Why a Sea Level Rise Adaptation Primer?

Sea level rise is a new challenge facing coastal communities in Canada. Uncertainty around how much sea levels will rise, when and what impacts may occur, all make adaptation a challenge. How can coastal managers respond to this new challenge? Fortunately local governments have a wide variety of existing tools to enable adaptation to sea level rise and build resilience. The Primer identifies 21 such tools and a broad array of applications.

Who should read the Primer?

Any level of local government with responsibility for coastal management, including staff, consultants and any other authorities and organizations with an interest in coastal zone management.

How is the Primer Organized?

Background

This section of the Primer briefly explores both historic and projected changes in sea level rise globally and along Canada’s southern coasts. In addition, some of the more destructive coastal hazards associated with sea level rise are briefly discussed.

Study Area

The Primer addresses Canada’s southern coasts, more specifically the coastlines of British Columbia, Quebec, and the Atlantic provinces of New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland and Labrador. A general description of the physical features of each provincial coastline is given and an indication of the population living on or near the coast as well as how sea level rise is being approached by each province.

Framework for Decision Making

A Sea Level Rise Adaptation Framework is introduced consisting of four interactive elements: Information Gathering, Public Education and Community Engagement, Adaptation Tools, and Monitoring and Evaluation. The figure at right shows this constantly evolving relationship. This section also discusses four strategies for adaptation to sea level rise:

Protect

Accomodate

Retreat

Avoid

Adaptation Tools

For the most part, the tools reviewed are already used by local government. They are organized into Planning, Regulatory, Land Use Change or Restriction, Structural and Non-Structural tools as shown at right.

Hybrid Techniques

The integration of structural and non-structural protection methods is sometimes referred to as hybrid shoreline protection systems. At first glance, structural and non-structural adaptation tools may appear to represent polar opposites; however, they are often used in combination to reduce costs or to meet environmental objectives.
## Planning Tools

### Objectives & Policies

**Application:**

Objectives and policies may be included in comprehensive plans, community plans, neighbourhood plans, strategic plans, and growth management strategies and may be used as an adaptation tool by all coastal communities. Objectives establish the broad direction for the future of a community. Typical objectives include:

- Protecting people and property by avoiding development or managing risk on lands subject to hazards;
- Protecting environmentally sensitive areas (e.g., marshes and dunes).

Policies are more specific and reflect the means of implementing or attaining the overall objectives. Local government policies may identify:

- How coastal hazards such as erosion, storm surge and inundation should be addressed;
- Conditions suitable to accommodate “appropriate growth”;
- Where development should be avoided.

### Advantages

- Communities already have a coordinated and comprehensive approach to setting land use planning objectives and policies - which can easily incorporate coastal hazards associated with sea level rise.
- Objectives and policies provide a framework for action (e.g., bylaw changes, coastal mapping).
- The planning process provides opportunities for public involvement and education.
- The degree to which objectives are met and policies are implemented can be measured and monitored.

### Disadvantages

- Local governments may lack the resources to develop and implement policies but may rely on interim measures (e.g., increased floodproofing).
- The addition of policies may be controversial, particularly ‘avoid’ or ‘retreat’ policies.
- In a regional goal setting process such as a regional growth strategy, mediation of different local governments may be required.

### Economic:

- Economic considerations include the cost of developing and setting objectives and policies and the cost of implementing them.

### Environmental:

- Restricting development in regions at risk of sea level rise and related coastal hazards may also enhance protection of environmentally sensitive features and environmental hazards.

### Social:

- Objectives and policies will need to complement other planning measures designed to manage residential growth and other forms of development, recreation and open space needs, community facilities and other infrastructure needs.
- The successful implementation of new objectives and policies often depends on a strong public education and consultation process as they are developed.
Coastal Hazard Mapping

Application:
Coastal hazard mapping may be used in all areas at risk of sea level rise to:

- Identify areas at risk due to the adverse effects of sea level rise and associated coastal hazards (i.e. flood and erosion areas).
- Provide a basis for directing new development away from areas at risk. Accommodate development in areas where the risk can be mitigated through floodproofing.

Advantages
- Mapping provides valuable information, both for public education and planning purposes.
- Mapping assists with disaster preparedness by identifying critical infrastructure (e.g. generation facilities, firehouses) in hazardous regions. Communities may choose to relocate or better protect this infrastructure.
- Mapping may encourage hazard zone residents to take their own proactive measures to reduce flood risks.

Disadvantages
- Coastal hazard mapping alone will not cause a reduction in risk. Mapping must be integrated with other adaptation tools before the full benefits can be realized.
- Coastal hazard maps may increase fear and anxiety in some people, as residents become more aware of the risks, but not how to address them.
- The collection and analysis of topographic and bathymetric data can be expensive.

Elements:
To effectively map coastal hazards, accurate topographic data is required, ideally with a contour interval of 1 m or less. The traditional method is to conduct field surveys; however, LiDAR (Light Detection and Ranging) data, collected from an aircraft using a laser, is increasingly being used.

Engineering analysis is then used to map areas at risk, design conditions and Flood construction levels. These maps may incorporate assessments of vulnerability (e.g. people, land, buildings and infrastructure at risk).

Economic:
- Engineering expertise in flood risk modeling.
- Topographic surveys to provide information on land elevation for the flood risk model (extreme event data such as water levels, wave heights, etc.).
- Cost of adding or updating coastal hazard mapping.

Environmental:
- May include coastal habitats or sensitive ecosystems.
- May enable better environmental protection for areas at risk.

Social:
- Identifying housing, roads, underground services and community resources subject to coastal hazards.
- Visualization of past and future coastal changes (3D) can provide a unique learning opportunity to increase public awareness.
- Public education about coastal hazards and what is at risk leading to more informed decision making.
Planning Tools

Risk Management

Application:
Risk management with respect to sea level rise and associated coastal hazards generally has two components:

1. The identification, measurement, and prioritization of risks from sea level rise (risk assessment). Coastal hazards due to sea level rise may include the risk of a major disaster such as a dike failure, or gradual changes such as increasing salinization of groundwater. The measurement process may be quantitative, such as calculating the probability of an inundation in excess of current linear protection or qualitative, such as documenting increasing vulnerability and reduced resilience or determining how much risk a community is prepared to accept.

2. Selecting the most appropriate strategy and adaptation tools to respond to the risk assessment. Four adaptation strategies have been identified in the Sea Level Rise Primer: avoid, protect, accommodate and retreat.

In BC, Provincial Guidelines are based on an Annual Exceedence Probability (AEP) of 0.5% (also referred to as a 1 in 200 year flood). In 2011 these guidelines were updated to allow for sea level rise of 1 metre by 2100 as well as a revised assessment of storm surges and wave effects based on a study by Ausenco Sandwell. Atlantic Canada typically uses an AEP of 1%.

Advantages

- Knowing what is at risk is likely to lead to more informed decision making.
- Requires a long-term perspective but this can involve interim measures.
- Can involve a rigorous analytic approach.
- Can be an essential tool to help determine the most appropriate response to coastal hazards.

