A Phase-by-Phase Approach in Developing Hybrid and Nature-Based Coastal Protection Measures Alongside Municipalities Influenced by Changing Winters – A Preliminary Case Study in NB's Acadian Peninsula

Christopher Mea, EIT
June 2025

CORBO GÉNIE CONSEIL | ENGINEERING

VALORĒS
INSTITUT DE RECHERCHE SUR LES ZONES CÔTIÈRES INC.
COASTAL ZONES RESEARCH INSTITUTE INC.

Map

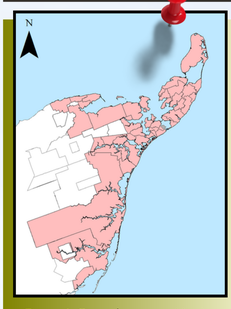

Figure 1. Coastal communities in the Acadian Peninsula, NB (Valorēs, 2011).

Challenges

LOCAL CLIMATE

In line with regional observations, local studies[3] demonstrate a sharp increase in the rate of sediment loss in autumn and winter, exceeding that of the past. More frequent freeze-thaw cycles, increased dynamics in the ice regime, and harsher storm events, along with the strong winds typical of the region, are all contributing factors, and the loss of ice cover protection in winter further adds to the vulnerability of AP coastal ecosystems.

EXCESSIVE ARMOUR STONE

With most of the AP's population living in proximity to the coast, the shoreline is continuously hardening. Every year, many residents choose to protect their backyards with an armour stone revetment, and those who do not, or who lack the means to do so, see increased scour from neighbouring interventions. In some areas, hard rock structures already cover over 50% of the shoreline[4].

RELUCTANCE TO EXPERIMENT

As armour stone revetments have historically been the dominant solution to coastal erosion in the AP and typically require very little maintenance in the short term, they have become the default solution in most scenarios with little variety in design. Despite cost savings associated with hybrid or nature-based solutions, alternatives are largely unpopular, with many doubting their efficacy.

Early Findings

Many residents in the AP living in proximity to the coast have a good understanding of climate change risks and anecdotal evidence of the impacts over time. Most want to act accordingly but lack funding or awareness of alternatives beyond armour stone, which often discourages homegrown methods.

The importance of communication across all parties is repeatedly emphasized during community-wide interactions, where plain language is preferred. In some cases, people are unaware that aside from direct government compensation, everyone has some degree of responsibility in coastal stewardship.

Spending more time on the pre-design phases has made revisions and changes in the project timeline easier to accommodate for, especially in larger projects requiring support from a greater number of decision-makers.

Overall, great early feedback was received for promoting transparency in the design process, and each project improves upon the previous in that aspect.

References

1. Greenan, Blair J. W., Thomas S. James, John W. Loder, Pierre Pepin, Kumiko Azetsu-Scott, Debby Ianson, Roberta C. Hamme, et al. "Changes in Oceans Surrounding Canada," 2019. https://doi.org/10.4095/311338.

2. Manson, Gavin K. "Nearshore Sediment Transport as Influenced by Changing Sea Ice, North Shore of Prince Edward Island, Canada." Canadian Journal of Earth Sciences 59, no. 11 (November 2022): 935–44. https://doi.org/10.1139/cjes-2020-0150.

3. Hébert, Cindie, Annie Paulin, and Marion Tétégan Simon. "Monitoring of Dune Restoration Techniques to Protect Against Coastal Erosion and Flooding: Case Study of a Beach in Le Goulet (N.B.)." SSRN Electronic Journal, 2022. https://doi.org/10.2139/ssrn.4073287.

4. Diouf, Simon, Dominique Bérubé, and André Robichaud. "Impacts des structures rigides de protection sur la côte néo-brunswickoise de la baie des Chaleurs au Canada." VertigO Volume 21 Numéro 2 (2021). https://doi.org/10.4000/vertigo.32393.

Introduction

On the Acadian Peninsula (AP) in New Brunswick, there is both a gap in communication and knowledge regarding coastal stewardship. While most residents are aware of the effects of climate change on coastal hazards, there is a common reluctance to consider hybrid or nature-based alternatives to hard protection measures, or a lack of faith in their effectiveness. Residents may not always have the means to implement their own solutions, and municipalities also struggle to find the resources to adequately support their communities. In addition, fluctuating winter conditions and a gradual reduction in ice cover duration in the Chaleur Bay and Gulf of Saint Lawrence [1, 2] have only exacerbated local concerns.

To support sustainable alternatives in the region, **CORBO Engineering** and the **Valorēs Research Institute** have partnered to help recommend, design, implement, and monitor new coastal solutions alongside municipalities and their communities. A phase-by-phase approach is used to improve transparency and bridge communication and knowledge gaps between all parties. It also favours the use of easy-to-distribute components of the design process in the form of score sheets that highlight the advantages and disadvantages of every consideration. From there, and as the designs progress and are implemented through partial community engagement, an emphasis is placed on the creation of other visual aids that can serve educational and promotional purposes.

