 15 – Typical Home/Cottage
Photo by Paul Jordan

Figure 15 shows a typical home/cottage found along the coast, built prior to the establishment of planning regulations. It is located within a series of sand dunes next to the ocean. Sand dunes are one of the first lines of defence against storm surges and sea-level rise which protect residential development. With a home being located in the sand dune, it reduces the sand dune's natural ability to grow and to protect.

Figure 16 – Contrasting Housing Types
Photo by Paul Jordan

Figure 16 is an example of how housing along the coast is changing as compared to the traditional housing found within the community. The large house on the right side of the photo is a permanent home, whereas the much smaller homes to the left are seasonal homes, which reflect the characteristics of the majority of both the traditional permanent and seasonal homes found in this coastal community. Existing planning regulations permit the development of larger homes all along the coast. These larger permanent homes were impacted during the last couple of storm surges and will most likely be impacted in the future by other storm surges. With more and more larger and more expensive homes being built along the coast, the costs associated with repairing and replacing are expected to rise.

Figure 17 - New Coastal Homes
Photo by Paul Jordan

Figure 17 shows the types of homes being built in the community of Robichaud. They are large and located within close proximity to the water line. **Figure 17** also shows that homeowners have placed large blocks of cement along the edge of the beach to help protect against storm surges. Coastal armouring is a typical response along this coast.

Figure 18 - Changing Housing Types
Photo by Paul Jordan

Figure 18 reveals the differences in typical housing styles currently found along the coast. The smaller homes to the left of the photo are typical or traditional coastal homes built in the study area. The larger home on the right of the photo shows a more recent style and size of home being built.

Figure 19 - Ice Damage due to a Storm Surge
Photo by Paul Jordan

Figure 19 shows the impact of storm surges on coastal housing. This photo was taken a few days after the January, 2000 storm surge. It shows how ice from the surge was pushed to within a few metres of this coastal home. The yellow pole in the middle of the photo indicates that the height of the ice is just above five feet.

Figure 20 - Flooded Coastal Streets and Homes
Photo by Paul Jordan

Figure 20 shows the impact of the January 2000 storm surge on coastal homes in the Robichaud area. Sea water from the storm surge flooded the entire area up to the road that runs behind the front line of coastal homes pictured in **Figures 17** and **18.** Damage to coastal homes in this general area was extensive.

5.0 Policy and Regulation Analysis

In Canada, government policies and regulations essentially direct residential growth to certain areas. Current policies and regulations at all three levels of government impact the residential development in coastal areas. However, it is provincial policies and regulations which have the most impact both positive and negative.

Figure 21 identifies federal, provincial and municipal/local Acts and Policies that influence residential development in coastal areas of New Brunswick, more specifically in the case study area. There are very few federal Acts or Policies that influence or impact residential development in coastal areas. Much of the authority is at the provincial level.

Figure 21 - Relevant Acts and Policies for Coastal Residential Development

Federal Department	**Act/Policy**	**Areas of Responsibility**
Fisheries and Oceans Canada	*Fisheries Act*	fish habitat protection and water quality
Provincial Department	**Act/Policy**	**Areas of Responsibility**
Environment and Local Government	*Community Planning Act*	land use planning, subdivision regulations and standards, natural resource protection, coastal development
Environment and Local Government	*Clean Water Act*	protection of water courses, potable and non-potable water, controls development within 30 metres of a water course
Transportation	*Highways Act*	roads, street standards and subdivision regulations. Establishes a standard of a 20 m road width.
Health and Wellness	*Health Act*	septic systems and potable water
Environment and Local Government	Coastal Land Policy*	protection of coastal features (dunes, beaches, vegetation), established a 30 m buffer and controls development within 30 m of a coastal feature.
Natural Resources and Energy	Wetlands Conservation Policy*	protection of wetlands including coastal salt marshes, controls development within 30 m of a wetland
Municipal/Local Government	**Act/Policy**	**Areas of Responsibility**
Town of Shediac	Town of Shediac Municipal Plan	land use planning, zoning within the Town of Shediac
Beaubassin Planning District Commission/ Beaubassin East Rural Community	Beaubasssin East Rural Plan	land use planning and zoning within Beaubassin East Rural Community