Disadvantages

- Cost-benefit and other analytical studies may have significant costs. Costs must be measured against the risk and may represent a small cost for a large project or where the stakes are high.
- The absence of detailed studies should not prevent the use of interim measures to reduce risk (e.g. minimum setback and elevation from the natural boundary).

The risk management approach to sea level rise adaptation will shape the overall strategy employed and which tool or combination of tools will most effectively allow the risk to be managed within acceptable levels.

Economic:
- A rigorous process in comparing and selecting the appropriate tools and strategy.
- Committing the capital and maintenance costs required to implement the risk management plan.
- Can be compared to the cost of “doing nothing”.
- A cost-benefit analysis can determine how well, or how poorly, a planned action will likely turn out.
- To provide an objective basis for comparing different options and sound decision-making.

Environmental:
- Can address environmental assets and species at risk due to sea level rise.
- Protection of wetlands is of particular importance due to historic losses, as are intertidal areas, due to their high productivity. Loss of habitat in coastal areas can lead to additional stress on species at risk or species in decline.

Social:
- Determining the level of acceptable risk.
- What community assets will be protected, establishment of priorities. Example: storm damage to a local industry can be devastating to a small community.
- When, or if, a different strategy should be adopted to respond to the long-term consequences of sea level rise, (i.e. protect, accommodate, retreat, or avoid).

“A process widely used to identify and manage the adverse impacts of a change in conditions.”
Emergency Planning & Preparedness

Application:
Emergency planning and preparedness refers to measures undertaken in advance of a disaster or to mitigate the risks of a disaster.

Local authorities across Canada have primary responsibility for responding to local emergencies and must have an emergency plan in place to address flood events and maintain public safety.

Provincial governments provide support to local authorities for emergency planning and preparedness. If a disaster exceeds the capacity of a local government, provincial and federal government support are available.

For example, in B.C., local authorities:
• must prepare a local Emergency Plan;
• must establish and maintain an Emergency Management Organization;
• may cause the plan to be implemented;
• may declare a state of local emergency; and
• may do all acts and implement all procedures considered necessary to prevent, respond to or alleviate the effects of an emergency or disaster.

Advantages
Local governments are responsible for emergency planning. Sea level rise and storm surges represent additional risks to be addressed within a well established framework.

Proactive planning can reduce the risk to people and buildings in the event of a disaster.

The local government has the authority to declare a local emergency.

A collaborative process involving other agencies and the province.

Starts from the ground up and involves teamwork with other agencies and the Province.

Demonstrates that hazards are real, particularly when public education is included.

Disadvantages
The quality and effectiveness of emergency management plans may vary depending on local priorities and available resources.

Plans must be updated regularly to remain current.

Monitoring and enforcement of emergency response plans requires a commitment of time and resources.

Economic:
• Costs and resources for preparing emergency plans, coordinating with other agencies and obtaining resources for plan implementation.

Environmental:
• Not designed to address environmental issues.

Social:
• Lays the groundwork to prepare and respond to a possible emergency.
• An engaged citizenry is better able to assist in the event of an emergency such as a flood including the implementation of emergency response plans.

"Measures undertaken in advance of or to mitigate the risk of a disaster."
Regulatory Tools

Subdivision Regulation

Application:
This tool applies to the subdivision of land at risk of coastal hazards due to sea level rise and can be utilized in conjunction with zoning.

Subdivision refers to the process of developing a new legal title for property by creating new additional lots, changing existing lot boundaries, land dedication, or consolidating existing lots. This can involve a fee simple property, bare land strata lot, or a strata unit (e.g., townhouse, row house, or condominium unit in an apartment building).

Any proposed subdivision must go through a review process, which culminates in the approval (including approval with conditions) or refusal of the proposed subdivision.

Where an area is at risk from flooding or other coastal hazards, the Approving Officer can decline the subdivision on grounds of public safety unless appropriate mitigation is provided.

Implementation of subdivision regulation has some challenges namely:

- Reliance on accurate information resources, including coastal hazard mapping, to give grounds for the approval or refusal of a subdivision
- Subdivision development will need to comply with the Official Community Plan or equivalent growth management objectives and policies

Advantages
- Regulates the conditions under which the subdivision of land can proceed.
- May include an environmental impact assessment or report from a professional engineer or a geoscientist concerning mitigation measures.

Disadvantages
- Should not be undertaken ad hoc or without supporting guiding policy or a strategy in place.
- Without the identification of potential coastal hazard areas, particularly areas at risk of flooding and erosion, it is difficult for the Approving Officer to decline to approve a subdivision.

Economic:
- Costs associated with subdivisions and land considered at risk are generally borne by the property owner/developer (i.e. until all approval conditions have been met).
- In the event of a disaster such as a flood, disaster financial assistance costs will be incurred by senior governments according to their policies.
- If subdivision regulation does not address sea level rise, taxpayers may become responsible for avoidable disaster financial assistance costs in the future.

Environmental:
- May include the impact the subdivision will have on the natural environment due to sea level rise (i.e. suitability of land use).

Social:
- How the public interest is affected by the approval or refusal to approve a subdivision.
- Guidance shall be provided as to the suitability of subdivision, particularly for residential use in areas at risk.
Regulatory Tools

Building Regulation

Application:
This tool applies to the subdivision of land at risk of coastal hazards due to sea level rise and can be utilized in conjunction with zoning.

Subdivision refers to the process of developing new lots, changing existing lot boundaries, land dedication, or consolidating existing lots. This can involve a fee simple property, bare land strata lot, or a strata unit (e.g., townhouse, row house, or condominium unit in an apartment building).

Any proposed subdivision must go through a review process, which culminates in the approval (including approval with conditions) or refusal of the proposed subdivision.

Where an area is at risk from flooding or other coastal hazards, the Approving Officer can decline the subdivision on grounds of public safety unless appropriate mitigation is provided.

Advantages
The ability to withhold building permit approval until the hazard risk has been addressed to the satisfaction of the building inspector.

Site specific measures can be incorporated as an integral part of the design and construction of a building.

While a local government may have limited resources to address coastal hazards, a building inspector can put the onus on a qualified professional to provide the necessary skills.

Can prevent the transfer of risk from one property owner to another unknowing purchaser. Registration of a covenant on title ensures that any future owner or prospective purchaser is aware of the site-specific building requirements.

Disadvantages
Use of this tool comes late in the development process. This can be a concern if a property owner is not aware of any potential risk and only finds out after a building permit application is submitted.

Not all local governments undertake a building inspection function. If there is no building inspector and no regulation of building activity, this tool will not be available.

Administrative costs of building regulation can be significant although permit fees will assist in cost recovery and Letters of Assurance or Undertaking can ensure compliance for engineering and architectural services.

Provincial Variations
A municipal building inspector in B.C. is authorized to withhold the issuance of a building permit until satisfied the land can be safely used for its intended purpose. A building inspector can require a geotechnical report if construction would be on land that is subject to or is likely to be subject to hazards such as flooding or erosion.