Phase 1 - Site Selection

Following consultations in each of the 6 coastal municipalities participating in the project and initial recommendations by Valorēs, 37 sites across the AP coasts were visited.

These included locations adjacent to critical infrastructure, important residential areas known for their critical erosion and flooding concerns, barrier sand dunes, public beaches, marshes, and bluff sites.

Each site was then assessed using 6 criteria: Stakes, Erosion Risk, Flooding Risk, Necessity, Accessibility, and Visibility. For each criterion, a score was given. A description of each site was provided with supporting comments and photographic evidence. Sites that ranked too poorly or had too low of a score in any category were disqualified. Some were rejected for logistical reasons after consulting with each municipality. **Ultimately, one site per municipality was selected.**


Figure 2. Maisonnette Dune, Rivière-du-Nord.

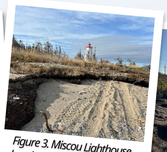
Figure 3. Miscou Lighthouse, Lamèque and Miscou Island.


Figure 4. Véloroute, Shippagan.


Figure 5. Saint-Anne-du-Bocage Beach, Caraquet.


Figure 6. Hay Island, Neguac.


Figure 7. De l'Anse Road, Tracadie.

Examples

Municipality	1 - Shippagan	Score	4.83
# Site	1.3	Site name	Le Goulet (Marcel Street, De l'Église Road and De la Cèe Street)
ANALYSIS			
Stakes	Very Strong	Necessity	Very Strong
Erosion Risk	Very Strong	Accessibility	Very Strong
Flooding Risk	Very Strong	Visibility	Strong
COMMENTS			
Description and comments	Existing work has been done previously by the community (infill, coastal grass plantings, installation of lobster traps, shoreline studies). The erosion is very advanced in some places. The low elevation renders this zone particularly vulnerable to both erosion and flooding.		
Conclusion	Site not retained due to unrelated planned works.		

Table 1. Score sheet for Le Goulet, Shippagan.

This site, although scoring well, was ultimately rejected due to a change of plans by the municipality to implement solutions outside of the scope of this project.

Municipality	2 – Lamèque-Miscou	Score	3.83
# Site	2.4	Site name	Wilson Point
ANALYSIS			
Stake	Very Strong	Necessity	Very Strong
Erosion Risk	Very Strong	Accessibility	Low
Flooding Risk	Medium	Visibility	Medium
COMMENTS			
Description and comments	Residents have already installed armour stone or plan to do so in the near future, limiting possibilities of other solutions. The erosion is acute in many places, and some houses are very close to the shoreline. A few residents without the means to install rocks have tried to limit erosion through other means (rock-filled lobster traps), but without success.		
Conclusion	Site not retained due to many existing solutions already in place and a lack of public access in many parts of the site.		

Table 2. Score sheet for Wilson Point, Miscou Island.

This site showed a need for intervention in many areas of acute erosion, but the high number of rock armouring projects in progress and the private ownership of most of the land in the area made the site particularly inaccessible.

Municipality	2 – Lamèque-Miscou	Score	4.67
# Site	2.8	Site name	Phare de Miscou
ANALYSIS			
Stakes	Strong	Necessity	Very Strong
Erosion Risk	Very Strong	Accessibility	Very Strong
Flooding Risk	Strong	Visibility	Very Strong
COMMENTS			
Description and comments	Highly touristic location during summer, of great cultural and economic importance. An armour stone revetment is already present in front of the lighthouse, but the dunes on each side are exposed to force of waves from the Gulf of Saint Lawrence. The higher energy level on this site leads to greater waves and erosion and flooding risks.		
Conclusion	The visibility and importance of the site, in addition to the regional stakes and risks, greatly increase the need for intervention. Scour around the existing armour stone is worsening and the site is particularly vulnerable to sea level rise.		

Table 3. Score sheet for the Miscou Lighthouse, Miscou Island.

This site was selected for demonstrating a clear need for intervention as well as having strong public visibility and accessibility, making it an ideal site for future education and monitoring.

Phase 2 - Solution Analysis

After revising available data, past reports and climate projections for each site, a set of measures was proposed.

Emphasis was placed on hybrid and nature-based solutions, but hard solutions were also considered, even if only to provide caution on their usage.

For each measure, 5 criteria were used: Attenuation, Integration, Implementation, Maintenance and Cost. These were then scored from Very Poor to Excellent and ranked against each other. Scores, advantages and disadvantages were revised on a per-site basis, and recommendations were made according to local conditions. In every case, the final recommendation included a combination of different measures and adaptive management strategies.