Beaubassin Planning District Commission/ Beaubassin West Rural Community	Beaubassin West Rural Plan	land use planning and zoning within Beaubassin West Rural Community
Village of Cap-Pele	Cap-Pele Municipal Plan	land use planning and zoning within the Village of Cap-Pele

* proposed or draft policies not yet adopted as law.

5.1 Provincial Policies

Major factors impacting the design of coastal communities in Atlantic Canada are provincial and municipal subdivision regulations and provincial highway design standards. For example, in New Brunswick for the Department of Transportation to assume responsibility for a recently built road in a subdivision, the road must meet provincial design standards of a 20 metre (66 foot) wide right of way and an 8.5 metre (28 foot) wide road. The rationale for the wide roads is to accommodate road maintenance equipment and emergency vehicles such as snow plows, fire engines, and ambulances, and to facilitate on-street parking. All new roads in subdivisions within the province are being built to meet these standards. Some may argue these standards are not appropriate, or are too generous for the areas in which they are built, essentially creating more road than is required and adding extra costs to the developer. Another example relates to lot sizes. Lot size standards for lots without a municipal sewage system based on the *Community Planning Act* in New Brunswick are:

- Minimum width is 54 m (177ft)
- Minimum depth is 38 m (125 ft)
- Minimum area is 4000 m² (1 acre)

There are two proposed provincial policies that will have a tremendous impact upon coastal housing development: the Coastal Areas Protection Policy and the Wetlands Conservation Policy.

The Coastal Areas Protection Policy was released for public review in February 2002. The original draft policy had been prepared in 1996 and new objectives have been added since. The objectives better reflect issues of climate change and storm surges. There is a focus on limiting development in the very near shore where erosion and coastal flooding are issues. A 30 metre (98 foot) buffer setback has been established for housing. Homes now have to be built 2 metres (6'-6") above the Higher High Water Large Tide elevation. There are some weak areas of the policy. Housing development can continue to occur in areas where housing already exists so long as it is within 75 metres (246 feet) of existing development. People are also permitted to expand existing structures by 40%. Overall, the policy will go further to protecting housing development from storm surges than what already exists.

The proposed Wetlands Conservation Policy is aimed specifically at salt marshes and wetlands. The policy proposes no development in or within 30 metres (98 feet) of a wetland and that all salt marshes are to be protected. The potential impact of this policy is substantial as it has the ability

to protect salt marshes and control housing development around salt marshes.

5.2 Rural Plan Analysis

Neither of the Rural Plans (for both Beaubassin East and Beaubassin West) presently make reference to or make note of climate change or storm surges. However, they do mention erosion and flooding, which are impacts of climate change and storm surges.

Each of the Rural Plans have policy statements for the general development of each region. The plans also contain zoning regulations which establish zones for specific uses within the regions. Much of the coastal development falls within two zoning categories: Conservation Zone, and Rural Residential Zone. The Conservation Zone has been established along all waterways with a 75 metre (246 foot) zone back from the edge of the water course. Although the intent of this zone is to protect the environment and to provide space for flooding, residential development is still permitted within this zone. This limits the natural ability to protect homes from storm surge flooding. Not allowing residential development or placing restrictions or conditions on residential development in this zone would better protect homes from storm surges and sea-level rise.

5.3 Town of Shediac Municipal Plan Analysis

In the Town of Shediac, residential development is a primary objective and there is a desire to increase residential development. There is no mention of climate change or storm surges in the Town of Shediac Municipal Plan.

However, Section 2.6.1.7 identifies that coastal erosion is an issue that needs to be studied, and that a public awareness program on the issue needs to be initiated.