In the Municipality of Beaubassin Est, NB, a building permit holder for a property in the coastal zone must produce an approved survey plan to prove the building meets the required vertical and horizontal zoning setbacks prior to final approval.

Environmental:
- Addresses natural hazards such as erosion and flooding.
- This tool has limited applicability to environmental criteria.

Social:
- Designed to address public safety directly.
- Intent is to ensure that the occupants of a building are not subject to excessive risk.
- Use of this tool gives priority to the protection of the public.
- Safe use is a responsibility of the property owner.

Economic:
- Requires a qualified professional to take responsibility for the safe construction and use of a building.
- Nominal cost to the public.
- Owner’s costs may vary considerably due to the wide variety of circumstances that may apply.

“...The ability of a building inspector to require a geotechnical report to ensure that a building can be safely used for its intended purpose...”
**Regulatory Tools**

## Land Use Regulation

### Application:
Zoning regulation can include a wide range of considerations including:
- different land uses
- land use densities
- setbacks
- siting circumstances
- servicing standards in different areas of a local government jurisdiction

Zoning is the most commonly used form of land use regulation but, whether direct or indirect, it can occur in other forms including:
- neighbourhood plans
- character guidelines
- capital works plans
- strategic plans
- growth management plans

The key elements of land use regulation pertaining to sea level rise and coastal hazards consist of:
- Minimum building setbacks from coastal hazards
- Structural protection from coastal hazards
- Minimum elevation of habitable buildings in areas subject to flood risk
- Limitation of land uses and density to manage risk

This tool can also be used to create a new composite zone, such as a Sea Level Rise Planning Area or Coastal Climate Change Adaptation Area, with respect to adaptive measures for coastal areas at risk.

### Advantages
- Zoning or floodplain related bylaws allow the restriction of land uses based on identified risks within a specified area (e.g., floodplain).
- Gives a local government great flexibility in addressing different conditions and needs within its physical boundaries.
- Can identify areas for further study (e.g., development information area in B.C.)

### Disadvantages
- Local government cannot impose zoning that will render the land sterile (i.e., unable to be used) but it can restrict the way in which land and buildings are used so that risks can be addressed.
- Detailed technical requirements to assess coastal flood hazards may be expensive (e.g., floodplain mapping, design briefs, updated flood risk assessment), as will implementation measures to adapt to or reduce flood risk.
- However, interim measures can have modest costs (e.g., sea level rise study area, development restrictions if less than X metres above high water mark or natural boundary).

### Economic:
- Zoning by its nature confers a set of development rights, and accordingly different zones have different values.
- Land use regulation can direct development away from areas at risk from sea level rise and other coastal hazards.
- Land use regulation can be expensive to implement and monitor.

### Environmental:
- Identification and zoning of environmentally sensitive areas or at risk to sea level rise and the management of environmental hazards.

### Social:
- The public interest should give priority consideration to the protection of human life.
- Direct growth away from high risk areas.
- Reduce risk for redevelopment of existing areas subject to sea level rise.
- Protect infrastructure from hazards.
- Locate essential services in low risk areas.

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**The establishment of appropriate zoning for areas subject to coastal hazards.**

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**Tofino B.C.**

(Photograph: West Coast Environmental Law)
Regulatory Tools

Development Permit

Application:
A Development Permit can be used to regulate development for a variety of purposes, two of which are applicable to sea level rise:

- Protection of the natural environment, its ecosystems and biological diversity, which may specify areas of land that must remain free of development or require specified natural features or areas to be preserved, protected, restored or enhanced in accordance with the permit.
- Protection of development from hazardous conditions, which may specify areas of land that may be subject to flooding, mud flows, or torrents of debris.

For each of these purposes, specified objectives must be met prior to the development approval.

Advantages

- Enables land use planning objectives to be addressed prior to a development proceeding.
- Provides for an independent professional to address risk (i.e., professional engineer with relevant expertise) at the applicant’s expense.
- Development affected by a hazard is broadly defined, as it includes a subdivision, building construction (whether or not a building permit is required) and alteration of land (e.g., re-grading, soil removal or soil deposition).
- No change in existing legislation is needed to create a Sea Level Rise DPA or Coastal Hazard DPA.
- After a permit has been issued, a notice must be filed in the Land Title Office. Through this process, any future purchaser is deemed to be notified.

Disadvantages

- Hazardous areas must be documented and identified prior to their designation as a DPA. Smaller jurisdictions may lack the necessary planning or technical resources.
- Use of a Development Permit is an additional procedural requirement and cost for a developer or landowner. However, the additional time by itself can be as little as four weeks and a Development Permit can be processed concurrently with a rezoning or subdivision application.
- DPA objectives and guidelines need to be well crafted. A Development Permit cannot be turned down by the local government if the specified objectives and guidelines are met. This can be an advantage as well as a disadvantage.

In B.C., implementation of a Development Permit Area (DPA) requires an amendment to the Official Community Plan or zoning bylaw.

Once a DPA is in place, the approval of a Development Permit requires a resolution from the local government.

Economic:
- The creation of Development Permit Areas and the granting or refusal of applications involves an additional step in the development and permitting process.
- The onus is on the applicant to demonstrate that the land can be safely developed; significant investment may be required to prove this.

Environmental:
- One of the few tools where the primary focus can be on the protection of the natural environment and biodiversity. This could include protection of sand dunes, coastal bluffs and beaches.
- Also provides protection from natural hazards, such as sea level rise.
- Is well suited to an avoid strategy.

Social:
- Establishment of a DPA requires a public approval process. A notice on title is required after a Development Permit has been issued.

A form of site specific land use regulation distinctive to B.C.
Land Use Change or Restriction Tools

Land Acquisition

Application:
Land can be acquired for a variety of public purposes including:
- Structural protection works (i.e., a dike or other hard protection) and related requirements, such as vehicular access and setbacks for public safety.
- To prevent high-risk development.
- For public benefit (i.e., environmental protection purposes or to avoid repeat Disaster Financial Assistance claims).

Land acquisition can be combined with other adaptation tools such as structural protection, to provide public open space, or buffer areas for the landward migration of endangered coastal habitats.

Expropriation is a form of land acquisition and may also be referred to as a compulsory acquisition, compulsory purchase or eminent domain.

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<td>May include a high purchase cost, (i.e. the cost of acquiring and demolishing existing building improvements). This would typically apply to the acquisition of highly valued coastal property, which has a finite supply.</td>
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<td>May be used in combination with other tools to reduce the cost of flood protection.</td>
<td>Involves use of scarce financial resources. Local and senior governments may be reluctant to set aside funds for land acquisition unless it is part of a capital improvement project.</td>
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<td>Acquisition of coastal land can provide a buffer against sea level rise and associated area coastal hazards.</td>
<td>Expropriation is seen as an option of last resort by government and is not typically viewed favourably by the general public or land owners.</td>
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<td>Can be a key element in a managed retreat strategy.</td>
<td>Where necessary, expropriation will enable property acquisition if a voluntary purchase is not possible.</td>
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Application:
Land can be acquired for a variety of public purposes including:
- Structural protection works (i.e., a dike or other hard protection) and related requirements, such as vehicular access and setbacks for public safety.
- To prevent high-risk development.
- For public benefit (i.e., environmental protection purposes or to avoid repeat Disaster Financial Assistance claims).

