Engineering considerations for coastal adaptation:
Recent examples from Atlantic Canada

Vincent Leys, Coastal Engineer with CBCL Limited
vincentl@cbcl.ca
Outline:
1. Coastal Community Adaptation Tool-kit
2. Brief examples of recent studies showing range of options: Truro, Mahone Bay
Coastal Community Adaptation Tool-kit
http://atlanticadaptation.ca

- Interactive online decision tool
- Guidance documents: land use planning and engineering
- Downloadable fact sheets
- Community profile builder
Coastal Community Adaptation Tool-kit
http://atlanticadaptation.ca

Atlantic Climate Adaptation Solutions Association (ACASA)

Funding
NRCan

All 4 Atlantic Provinces

Project lead
University of Prince Edward Island

Decision tree, geomorphology

Land-use planning

Engineering

Community Consultation

Risk Sciences International

Web-based tool

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Coastal Community Adaptation Tool-kit

Guiding principles

Flooding / erosion problems within local community

Online guidance tool using multiple choice questions

- Shoreline type
- Elevation
- Geology
- Existing land use
- Exposure

Potential planning and engineering options

- Fact sheets for each tool
- Guidance document for further information and tool comparison

- Informative checklist for potential solutions at the community level
- Not a design guideline
- No substitute for site-specific professional engineering advice

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Coastal Community Adaptation Tool-kit

3 categories:
Erosion mitigation, flood mitigation, both

Atlantic Climate Adaptation Solutions Association

Home → Decision Tree

Progress: 7%

2. What issues are happening at the site?

- Coastal flooding
- Coastal erosion
- Coastal flooding and erosion

Coastal hazards are physical processes that expose a coastal area to risk of environmental and property damage. Coastal hazards include flooding and erosion and can occur as continuous, long-term problems or single sudden events (storms).

- Flooding
- Erosion

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Adaptation approaches

- **Relocation** - decide what to relocate
  - question # 1

- **Protect** - Defend shoreline with hard structures and/or nature based approached

- **Accommodate** - Raise/flood-proof/floating infrastructure
### Coastal Community Adaptation Tool-kit

#### Tool suitability by coastal type and conditions

<table>
<thead>
<tr>
<th>Coastal region</th>
<th>Estuary</th>
<th>Salt marsh</th>
<th>Coastal sandy system</th>
<th>Cobble beach</th>
<th>Cliff/bluff</th>
<th>Rock shore</th>
<th>Built</th>
<th>Existing dykelands</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atlantic seaboard - NS, NL</td>
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<tr>
<td>Bay of Fundy - NS, NB</td>
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<tr>
<td>Gulf of St Lawrence and Northumberland Strait - NS, PEI</td>
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</tbody>
</table>

### TOOLS

#### Erosion Mitigation

- **P** Scour protection
- **P** Engineered revetment
- **P** Rip-rap armouring
- **P** Groynes (groins)
- **P** Shore perpendicular breakwater
- **P** Nearshore breakwaters
- **P** Retaining wall
- **A** Artificial reefs
- **A** Perched beach (sill)
- **A** Beach nourishment
- **A** Plant stabilization

#### Erosion & Flood Mitigation

- **P** Seawall
- **P** Buried revetment
- **A** Living shoreline/wetland
- **A** Dune building

#### Flood Mitigation

- **A** Dredging
- **A** Bluff drain
- **A** Stormwater management (also includes drainage ditch, detention pond, and rain garden)
- **P** Tide barrier/aboiteau
- **P** Dry flood proofing building
- **A** Wet flood proofing building
- **A** Raised infrastructure
- **A** Floating building
Consider coastal processes:

- Sediment transport does not stop at property boundaries
- Some local hard protection measures may negatively impact adjacent shoreline
Coastal Community Adaptation Tool-kit
Consider nature-based shore protection techniques

To be considered together with non-engineering approaches: land-use planning and public policy

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Coastal Community Adaptation Tool-kit

Decision tool results page

Coastal Flooding and Erosion Decision-Support

Welcome to the Decision Tree Results Page. Your adaptation options have been organized into Land Use Planning option and Engineering option summary tables, based on the responses you provided working through the Decision tree. By clicking on hot-linked items within the summary tables, you are also able to access further details on any or all listed options.

## Adaptation Options

<table>
<thead>
<tr>
<th>Option</th>
<th>Output Rank</th>
<th>Description</th>
<th>Cost</th>
<th>Environmental Impacts</th>
<th>Habitat/biodiversity</th>
<th>Next steps: Information typically required</th>
<th>Degree of Regulatory Requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>E28 - Relocate infrastructure</td>
<td>Good</td>
<td>The decision to relocate or abandon a coastal road, building or other type of infrastructure must be based on a complex cost-benefit analysis that includes socio-economic factors.</td>
<td>HIGH</td>
<td>Removal of infrastructure may cause temporary disturbance to habitat</td>
<td>Enhances sustainability</td>
<td>topography, erosion rate, flood mapping, water level</td>
<td>High</td>
</tr>
</tbody>
</table>

Each option linked to a PDF fact sheet with pros/cons
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http://atlanticadaptation.ca

Summary

• **Education purposes**: think about coastal processes, sea level rise, project objectives
• **Planning comes first** - **Is relocation an option?**
• **Flags pitfalls** and maladaptive responses
• **Introduces** **nature-based approaches** that have proven successful elsewhere, e.g. living shorelines
Examples
Flood and erosion mitigation design studies
Example 1 – Mahone Bay waterfront
Flood and erosion mitigation design study
Example 1 – Mahone Bay waterfront
Seawall option
Example 1 – Mahone Bay waterfront
Nature-based option
Example 2 - Truro Flood Mitigation Study
Dyke re-alignment to accommodate floods

Proposed large scale infrastructure approach, if funding is available

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Example 2 - Truro Flood Mitigation Study
Most cost-effective options

<table>
<thead>
<tr>
<th>Approach</th>
<th>Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Land use planning</td>
<td>Update flood lines</td>
</tr>
<tr>
<td></td>
<td>Public education, emergency management</td>
</tr>
<tr>
<td>Retreat</td>
<td>Relocate buildings most at risk</td>
</tr>
<tr>
<td>Accommodate</td>
<td>Reduce upstream flows (storage or infiltration)</td>
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<tr>
<td></td>
<td>Widen dykes, pumps, partially restore floodplain</td>
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<tr>
<td></td>
<td>Floodway bypass</td>
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<tr>
<td></td>
<td>Dredge river</td>
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<tr>
<td></td>
<td>Raise roads</td>
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<tr>
<td>Protect</td>
<td>Tide gates</td>
</tr>
<tr>
<td></td>
<td>Raise/build dykes</td>
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<tr>
<td></td>
<td>Localized berms</td>
</tr>
</tbody>
</table>
Conclusion

4 Keys to Coastal Resilience

1. Manage shoreline risks
   - Wave action, tides, sea level rise, erosion
   - Land-use planning
   - Relocation of infrastructure

2. Work with nature
   - Consider hybrid protection
   - Accommodate coastal processes

3. Include inland effects
   - Rivers, runoff, development

4. $$ and permits
   - Implement in steps, using adaptive maintenance
   - Stay within budget and regulatory limits

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