Under Section 2.6.2, the Town indicates that marine shorelines, marshes and estuaries are important, and that land uses should not impair their ability to function naturally.

Key policy statements missing from the provincial and municipal policies are those with references to sea-level rise. There are no community-wide or provincial-wide policies to address climate change, specifically sea-level rise. There is mention of flooding and erosion, but very little is being done to address these issues. Many of these land use policies are intended to protect the natural environment, and protect a quality of life and property from damage due to storm surges and coastal flooding. However, they fall short because policies attempt to accommodate and encourage new residential development while protecting the natural environment.

6.0 Financing and Insuring Coastal Homes

Coastal areas of the Beaubassin District are becoming more populated with primary residences. There is a fast transition as people turn their summer residences into permanent residences. Key informant interviews with insurance industry representatives indicate that most insurance companies in New Brunswick will not insure a secondary home against flood damage due to

coastal flooding and storm surges. In New Brunswick insurers also tend not to insure a person's primary residence against storm surges and coastal flooding if the home is located in areas prone to coastal flooding. However, insurance companies will cover such items as travel trailers, automobiles and snowmobiles if damaged by flood waters. Key informant interviews also indicated there were a number of homes in the coastal area which do not have flood insurance. It is expected that as flooding becomes more of an issue in the future, then it will be more difficult for homeowners to insure their homes as well as receive a mortgage. Insurance companies are already not providing insurance in certain areas due to the flood risk.

The Province of New Brunswick provides Disaster Financial Assistance to individuals who have incurred damage due to coastal flooding. It is important to note that "It is not insurance, and it does not cover all items that may have been damaged or lost in a disaster" (EMO NB website, 2001). Disaster relief is only available on primary residences and not secondary residences or cottages. There is a cap to the assistance of $71,250 per household for structural damages to homes. It can be argued that the relief fund provides an incentive for individuals to remain in place who build in areas prone to flooding. People are able to rebuild rather than being forced to move or abandon the dwelling. This seems to be the case for many of the coastal properties along the Beaubassin area.

Damages in coastal areas of New Brunswick due to storm surges are extensive and will likely increase with more coastal development. The January 2000 storm surge caused $2.0 million worth of damage province wide. The damage was mostly incurred along the eastern coast including the study area (Kinney, 2001). In October 2000 a storm surge caused even more damage ($2.5 million), on a province wide basis and included the study area (Kinney, 2001).

7.0 Existing Coastal Development Issues: Unsustainability of the Built Environment

With the onset of sea-level rise in the future, existing coastal land use and development issues become compounded. Past and present land use practices have created a number of issues. Much of the coastline, especially around Shediac Bay, has been fortified by property owners mostly by building sea-walls and retaining walls to halt coastal erosion.

Design and planning issues found in the case study area:

- unplanned settlement patterns
- historic road and infrastructure condition and layout
- recent construction and home development in environmentally sensitive areas
- population growth trends
- servicing issues (water, sewage, and streets)
- emergency access
- salt water intrusion
- coastal erosion
- coastal flooding
- inadequate septic systems
- inadequate policies and regulations

Another issue related to the present settlement form is access to potable water. Homes and cottages located in these coastal communities have individual private wells, which are dependent upon ground water aquifers. During past storm surges in the area, homeowners wells were inundated with salt water (called salt water intrusion). With homes being located so close to the coastline, salt water intrusion is an issue without climate change being added to the equation. With a predicted increase in sea-level, it is expected that more and more homes along the coast will experience salt water intrusion into their private wells.

Figure 22- Home/Cottage Built in a Sand Dune
Photo by Paul Jordan

Figure 22 shows a home built so close to the coast sand dunes are beginning to overcome the home. Buildings in return reduce the sand dunes ability to naturally absorb the pounding surf and strong winds. The sand dune will eventually retreat back to consume this home.