FEMA Buyouts

In the U.S., the Federal Emergency Management Agency (FEMA) has funded 75% of the cost of acquiring over 20,000 properties since 1993. The primary purpose of property acquisition is for hazard mitigation by permanently eliminating buildings in harm’s way. The program is administered by state and local governments. Priorities are determined by states with input from local communities. All buyouts are voluntary with fair market value determined by an appraiser based on the pre-disaster value. After the private property is acquired, buildings are removed. The land must remain as permanent public open space and cannot be sold or developed. An equivalent program does not exist in Canada.

Case Study

In 2010 in the Bas St. Laurent of Quebec, 100 homes were destroyed due to a storm event which eroded 7 metres of shoreline. In response, the province offered to compensate homeowners for relocation, and the properties were then offered for sale to the municipality for $1.00. The role of the province in this case allowed the municipality to acquire the land at risk and prevent future development.

The purchase (including expropriation) of land by local government for the primary purpose of addressing public safety concerns.

Economic:
- Potentially expensive to buy land, especially highly valued coastal properties.
- Ongoing costs and liability associated with ownership once land has been acquired.
- Loss of tax revenue for land in public ownership.

Environmental:
- Can provide foreshore protection for environmentally sensitive land or where development is not advisable.
- May also be used to provide for public open space, subject to restrictions on improvements.

Social:
- The acquisition of private land to protect the public interest.
- Acquisition of public open space for conservation protection, including public access along a dike.
Land Use Change or Restriction Tools

Transfer of Development Potential

Application:
This tool can be used to direct development away from the area at risk by designating the "donor" or "sending" area and allocating it to an appropriate "receiving" area where development or increased density can be safely accommodated (may also be referred to as Density Transfer). Application in Canada may be limited.

Can be used in association with zoning where the development potential is measurable (e.g. the number of dwellings units or floor space ratio), typically applied to residential uses.

An Official Community Plan or other policy document is needed to determine both areas at risk and areas where additional density is deemed suitable.

Density transfer could also occur by setting up a "density bank" in which a specific density is removed from the "sending" site without the need to identify a "receiving" site. Density transfer relies on an administrative process to regulate exchanges and a market to determine value. Density transfer would be best used in conjunction with a strategic plan where managed retreat is an objective.

Advantages
- The transfer of development potential can occur within the normal local government powers of zoning.
- May provide a less costly alternative to land acquisition (whether voluntary or through expropriation).
- Could be combined with land acquisition in which the local government acquires ownership of the land and transfers the development potential to the former owner elsewhere in the same local jurisdiction.

Disadvantages
- Limited potential for small communities or ones with a static or declining population, where there is little or no market for development or increased density.
- Owners of coastal properties may resent land use restrictions or "down-zoning" if they perceive no imminent risk.
- May not prevent the development of areas at risk from coastal hazards as this tool is a voluntary undertaking.

Economic:
- This tool assigns an economic value to a property's development potential.
- Development potential is transferable from areas at risk to areas suitable for increased density.
- Requires a market-based mechanism to determine the value of the density transfer based on market demand.

Environmental:
- Can be used to protect sensitive coastal areas at risk from development.
- Can increase coastal wetlands or green space.

Social:
- Primary use would be to reduce the development or redevelopment potential of land in areas at risk from sea level rise and associated coastal hazards.
# Land Use Change or Restriction Tools

## Easements and Covenants

### Application:

An easement is a legal agreement in which one landowner grants the use of some real property rights to another for a specific purpose. It represents an interest in land but not the right of exclusive possession. This can be used to allow access over, use of or other limitation that benefits one piece of land and burdens another without resulting in a change of ownership. A statutory right-of-way is a form of easement available to governments and other public agencies in B.C.

A covenant is a written agreement between two or more parties to limit the use of the land or require its use in a particular way. Examples include maintenance of coastal wetlands, minimum building elevations, and limitations of use.

In B.C. and PEI, a covenant can be of a positive or negative nature requiring an undertaking by a landowner. Examples of positive undertakings are requirements to plant trees or to maintain privately owned flood protection works. Examples of restrictive or negative requirements include a limitation on development for flood protection purposes, prevention of building construction or the use of fill.

### Advantages

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<tr>
<td>Can restrict the use of land permanently or for a specified time. Can include provisions preventing building on the land or subdivision.</td>
<td>Annual compensation or a lump sum payment may be required to secure the easement or statutory right of way process or servitude.</td>
</tr>
<tr>
<td>May require land be protected, preserved, conserved, maintained, enhanced, restored or kept in its natural or existing state in accordance with the covenant conditions.</td>
<td>Legal, land survey and appraisal services may be required.</td>
</tr>
<tr>
<td>Owner is able to retain ownership of the property and may be able to use areas considered not at risk.</td>
<td>Securing an agreement between the affected property owners may be challenging.</td>
</tr>
<tr>
<td>Cost for a covenant or statutory right-of-way is typically much less than fee simple acquisition.</td>
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<tr>
<td>May be used in conjunction with other tools such as subdivision, building or land use regulation.</td>
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<tr>
<td>May be negotiated as part of the development approval process with no direct cost to the local government.</td>
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### Legislation

In common law jurisdictions in Canada (every province but Quebec), easements and covenants are authorized by either common law or statute. A servitude is a comparable legal provision in Quebec.

### Clayoquot Island Covenant, B.C.

*Photo: The Land Conservancy of B.C.*

“... a legal agreement in which one landowner grants the use of some real property rights to another for a specific purpose(s)...”

### Economic:

- Cost of restricting land use to reduce the risk of flooding in the future.
- Save Harmless provision can be used to protect a local government from financial damages in the event of future flooding.
- Cost will depend on applicable conditions (e.g. appraisals commonly used to determine value).
- Compensation to the owner could be a lump sum or an annual payment based on a percentage of market value.
- A local government may be able to issue a tax receipt for a conservation easement if it is classified as a charitable gift by the Canada Revenue Agency.

### Environmental:

- Well suited to conservation purposes. Part/All of the land may be restricted for habitat conservation.
- Covenant may also be used to require an undertaking for environment enhancement purposes.