Category	1 – Hard solutions
# Solution	1.1
Solution name	Armour stone revetment
ANALYSIS	
Attenuation	Good
Integration	Very poor
Implementation	Adequate
Maintenance	Good
Cost	Poor
Score	2.80
COMMENTS	
Description	An armour stone revetment consists of large rocks placed along the coast, where erosion is most visible, with a slope allowing for attenuation of some wave energy.
Advantages	✓ Minimal maintenance once installed. ✓ Can resist large storms without being displaced. ✓ Considerably reduces wave energy.
Disadvantages	× Prevents sediment transport. × Considerably reduces vegetation presence and starves soils of nutrients. × Makes coastal access more difficult. × Can accelerate scour below or around rocks as wave energy is reflected. × Requires more intense work during installation. × Modifies coastal geomorphology quicker over time.
Conclusion	Armour stone revetments are more efficient in environments having a higher energy level like those exposed to powerful waves and winds. Although the site has these characteristics, the revetment is only recommended as a last recourse in critical eroded areas to avoid accelerating scour in other areas.

Table 4. Score sheet for an armour stone revetment at the Miscou Lighthouse site.

Category	2 – Hybrid solutions
# Solution	2.3
Solution name	Wattle fence
ANALYSIS	
Attenuation	Good
Integration	Good
Implementation	Good
Maintenance	Good
Cost	Excellent
Score	4.20
COMMENTS	
Description	A wattle fence consists of anchoring stakes in the soil and bending long branches such that they get weaved horizontally to create a natural fence. Young trees (often willows) are planted between stakes through the fence.
Advantages	✓ The seasonal installation can be achieved without specialized training. ✓ The initial fence is biodegradable, leaving room for young trees to grow and occupy that same space. ✓ Traps sediments by acting like a filter. ✓ Attenuates the force of waves and winds to promote better growth behind. ✓ Can delineate a vulnerable ecosystem and redirect human traffic.
Disadvantages	× Requires annual maintenance to re-weave new branches among the previous. × Initially more vulnerable to large storms.
Conclusion	A wattle fence creates a sustainable and natural fence that can delimit and protect a vulnerable zone all while contributing to the accumulation of sediments and beach growth. Its implementation is more involve than that of sand fencing but remains simple.

Table 5. Score sheet for a wattle fence at the Miscou Lighthouse site.

Category	3 – Natural solutions
# Solution	3.3
Solution name	Woody debris and tree trunks
ANALYSIS	
Attenuation	Adequate
Integration	Good
Implementation	Excellent
Maintenance	Good
Cost	Excellent
Score	4.20
COMMENTS	
Description	Woody debris and tree trunks can be put along the shoreline in areas where this type of debris already naturally exists.
Advantages	✓ Helps with sediment retention. ✓ Soft attenuation of wave energy. ✓ Adds nutrients to the coast and for plants upon decomposition. ✓ The larger trunks can serve as benches or as a natural barrier against all-terrain vehicles.
Disadvantages	× May be seen as debris and as an obstruction if poorly identified. × Can crush plants or have the negative effects of a hard structure if placed in inadequate areas. × Can be taken away and displaced during large storms. × An excessive presence of woody debris can have a negative impact on the coast.
Conclusion	Woody debris are very robust and act as an obstacle for waves which can decrease the erosion rate on a coast, but they must be placed in strategic locations to not obstruct natural cycles. The large trunks can serve as benches for tourists, which can eliminate the need to build typical benches that don't contribute to the ecosystem.

Table 6. Score sheet for woody debris and tree trunks at the Miscou Lighthouse site.

Phase 3 - Recommendations Report

To facilitate discussion of proposals with communities before moving on to detailed designs or implementation, **select site photos are reused and annotated with an overview of the recommended measures in context.** A general site management plan is also provided prior to issuing of a final site plan and drawings.

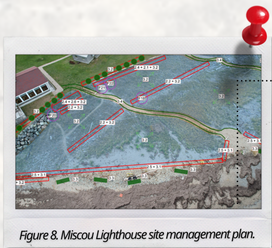
Figure 8. Miscou Lighthouse site management plan.

On larger overview plans, numbered measures are identified in target areas following recommendations, as areas of greater concern may have different needs and may require other, more suitable measures. Site details and photos are referenced on the plan for added context.

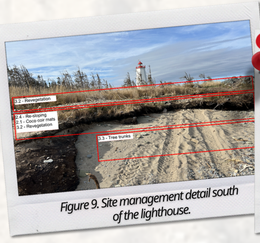

Figure 9. Site management detail south of the lighthouse.

Figure 10. Site management detail north of the lighthouse.

Phase 4 - Detailed Design and Implementation

Once recommendations are approved, and depending on the complexity of the measures proposed, a more traditional set of design drawings can be added, usually when a site requires the involvement of civil engineering works.

Wherever applicable, community engagement during the implementation phase and the use of local materials are favoured. Post-implementation aerial surveys and annual monitoring through the end of the project will help create a comprehensive set of case studies to promote alternatives to hard solutions in the region.

Phase 5 - Stewardship and Education

Adaptive management strategies outlined in the reports help guide municipal leaders and community members in actively engaging as stewards of the coasts, and bilingual educational signage provided at every site emphasizes sustainable practices while raising awareness among visitors.

With the help of Valorēs, further material will be created for presentations during workshops with the public and in schools, and visits to implementation sites with students will continue educating the next generation.