Figure 23 - Ice Damage to a Coastal Home due to a Storm Surge
Photo by Paul Jordan

During the January 2000 storm surge along the Northumberland Strait, many homes received severe ice damage (**Figure 23**). The damage occurred because many homes are located too close to the coast. The surge pushed thick winter ice from the ocean up into the face of some homes caused millions of dollars worth of damage.

Figure 24 - Retaining Wall to Hold Back the Sea
Photo by Paul Jordan

Figure 24 is an example of a coastal property owner who has decided to use a retaining wall to hold back the sea. The result is increased erosion on either side of this property, thus creating a small fortified peninsula. Sea-level rise will increase the coastal erosion rate and will put this person's property in jeopardy.

Figure 25 - Home Development in a Salt Marsh
Photo by Paul Jordan

Figure 25 is an example of a new home built in a coastal salt marsh.

Past policies and regulations have been weak in protecting salt marshes from housing development. More recently new policies have been put in place to curb such development.

Figure 26 shows how past settlement patterns have resulted in poor coastal land use practices such as building roads through sand dunes. This road does not meet existing provincial road standards and would be difficult for emergency vehicles to traverse, especially during inclement weather.

Figure 26 - Road Through Sand Dune
Photo by Paul Jordan

Figure 27 shows the small holes where swallows have made their homes in the top right hand corner of the cliff face. The soft sandstone cliffs are being eroded by the sea as well as by birds.

Figure 27 - Swallow Homes in the Soft Sandstone
Photo by Paul Jordan

Figure 28 - Storm Surge Damage
Photo Courtesy Beaubassin Planning District Commission

Figure 28 shows how once a coastal area has been inundated by sea water, it is easy for on-site wells and on-site septic systems to become contaminated. This photo also shows how roads act as large pathways for storm water to move inland.

Figure 29 - Flooded Coastal Community in January 2000
Photo Courtesy Beaubassin Planning District Commission

Figure 29 shows that infrastructure such as roads and electrical lines are also impacted by storm surges. Many of the automobiles in these coastal communities were destroyed due to the fact the storm surge hit quickly. People could not drive them out because roads were flooded and the temperature fell to below zero, encasing the automobiles in ice. Some individuals during this storm were stranded and had to be rescued by boat.

8.0 Adapting to Climate Change in Coastal Communities

This section examines existing ways in which communities and homeowners in the Beaubassin area are attempting to adapt to climate change, specifically to coastal erosion and storm surges. It also recommends ways communities and homeowners can adapt to these problems and environmental trends.

8.1 Existing Adaptive Techniques Being Used

The provincial government, individual homeowners and homeowners associations in the Beaubassin area are attempting to adapt to storm surges and sea-level rise. Based on key informant interviews and research some of the techniques used are:

- concrete, cement and wood retaining walls
- building homes on pilings
- raising foundations
- rebuilding sand dunes
- using snow fencing to protect existing sand dunes
- beach nourishment
- infilling property
- moving homes

Figure 30 - Beach Nourishment at Parlee Beach
Photo by Jim Scott

Figure 30 shows how the provincial government is attempting to save Parlee Beach Provincial Park from erosion. At low tide, sand that has been washed off-shore is trucked back on the beach. This is one method to slow erosion. It is also a very expensive process when it is repeated just about every year, such as in this case.

Figure 31 - Rock Wall in Cap Bimet
Photo by Paul Jordan

Figure 31 shows how residents of Cap Bimet have distributed large rocks along the shoreline to slow the erosion process and protect homes located along the coast. In fact, many parts included in this case study coast have been armoured with rocks and wood to slow the erosion process. Armouring of the coast is a very expensive means to protect property. It has also been proven to be detrimental to non-protected coasts, actually increasing erosion.

Figure 32 - Building on Pilings to Avoid Flood Waters
Photo by Paul Jordan

Figure 32 shows another adaptive technique. Building on pilings will allow flood waters to move below the home. Eventually as the coast retreats and sea-level rises this house may be in the ocean. For the time being it is an effective means to protect against rising seas and storm surges.