### Social:

- Provides an alternative to land acquisition that meets the needs both of the landowner and the local government and can include limited development or no development on land subject to coastal hazards.
- Offers flexibility without necessitating a change in ownership or requiring subdivision.
Land Use Change or Restriction Tools

Land Trust

Application:
While there are many land trust organizations with varied purposes, their general objective is to acquire ecologically significant, often threatened land through purchase, donation, covenant or lease. Land trusts consist of nationally or provincially based organizations, typically non-profit societies with the ability to offer tax deductible charitable receipts. National organizations include Ducks Unlimited Canada and the Nature Conservancy of Canada. Provincial organizations include the Nature Conservancy of British Columbia, The Land Conservancy of B.C., Nature Action Quebec, the Nature Trust of New Brunswick, the Island Trust in P.E.I, and the Nova Scotia Nature Trust.

Land trusts work with individual donors, foundations, corporations, and all levels of government to acquire and maintain land for environmental conservation purposes. Land trusts may:
- accept gifts of land from private donors
- undertake fundraising to acquire land to prevent the loss of environmentally significant values
- manage land in public ownership to protect and enhance its habitat
- compensate a landowner for maintaining wetlands or for taking environmentally sensitive land out of production.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary focus is on environmental protection and enhancement. This distinguishes the approach of a land trust from a local government as environmental protection is rarely a primary objective for the latter, particularly if human access needs to be restricted.</td>
<td>Cost considerations (capital and operating) may limit the ability of a land trust to secure, restore and manage environmentally significant land.</td>
</tr>
<tr>
<td>Many land trusts have an extensive and exemplary record of environmental stewardship.</td>
<td>The appeal of land acquisition varies greatly depending on its environmental significance and the cost of maintaining or restoring the land.</td>
</tr>
<tr>
<td>Fundraising for privately managed land acquisition by a land trust offers opportunities that may not be available if government is involved.</td>
<td>Local governments can work with land trusts to achieve a common purpose. A local government may identify potentially environmentally sensitive land or habitat but may lack the means to acquire the land. For some land owners, the idea of having a conservation based non-governmental organization as the guardian of their land holds strong appeal.</td>
</tr>
</tbody>
</table>

Economic:
- Include costs of acquisition, restoration, improvements, and maintenance.
- A local government could facilitate involvement of a land trust without having to expend financial resources to achieve the objective of protecting people from coastal hazards.

Environmental:
- Primary purpose of a land trust is for long-term environmental protection.
- Is well suited to acquire and protect environmentally sensitive land or habitat rehabilitation areas.

Social:
- Can either restrict or enhance public access to environmentally sensitive land or habitat rehabilitation areas.
- Has wide appeal for those wishing to conserve environmentally sensitive areas in perpetuity.

A non-profit private organization created for the purpose of environmental conservation or other similar purpose.

A conservation agreement is central to a land trust. While this does not specifically refer to sea level rise adaptation, the conservation objectives of existing land trusts can easily accommodate this aspect, particularly with habitat creation or enhancements such as coastal wetland and sand dune creation, or rehabilitation.
Land Use Change or Restriction Tools

Foreshore Tenure

Application:

Foreshore tenure is a legal instrument that authorizes the use of an intertidal or subtidal area. The foreshore tenure can be used by a local government as part of a comprehensive approach to shoreline management. Use of this tool will be limited to areas with suitable shoreline conditions and bathymetry.

This tool does not affect the underlying Crown ownership of land (including land under water) below the visible high water mark.

Foreshore tenure may be granted by a local government, the provincial government, or a port authority under the Canada Marine Act. Some provinces have aquaculture leasing programs in conjunction with DFO. This creates an aquaculture zoning system.

A licence of occupation may be used if the term is short, where minimal improvements are proposed or for remote sites where survey costs may be prohibitive.

Advantages

- Could enable a local government to undertake a broader range of shoreline management and adaptation measures in response to coastal hazards.
- Could enable environmental enhancement to occur with less reliance on structural protection, such as beach nourishment, artificial reefs or the creation of off-shore islands and sand dunes.
- A foreshore lease works in conjunction with zoning.

Disadvantages

- Limited suitability due to environmental, bathymetric and other constraints.
- Administrative procedures may be complex and time consuming.

In B.C., foreshore leases require a legal survey to define the tenure area and are typically issued for periods of 10 to 30 years. If the lease is surveyed and has a term of 5 or more years, it can be registered in the Land Title Office.

Advantages

- Increased recreational use and foreshore access may provide an additional indirect benefit to the wider community.
- Can help foster a sense of ownership and responsibility at the community level for adaptation along the coast.
- Can allow for partnerships with riparian land owners and local community groups to provide protection for upland areas or intertidal habitats.

Disadvantages

- The cost of a foreshore lease is set by the Province or local government and could range from a nominal cost to fair market value (prepaid or annual lease payment).
- Can facilitate implementation of innovative soft armouring approaches.
- A foreshore lease does not absolve the holder of any responsibility under the Fisheries Act or other legislation.

Economic:

- The cost of a foreshore lease is set by the Province or local government and could range from a nominal cost to fair market value (prepaid or annual lease payment).

Environmental:

- Allows the management of the foreshore to be treated as a complete system rather than stopping at the high tide mark or natural boundary.
- Can facilitate implementation of innovative soft armouring approaches.
- A foreshore lease does not absolve the holder of any responsibility under the Fisheries Act or other legislation.

Social:

- Can allow for partnerships with riparian land owners and local community groups to provide protection for upland areas or intertidal habitats.
- Can help foster a sense of ownership and responsibility at the community level for adaptation along the coast.
- Increased recreational use and foreshore access may provide an additional indirect benefit to the wider community.

“

A legal instrument that authorizes a use or uses over intertidal and subtidal areas.”

Photo Credit: Pat Burnham, BCLS

Granville Island, Vancouver, B.C. (Photo: Pat Burnham, BCLS)
Scour Protection

Application:
Scour protection is a form of erosion control typically applied around shoreline structures or a building foundation. It may consist of riprap or rock revetments designed to withstand wave action and the force of moving water. Scour protection is often used in conjunction with structural elevation.

Implementation typically occurs following an engineering analysis of risk accompanied by mitigation measures to reduce the risk to an acceptable level.

Different forms may apply depending on the application: a scour apron refers to site-specific protection around the base of a building. This tool is also used around bridges to protect against water flow and ice rafting damage.

Advantages
- Provides a barrier to protect the foundation of a building or other structure from wave action or other form of rapidly moving water. If the foundation of a building is not protected, the building will be at risk.
- Visible scour protection provides awareness and a constant public reminder that the site is subject to inundation risks and that mitigation measures have been taken.

Disadvantages
- Costs of scour protection can be significant and include design, transport, installation and maintenance.
- Scour protection for buildings may have a harsh appearance. This aesthetic drawback can often be mitigated by providing an erodible top to cover the scour protection or provide a more gradual grade away from the building.

Other commonly used scour protection applications include protecting:
- bases of transmission towers,
- bridge foundations, and
- along coastal corridors containing a highway, railway or pipeline.

Erosion protection can be an integral part of a shoreline protection system such as:
- armour rock,
- gabions,
- concrete slabs, and
- similar systems.

Economic:
- Cost of scour protection measures vary depending on site-specific circumstances.

Environmental:
- Where scour protection applies to buildings or structures, environmental considerations will be limited to the area around the building footprint.
- If scour protection applies to a linear corridor, environmental impacts may be broader (e.g. seawall, storm water or sewage outfall).
- Intertidal areas are typically associated with high environmental values. Protective measures in these environmentally sensitive areas will often result in some reduction or loss of environmental quality.

Social:
- If the risk to a building is reduced, so will the risk to the inhabitants/employees.
Structural Tools (Flood Protection Works)

Structural Elevation

Application:
Structural elevation can be achieved in several ways including:
- raising the ground level of a building with the placement of fill;
- raising the habitable areas within a building;
- raising the entire building using stilts, foundation walls or similar elevating structures.

This approach may also be described as super elevation or floodproofing.

This tool is mainly used for new construction but can also apply to a major addition or retrofit. It can reduce the damage to buildings, infrastructure and land at risk of inundation by raising their elevation.

The required increase in elevation above the natural ground level is determined by a risk assessment by a qualified professional or as determined in accordance with local government requirements, guidelines or policy, such as Flood Construction Levels (FCLs).

Advantages
- Reduction of flood risk to the design standard by raising the habitable floor elevation.
- May not be a permanent solution, as sea levels will continue to rise and areas at risk of inundation will expand. However this approach can last for the lifetime of the building.
- A visible change in elevation for a dwelling or other habitable structure serves as a vivid and constant public reminder that flooding is a risk that must be addressed.

Disadvantages
- Costs associated with raising the elevation of a building can be considerable as they affect both design and structural elements.
- There is a limit to the amount of structural elevation that can occur. As structural elevation requirements increase (i.e., become higher), the increase in cost is geometric, not arithmetic.
- Use of structural fill to raise the ground level may not be aesthetically attractive if the elevation change is large. This is most evident on small infill lots.

Economic:
- Highly variable depending on the building floorplate (e.g. FCL), required elevation and design specifications. Estimated additional building costs for new construction may range from 3% to 30%.
- May require costs for coastal floodplain mapping and determining appropriate FCLs.

Environmental:
- Limited environmental considerations for infill development.
- More significant impacts on large sites subject to fill placement (e.g. previously undeveloped areas).

Social:
- Primarily minimizes risk to building inhabitants and structures.
- In areas where housing cost is high, there is a risk the owner may convert non-habitable space below the FCL into a living area after building occupancy has been granted.
- Structural elevation of an existing building poses a particular challenge in meeting the Building Code provisions for handicapped accessibility.
Structural Tools (Flood Protection Works)

Dikes

Application:
Dikes typically form the key defence element in a ‘protect’ strategy. The primary function of a dike in coastal areas at risk is to prevent the inundation of coastal lowlands from the sea under extreme conditions (i.e. temporary rise in sea level known as storm surge). Many of the dikes used in Atlantic Canada have been in place for 200 years or more.

Sea dikes
- Have a flatter gradient and erosion protection on the seaward side, for the purpose of dissipating wave energy and preserving dike integrity.
- Have toe scour protection consisting of riprap and an underlayer of filter rock or geotextile to prevent the dike from being undermined.

Advantages
- Can be engineered to provide a high level of protection for land and buildings if adequately maintained.
- Have the secondary effect of containing internal drainage on the land side, requiring it to be discharged through floodboxes by gravity at low tide levels or by pumping at high tide levels, when floodboxes are closed. (This can also be a disadvantage.)
- Dike crest may be available for use as a recreation corridor.

Disadvantages
- Expensive to construct.
- May restrict access to shore and reduce recreational value of a shoreline including reduced visibility.
- May cause erosion to adjacent unprotected areas, redirecting wave energy with unanticipated consequences.
- Dikes and revetments tend to absorb wave energy and therefore will be subject to damage and require ongoing maintenance and investment.
- Land may not be available.

Case Study
The Province of BC commissioned Kerr Wood Leidal to develop cost estimates for structural flood protection to meet the projected rise in sea level for the year 2100. The total ‘Class D’ cost estimate was $9,470 million for structural measures, land acquisition, seismic upgrading, environmental mitigation, project management, engineering and contingencies. The 2012 study titled Cost of Adaptation – Sea Dikes & Alternative Strategies covered 250 km of the Metro Vancouver coastal shoreline and the Fraser River shoreline east to the Port Mann Bridge.

A linear embankment structure designed to protect a designated area from flooding.

Economic:
- Risk and vulnerability assessment needed prior to dike construction.
- Land acquisition to accommodate the land base for the dike and road access for maintenance and emergency management purposes.
- Cost of new dike construction where a dike is not present.
- Cost to accommodate a higher dike elevation due to sea level rise (including additional land acquisition).
- Funding for dike upgrading requires large capital outlays, is typically program-based and requires approval by different levels of government.
- Ongoing cost of dike maintenance.

Environmental:
- Loss of intertidal areas from the seaward expansion of a dike, or agricultural and open space areas when landward expansion occurs.
- Presence of dikes can impede natural shoreline migration.

Social:
- Dikes provide some assurance of flood protection, so tend to promote shoreline development. This can lead to a false sense of security.
- Level of protection provided by a dike will slowly decrease over time if Flood Construction Levels are not increased in conjunction with sea level rise and climate change effects.
- History of successful use, but can have severe consequences in the event of failure.
- Includes the loss of housing due to land acquisition, roads, impacts on views and loss of community amenities in and around dikes.
Structural Tools (Flood Protection Works)

Other Hard Structural Defences

Groyne
A groyne is a rigid structure typically constructed of riprap or other heavy material extending from the upper foreshore or beach into the water. Groynes are located perpendicular to the shore or at a slightly oblique angle and are used to dissipate wave energy, trap sediment along an intertidal area and reduce the seaward transport of sediment. Groynes function by realigning short sections of the shore with respect to the incoming waves. Groynes are often constructed as a series of structures and may be used in combination with beach nourishment. Their design life is limited (typically around 20 years).

Breakwater
A breakwater is typically a rigid structure constructed of large rocks or concrete for the purpose of reducing the amount of wave energy reaching the shore. A breakwater has water on both sides. Breakwaters may also be structures placed offshore in relatively shallow water designed to protect a gently sloping beach or a vertical retaining wall designed to hold and prevent soil from sliding seaward. Breakwaters can also be floating structures, anchored offshore. Breakwaters are used to protect marinas, ports, harbours and other shoreline infrastructure from erosional forces due to wave action.

Seawall
A seawall is a structure, usually concrete or rock, constructed to provide protection against erosion and flooding. Seawalls are built parallel to the shore and generally have a deep foundation for stability. Seawalls are used to dissipate wave energy, and prevent flooding and erosion in constrained coastal areas. This may occur where the land drops off sharply on the seaward side or where the cost of land acquisition for a dike is prohibitive. Seawalls are typically used where available space is constrained due to physical or cost factors. If constructed without an engineering analysis, they can transfer risk and impacts to adjacent properties.