Figure 33 - Adding Fill to Prevent Flooding
Photo by Paul Jordan

In **Figure 33** the homeowner has chosen to add landfill to the lot to increase the height of the land to prevent flooding. The in-filled area is also a coastal marsh.

Figure 33 - Private Development in the Beaubassin Coastal Area
Photo by Paul Jordan

Figure 34 is an example of one of the many private coastal development communities occurring along the Beaubassin coast. The streets and lots are privately owned and public access is discouraged. The sign indicates this community is attempting to protect their investment with a dune restoration program which is publicly funded through a provincial grant.

9.0 Recommended Adaptive Techniques

The best method to address issues related to climate change and sea-level rise is to develop a comprehensive community wide mitigation program. A key component to creating land use planning policy is accurate and timely information. Understanding climate change and sea-level rise require scientific data validating such trends. For a mitigation program to be effective it requires information. Outlined below in **Figure 35** is a sea-level rise mitigation program that can be used by communities to identify issue areas and determine the appropriate solution.

Figure 35 A Community Sea-Level Rise Mitigation Program

Step	Activity	Outcome
Step 1 Data Collection	Light Detection and Ranging (LIDAR) data and mapping	Topographic data
	Create a digital elevation model (DEM)	Digital Elevation Model of coastline
	Map land uses (both developed and undeveloped land)	Land Use Map
	Map residential development, both location and type (make a distinction between primary or secondary home)	Residential Development Map
	Map shoreline changes (erosion and non-erosion areas)	Coastal Erosion Rate Map
	Map storm surge inundation areas	Storm Surge Inundation Map
	Map community infrastructure	Map of Community Infrastructure
	Collect land use and development policies	Land Use and Development Acts and Policies impacting coastal development
Step 2 Analysis	Analyse data, information and mapping	List of issue areas and prioritize issues. List of high; medium; and low risk areas for flooding and erosion. List of appropriate areas for present and future residential development
	Policy review	Summary of strengths and weaknesses existing land use and development policies to adapt to sea-level rise
Step 3 Objectives and Goals	Determine the objectives and goals of the community and of the individual homeowner	List of objectives and goals for combatting community-wide and individual homeowners issues.

Step 4 Actions / Solution	Determine most appropriate action; (1) protect; (2) retreat; or (3) accommodate	Appropriate action will be matched with issue area
Step 5 Implement Actions	Community-based actions will take place	Short-term and medium-term actions will take place first before long-term solutions
Step 6 Review	Continue to collect data and review issues and actions	Updating of present and future actions

Community efforts will be ineffective without accurate scientific data about the existing topography of the land, coastal erosion rates, and the rise of sea-level. Policies and plans must be based on accurate information. Some relevant information currently exists for the Beaubassin case study are with regards to coastal erosion rates (the study by Ollerhead and Rush, 2000). However, it applies only to a small portion of the coast. The data collection stage can be expensive, but likely not as expensive as some community revitalization after a major storm surge.

Similar detailed mapping efforts are required in Atlantic Canada and all coastal areas of Canada. Land use policies must be based on sound scientific data. The Coastal Impacts of Climate Change and Sea-Level Rise on Prince Edward Island project, has created digital elevation models (DEM) of the landscape using airborne Light Detection and Ranging (LIDAR) surveys (Environment Canada et al, 2001). The DEM and LIDAR information provide very accurate topographic data allowing scientists and policy makers to determine appropriate locations for construction. This type of information, combined with storm surge prediction models and appropriate land use policies, can ensure that residential developments are located in safe areas away from flood prone areas.

Researchers and scientists with the Atlantic Environmental Prediction Research Initiative, Dalhousie University Oceanography Department and the Meteorological Service of Canada (MSC) Atmospheric and Climate Sciences Directorate have created a model to predict storm surges in Atlantic Canada. The model is able to predict storm surge events within 48 hours of the event. The model is being used in the Maritimes to prepare local residents and emergency measures organizations for flooding (http://www.ec.gc.ca/science/sandesept01/article4_e.html). Information such as this provides local residents with necessary time to evacuate their homes just before a storm surge. This does not prevent residential development from being damaged or destroyed, but protects lives. Such a model will be useful to determine, over a long-term, areas prone to storm surges and flooding and allow local officials to plan housing development accordingly.

Some of the solutions may be short-term or long-term, while others will take longer to implement. Some will be relatively inexpensive, while others will require to be funded over a long period of time. For example, a review and amendment of land use policy is a relatively short-term and inexpensive solution that can have immediate and long-term positive consequences. In another example, the costs of building and maintaining breakwaters is very high. But in order to protect the downtown or key infrastructure in an urban centre, the

construction of a breakwater is warranted and justified. In a third example, the costs to protect a coastline that has no development and which is far away from any development, the construction of a breakwater may not be justified. Therefore, the most appropriate solution must be determined by the community.

The same holds true for the individual homeowners. Some individuals may have the capital and financial resources to raise their home on stilts. The value (monetary and/or sentimental) of that home in many cases would justify the expense of raising the home. The community must decide on the appropriate response based on its financial abilities, willingness and values placed on property and the environment.

9.1 Community and Individual Homeowner Actions

Local officials within the Beaubassin Planning District Commission must determine what adaptation and mitigation measures they and the public are willing to accept with regards to climate change, specifically to sea-level rise and storm surges. As identified by researchers (Titus; Bellliveau and Grant, 1994; Ollerhead and Rush, 2000; Forbes, Shaw and Taylor) there are three primary types of responses:

(1) protection
(2) accommodation
(3) retreat

Figure 36 outlines a number of approaches and actions that communities and individuals can choose from to address issues related to sea-level rise, storm surges and coastal erosion.

Figure 36 - Approaches and Actions to Adapt to Climate Change

	Type of Response			Action By	
	Protection	**Accommodation**	**Retreat**	**Community Action**	**Homeowner Action**
Set Back			✔	✔	
Rolling Easement			✔	✔	
Zoning Regulations			✔	✔	
Clustering of Homes		✔	✔	✔	
Raising Foundation		✔			✔
Raising Home on Pilings		✔			✔
Building Rock Walls	✔			✔	✔

Moving Home			✔	✔	✔
Land Swap			✔	✔	✔
Landfill	✔			✔	✔
Rebuilding Sand Dunes		✔		✔	✔
Rebuilding Wetlands		✔		✔	✔
Wetland Retreat (planned)		✔	✔	✔	
Education Program	✔	✔	✔	✔	
Redesign of Home	✔				✔
Opening Dykes			✔	✔	
Demolition Fee			✔	✔	
Topographic Mapping	✔		✔	✔	
Policy Review	✔		✔	✔	

The majority of the types of responses presently being used in the Beaubassin area are accommodation and protection. This is the typical response in an area presently heavily developed. The value of the property justifies the costs of protecting homes and infrastructure.

Figure 36 outlines a number of retreat options that can be used. The retreat options are not essentially associated with something an individual property owner can do, but are more or less community wide or provincial policies or programs. Retreat options tend to be long term with respect to development and implementation. In the Beaubassin area and the Province of NB there presently are no programs in place to assist property owners adapt to climate change. Therefore, homeowners are relying on common methods used by neighbours and other coastal property owners. These tend to be low cost and quick fix solutions. A long term and comprehensive approach is appropriate for addressing coastal flooding and sea-level rise.

A combination of protection, accommodation and retreat is likely the most appropriate way to respond to sea-level rise in the Beaubassin area. Leadership from the community and provincial levels is required by providing assistance and expert advice to homeowners to identify sustainable choices to protect their properties which balance the long term needs of the community.