ADVANTAGES
- Many forms of hard structural protection can be engineered to provide a reasonably high level of protection, if adequately maintained.
- Provide protection for high value development and can maintain or increase property values.
- A seawall may be available for use as a recreation corridor. The Stanley Park seawall in Vancouver is an example of an outstanding success with major recreation and economic spin-off benefits.

DISADVANTAGES
- Structural measures to protect against erosion in one place can increase erosion elsewhere.
- May cause localized erosion at the toe and require a deep foundation to dissipate wave energy.
- Are expensive to construct and maintain, can be unsightly and restrict shore access.
- As structural measures are fixed in place, they may offer limited protection against extreme and cumulative events such as waves, storm surge and high tide.

Economic, environmental and social considerations are similar to those for dikes.
**Structural Tools (Flood Protection Works)**

### Wet Floodproofing

**Application:**
This tool employs the use of flood resistant materials, the elevation of electrical and mechanical services and the use of building openings to equalize hydrostatic pressures to allow flood waters to freely enter and exit a building or structure. Residential applications are generally limited to below grade basements, crawl spaces, and attached garages.

Is distinguished from dry floodproofing, which aims to make a building watertight or impermeable to an expected flood level.

Wet floodproofing is selectively used in Canada. The most likely applications include existing developments with small land parcels where the infrastructure is below but not substantially below the Flood Construction Level or where there are few other viable alternatives. For example, a commercial storefront abutting a sidewalk that is at an elevation subject to flooding has few alternatives if the building has no setback from the property line.

Wet floodproofing may be used as an alternative to or in combination with structural elevation. Wet floodproofing is not recommended for residential living areas. Vehicle parking areas and areas for storage of goods not damageable by floodwaters are two possible applications.

<table>
<thead>
<tr>
<th>Advantages</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Can reduce the time and cost of cleanup after a flood.</td>
<td>Has limited applicability and appeal for long term adaptation to sea level rise.</td>
</tr>
<tr>
<td>Can be less costly than other retrofits as no additional land is required and the appearance of the building is not affected.</td>
<td>Clean-up is still required post-flood.</td>
</tr>
<tr>
<td>Allowing water to enter and exit a building may be a cost-effective alternative to structural elevation for dry floodproofing (which attempts to keep water out).</td>
<td>A residential building will be uninhabitable during a flood; other accommodation has to be provided.</td>
</tr>
<tr>
<td>A wide range of water resistant materials can be used at reasonable cost.</td>
<td>A commercial building cannot generally be used during a flood and may have goods damaged by floodwaters if they cannot be moved to higher ground.</td>
</tr>
</tbody>
</table>

Addressed storm surge and flowing water.

**Economic:**
- Cost of installing or retrofitting water-resistant materials.
- Cost of elevating electrical and mechanical services damageable by floodwaters.
- Temporary loss of use of areas subject to flooding, commercial operations loss of business and alternative accommodation required for residential use.
- May be cost-effective but only in limited circumstances.

**Environmental:**
- Environmental considerations do not apply to this tool, as it can only be applied to buildings, typically in developed areas.

**Social:**
- Concerns the reduction of risk to people and buildings.
- Post-flood recovery time may be rapid compared to dry floodproofing, allowing the dwelling or business to return to normal operation sooner.

“Providing protective measures below the Flood Construction Level for a building that allow water to enter and exit a structure with minimal damage.”
Non-Structural Tools (Soft Armouring)

Coastal Wetland Creation

Application:
Coastal wetlands comprise some of the most ecologically important and vulnerable coastal habitats. Coastal wetlands are found in the "transition zone" between land and sea, and have both upland and aquatic characteristics. As a result, they are extremely productive ecosystems and often have richer flora and fauna than other environments.

In the absence of a barrier to migration, if a wetland or salt marsh is losing area on its seaward side, it is likely claiming area on its landward side.

Salt marshes are the most commonly created or restored coastal wetland systems.

This tool can be used as part of a 'protect' or 'accommodate' strategy to dissipate incoming wave energy.

On the landward side, wetland creation can be part of an 'avoid' strategy or provide a transitional land use as part of a long-term strategy of retreat.

This tool does not apply to rocky coastlines or where the ocean depth increases rapidly.

Advantages
- Reduction of incoming wave and tidal energy in the intertidal zone.
- Coastal wetlands or salt marshes may be cost effective compared to purely structural coastal defences.
- Wetlands can help reduce coastal flooding and stabilize shorelines.
- Can provide highly productive new habitat and environmental benefits
- Can improve water quality and fishing in coastal waters by providing vital breeding and nursery grounds for fish and shellfish.
- Provided wetlands are not subjected to coastal squeeze and the rate of sea level rise is not too rapid to keep pace, wetlands are capable of adapting to sea level rise without further intervention or investment.

Disadvantages
- Space requirements in areas with existing development or high development potential may have high acquisition costs.
- A lack of public awareness of the flood and erosion protection benefits by these environments can be a potential barrier to implementation.
- Wetland creation is not feasible in many areas due to unsuitable bathymetric conditions or excessive erosion.

Legislation
The Federal Species at Risk Act could apply. All provinces have legislation concerning coastal wetland protection.

Economic:
- Cost of securing the land (which includes land covered by water) through a foreshore lease or other means.
- Cost of creating or restoring the land.
- Cost of long-term maintenance and management.
- Cheaper than dikes but not suitable in all locations.

Environmental:
- Dual benefits of environmental enhancement and reduced flood risk (such as new or enhanced habitat for fish and shellfish and improved water quality).

Social:
- Wetland creation in conjunction with other tools may reduce the land requirements for linear protection (e.g. dikes or seawalls).
- Potential passive recreational (e.g. bird watching) and interpretive opportunities.
Non-Structural Tools (Soft Armouring)

Dune Building

Application:
Naturally occurring dunes are wind-formed sand deposits representing a store of sediment in the zone just landward of normal high tides. They typically occur along wide sandy coastlines, are dynamic and constantly moving.

Artificial dunes are engineered structures created to mimic the function of natural dunes. The construction of such dunes involves placing sediment from dredged sources and shaping it to form dunes or installing fences or barriers intended to trap sediment. A source of appropriate sized sediment, similar to what would naturally occur on the shoreline, is required to create or rehabilitate dunes. Both natural and artificial dunes can be stabilized through vegetation planting; vegetation roots help keep the dune structure and aid in trapping sediment to build up the dune.

Dune building can be used with other tools.

Advantages
Can be used to provide an effective defence against coastal flooding and erosion by maintaining wide sandy beaches.

Serves as a store of sediment, which can be accessed in order to satisfy erosional forces.

Can meet multiple objectives, including environmental enhancement and protection, public and recreational access (i.e. boardwalks), tourism and hazard reduction.

Dunes and dune vegetation can provide an important environmental benefit by creating or increasing valuable coastal habitat for species at risk.

Similar in function to a seawall but able to adjust in response to changes in wind and wave climate or sea level.

Dunes can be allowed to build or regenerate naturally.

Disadvantages
Can be perceived as a barrier to beach access, and may conflict with residential purposes where the concern is maintaining “sea views”.

May be seen as an opportunity to encourage additional coastal development in areas at risk from sea level rise.

Unlike hard forms of protection, dunes are dynamic and constantly evolving; they require careful monitoring.

Has limited applicability since sandy shorelines and suitable material are not present in many areas. As well, the bathymetry near the shoreline may not be suitable for the use of this tool.

May require a large land footprint, which could have significant cost implications.

Economic:
- Cost of the land or foreshore lease required to accommodate dune building (i.e. land footprint).
- On-going maintenance includes availability and cost of sand, as well as the frequency with which dunes need to be replenished.
- Cost of construction.

Environmental:
- Likely to have a positive environmental impact (increased habitat in limited supply, tool that works with nature).
- Way of protecting areas landward of the dunes from erosion.

Social:
- Creating dunes on the landward side may result in a loss of land for existing residents and property owners.
- Loss of views and direct access to coastal areas may affect existing residents.
- Passive recreation opportunities could increase.
- Implementation could serve as a community education process about non-structural measures used in adapting to sea level rise.
Non-Structural Tools (Soft Armouring)

Beach Nourishment

Application:
As waves run up on a beach, they lose energy and are dissipated; the more beach (or similar surface), the more energy is dissipated. By adding a sediment supply, the beach provides storm protection and acts as a buffer.

Beach nourishment:
- Can reduce the detrimental effects of coastal erosion by providing additional sediment to satisfy the natural forces of erosion.
- Will not stop erosion; however, it will provide a sacrificial element against coastal erosion, rather than a hard barrier.
- Can use sediment material dredged from the ocean, or material barged, trucked, moved by heavy equipment or by a conveyor belt from a land-based source.

Advantages
- Provides sacrificial material to be eroded, effectively protecting landward areas from wave action.
- May provide an alternative to the use of hard protection such as groynes, which can disrupt natural processes of sediment supply to a beach.
- Can enhance the value of beaches by providing a more aesthetically appealing environment.
- May also have a positive effect on adjacent areas not directly nourished, as sediment is redistributed by natural forces or erosion.
- May address multiple objectives, including environmental enhancement and protection, public and recreational access and hazard reduction.

Disadvantages
- Use of beach nourishment is subject to a number of limitations, including a consistent supply of correctly sized sediment for the long-term and a suitable foreshore profile.
- Can become prohibitively expensive if a supply of sediment is not readily available and has to be transported long distances.
- Is not a permanent solution to shoreline erosion. Requires regular monitoring and periodic re-nourishment depending on the erosion rate.

Implementation
For successful implementation, engineering studies over an extended time period are required to determine the rate and extent of shoreline erosion and the volume of beach nourishment needed to address the sediment deficit. A sediment budget is used to describe the measurement of migrating and eroding sediment in a manner similar to the measurement of river bed aggradation. Ongoing monitoring will be required to evaluate the success of the beach nourishment and when additional beach nourishment is required.

Economic:
- Will require periodic re-nourishment (i.e. ongoing maintenance costs).
- Costs include acquiring, moving and placing sand or other suitable beach material on an eroded shoreline.
- Public vs. private costs and benefits need to be addressed (i.e. individual benefiting property owners and the community as a whole).
- May offer economic benefits as an alternative to or in combination with other forms of structural protection.

Environmental:
- May affect the productivity of intertidal areas.
- Negative impacts to be avoided include potential for sedimentation or cross contamination of shellfish beds, burial of existing marine organisms, and mismatch of deposited sediment with native beach material.

Social:
- Reduced risk and enhanced values for waterfront properties.
- Increased use of nourished beach areas by the public for recreational purposes.
- Beach can be preserved as there is a sediment source to sustain the beach. Hard protection tools tend to eliminate the beach.

“...The addition of sand or other similar sediment material to satisfy the erosional forces of wave action and prevent shoreline erosion...”

Parlee Beach, N.B.
(Photo: D. Jardine)
Hybrid Techniques

Living Shorelines

Application:
Goal is to optimize natural shoreline functions while reducing erosion risk.
- May involve different techniques from soft armouring to hard armouring depending on the site specific circumstances. Groyne or breakwaters may be used in combination with sand, other natural materials and/or marsh plantings stabilize shorelines.
- Has been in existence for over 40 years and has been applied by coastal U.S. states along the Atlantic and Pacific Oceans and the Gulf of Mexico. In recent years, this technique has been used in BC, Nova Scotia and PEI.

Advantages
- Works with existing environmental features and gives preference to native plant species.
- Protects riparian and intertidal environment including water quality.
- Aesthetically pleasing – tends to blend into the landscape.

Disadvantages
- Each site must be evaluated on its distinct features; therefore no single technique will work for all sites or as a general application.
- Requires periodic inspection and maintenance.
- May not work well in areas exposed to high energy wave action.

Green Shores
The B.C. version of living shorelines consists of hybrid techniques that promote the sustainable use of coastal ecosystems that recognizes their ecological features and functions. A key program component is a Coastal Development Rating System intended for use by designers, builders and owners to guide Green Shore design and assess design performance. This is a trademarked program of the Stewardship Centre for British Columbia.

Four principles of Green Shores:
1. Preserving the integrity of coastal processes
2. Maintaining habitat diversity and function
3. Minimizing marine pollutants to the environment
4. Reducing cumulative impacts to the coastal environment

www.greenshores.ca

Case Studies

Caribou Island, N.S. - The Ecology Action Centre in Nova Scotia has undertaken three Living Shorelines projects in the Northumberland Strait. The largest on Caribou Island had a 10m tall, steep cut bank with exposed soil. The slope was stabilized using a variety of techniques; building a brush wall to add biomass, providing soil cover, and transplanting dogwood and willow to encourage seedling growth. www.ecologyaction.ca

Point Ellice Park, Victoria, B.C. - Involved the containment of eroding foreshore fill on a former industrial site. The project objectives included re-establishing areas of natural coastal riparian vegetation and intertidal marshes, and an intertidal beach contained by a boulder headland. In addition to bank stabilization and shoreline restoration, the Dockside Green project upgraded a section of the popular Galloping Goose trail.

www.greenshores.ca

Economic:
- Can result in lower construction and maintenance costs.
- Cost effective absorption of wave energy and storm surges.
- Preserve natural state and thus maintain property values.

Environmental:
- Improved water quality by trapping sediment and filtering pollution.
- Providing important aquatic and terrestrial habitat (e.g. marshes and wetlands).
- Reduced erosion and maintenance of natural shoreline dynamics.

Social:
- Public education and partnerships are essential elements.
- Collaborative approach of working with multiple stakeholders, riparian owners, nature trust organizations or other non-government organizations.
- If public land and access are involved, on-site project documentation is an ideal opportunity for interpretive signage.

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www.greenshores.ca

A way of managing coastal areas that protect, restore, enhance or create natural shoreline habitat.”