10.0 Conclusions

Unsustainable planning practices have led to coastal development problems that must be addressed. The issues such as coastal erosion, coastal flooding, and salt water intrusion will become more pressing as more and more people continue to build their homes along this coast. With proper planning and mitigation, issues of the past and present can be corrected and prevented from occurring in the future.

The case study has shown how individual homeowners are attempting to halt the eroding action and coastal flooding issues found in their communities. While there are still unsustainable development practices taking place, the provincial government is working to improve the situation province wide.

The development issues identified within the coastal communities of the Beaubassin coastal area will serve as an example that other communities in Canada can learn from. The adaptive measures presently taken by coastal residents are similar to those being used by other homeowners through Canada, the United States and even the world. Proper planning, and the right combination of policy, planning and engineered solutions can ensure that a sustainable balance is found in coastal communities.

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12. 0 Appendix A Key Informant Interviews

Key informant interviews were conducted with individuals involved either directly or indirectly with the housing industry in the Beaubassin Planning District Commission. The interviews were intended to gather information and confirm development trends. Interviews were either conducted in person where possible or by telephone. A total of seven key informant interviews were completed with a municipal planner, building inspector, insurance agents, and home builders. Informal discussions were held with individuals with provincial and federal government departments to confirm policies and regulations.

The interview questions focussed on:

- awareness of climate change and storm surges
- perception of potential issues
- evidence of impacts of storm surges
- identification of potential solutions

Key Informants Interviewed

Planning Officials

Armand Robichaud, Director, Beaubassin Planning Commission

Rhéal Doiron, Building Inspector, Beaubassin Planning Commission

Contractors

Casey Contractors

Shediac Building Movers

Landco Construction

Insurance Companies

Lee Woodside, Allstate Insurance Company

Vienneau Insurance

Summary of Findings

- All of the key informant interviewees felt they had a “good” understanding of climate change and all were aware of recent storm surges.

- The damage respondents witnessed after the most recent storm surges were: coastal erosion, ice damage, removal of steps and decking, flooded basements, flooded first floors, flooded garages, complete destruction of homes, and destruction of automobiles.

- Key informants have seen an increase of new homes being built in the coastal areas and are perceived to be built in areas prone to coastal flooding.

- Damage to infrastructure that interviewees witnessed were to: sewage systems, private wells, sewage pumping stations, private on-site sewage systems, and to telephone and electrical wiring.

- Adaption or rehabilitation measures respondents have seen homeowners use after the storm surges are: infilling or building up their properties, building higher foundations, putting their homes on stilts or pilings, building erosion control structures such as stone armouring, moving their homes, and selling their properties.

- When asked who should be responsible for protecting homes from coastal flooding, respondents answered: the homeowner, contractors/homebuilders, planning commission, all three levels of government, real estate agents, building inspector, and insurance companies. The most frequent answer was the homeowner. Individuals felt that the buyer or builder needs to be aware and need to educate themselves about coastal flooding and erosion issues.

- When respondents were asked whether they felt storm surges will be a bigger problem in the future, four said yes, one person said no, and three people did not answer the question.

- It is perceived that existing land use policies are not sufficient to protect homes from storm surges.

- When respondents were asked to comment on what should be done to better protect homes they answered: better zoning/regulations, better building design, better site design guidelines, more education for planners, more education for construction people, more homeowner education, move existing buildings and build according to nature. Overall, most people responded by saying more homeowner education is required.

- Respondents indicated that coastal land has become very expensive and only the wealthy are able to purchase land and build. Generally speaking these people are able to pay to repair their homes after a storm or coastal flooding.

- It was also identified that no agency has a clear mandate to address climate change or coastal flooding. The existing policies and regulations are no sufficient to either address or plan for sea-level rise.

- Respondents also felt there was not enough local scientific knowledge or data to adequately plan for sea-level rise.

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