BUILDING THE CASE:
Strategic decision making for managed realignment of agricultural marshlands

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Geographical Setting

Minas Basin

New Brunswick

Chignecto Bay

Nova Scotia

Minas Basin
Relative SLR projections for the Bay of Fundy/GOM

- Up to 0.70-1.33 m by 2100 (RCP8.5max) (including tidal expansion) (Daigle, 2014; James et al., 2014; Greenburg et al., 2012).
- Increase resultant impact of even minimal storm surge

Impacts:
- ↑ Flooding/Inundation
- ↑ Erosion
- ↑ Tidal Range
- Loss of Habitat
- Loss of Livelihood
- ↑ Dyke maintenance cost
Dykelands and Climate Change

• Salt marsh primary line of defense before dykes or transportation infrastructure

• Increased development behind dykes = altered stormwater drainage, increased vulnerability of ponding

• Coastal flooding and erosion can lead to significant economic, physical, cultural and social loss within communities

• Approximately 85% of former salt marsh habitat has been dyked in the Bay of Fundy

• Changing culture - Ecosystem engineers – drivers of habitat creation, productivity & carbon sequestration

CN Rail line between NS and NB, high tide ~1970s, photo by C. Desplanque
• Currently NSDA manages 240 km of dyke infrastructure and 260 aboiteaux structures with limited resources

• Responsibility of dyke maintenance within NSDA however mandate and design is to protect agricultural land – disconnect with actual land use in many areas

• Currently dyke topping prioritized for marshlands with greatest physical and agricultural assets – material from foreshore marsh – ‘renewable’?

• Muddy, dynamic macrotidal estuary provides significant geotechnical, engineering challenges to control erosion. LTK critical.
Managed realignment (MR), managed retreat, or set back, and involves the deliberate breaching of a coastal defense structure (French, 2006).

The two main functions of MR are:

- Restoration of tidal wetlands
- Expanding the extent of sustainable coastal defenses while decreasing maintenance costs (Pendle 2013).

Options or designs for MR (DEFRA and EA 2002), include: **retreating** to higher ground, **constructing** a set-back line of defense, **shortening** the overall defense length to be maintained (partial or complete removal), **reducing** wall or embankment **heights** or **widening** a river flood plain (Möller et al. 2001; Wolters et al. 2005; Shepard, et al. 2011; Luisetti et al. 2011).
• Context of dyke maintenance and protection has evolved (culture shift).
• Optimal elevations and engineering standards are essential BUT depend on the local context for decision making – collaboration is essential – How to get there?
A geospatial information system was developed to record historical, present and future location-based information related to agricultural marshlands to provide informed decision making, accurate budget planning and reliable priority setting.

- Integrated geodatabase with ArcGIS
- Standardization and validation
- Integration with GEONOVA
- Framework and standards for integration of field surveys/condition reports/maintenance

Solid Foundation for Decision Making / Collaboration
### Concerns Identified at the Workshop

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<thead>
<tr>
<th>Area</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>A</strong></td>
<td>Proposed location for new sewage treatment plant, concerns regarding drainage to St. Croix river</td>
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<tr>
<td><strong>B</strong></td>
<td>Planned dyke armouring and top-up, require fill, issues with silting aboiteau</td>
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<td><strong>C</strong></td>
<td>Current culvert size does not effectively accommodate fresh water discharge</td>
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<tr>
<td><strong>D</strong></td>
<td>New proposed commercial development (Sobey’s) on flood plain areas. Concerns re drainage plan for fresh water discharge and protection of assets. In additional, concerns regarding floodwaters moving through highway underpass</td>
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### Stakeholder Workshops

- Consensus of areas of concern, collaboration and sharing resources
- Dependent on accurate geospatial data information system and vulnerability assessment modelling (hydrodynamic)
Managed Realignment Decision Support Tool

GIS Framework

- Habitat
- Biomass
- Carbon sequestration

Ecosystem Services
- Storm water retention
- Wave energy dissipation
- Water filtration

Adaptive Capacity

Infrastructure/Cost
- Infrastructure affected
- Accommodation space
- Maintenance vs repair costs

Re-alignment

Maximize future ecosystem services and adaptive capacity to climate change.

See Poster: J. Graham, CBWES. #19
Quantify the potential ecosystem services provided by a realignment project and highlight the habitat quality or productivity of the site.
Adaptive Capacity

Adaptation, according to the IPCC, is the “The process of adjustment to actual or expected climate and its effects” (IPCC 2013).

GOAL: Take advantage of the inherent characteristics of salt marshes to decrease erosion & reduce flooding impacts

- Provide accommodation space
- Increase stormwater retention
- Wave energy dissipation
Infrastructure Cost

- Infrastructure in marsh body
- Infrastructure within accommodation space
- Condition of dyke and marsh body
Assessment Metrics: Attributes

Descriptive
- NSDA Derived
  - MarshNOM, Text_label, NSDA_tract, Current Land Use
- OTHER
  - Cell, HHWLT, MHW

Ecosystem Services + Adaptive Capacity
- MORPHOLOGY
  - Area, W:L Ratio
- HYDROLOGY
  - Aboiteaux, ABTSize, Drainage Density
- HABITAT QUALITY
  - P:A Ratio, Thickness, Depth, Terrain Variability, PM:A Ratio
- FLORA & FAUNA
  - Biomass

Cost
- INFRASTRUCTURE ON MARSH
  - Buildings, Roads and Railways, Other
- INFRASTRUCTURE IN ACCOMMODATION SPACE
  - Buildings, Roads and Railways, Other
- DYKE AND MARSHBODY
  - Dyke Height, A:DL Ratio

Realignment Score
Managed Realignment Decision Support Tool

Realignment Score
Cornwallis River Estuary

0 2 4 Km

1:100,000

Maritime Provinces Spatial Analysis Research Centre

[Map of Cornwallis River Estuary showing realignment scores in green, yellow, and red]
Application Considerations

• Critical to foster dialogue re priorities for proponents (e.g. impact of dyke length)

• The type and extent of coastal protection may exceed what is required to secure valuable assets (i.e. length of dyke longer than needed for amount of land being used for agriculture)

• The cost of reducing, relocating or removing the defense structure
  – greater ecological benefits through the restoration of tidal wetland
  – free up resources that could be allocated to the maintenance of other defense structures which are protecting critical infrastructure.
Application Considerations

Foreshore Width

- Protection from tidal currents & wave E
- Source of material for topping
- Erosion feeds sediment budget of estuary

Conclusions and Future Directions

• MR is a viable option in Atlantic Canada

• Possible to maximize both ES and AC while minimizing costs

• Feedback from two NSDA stakeholder workshops - timely and potentially very helpful in assisting with “what to do”, “where”, and the “why” in regard to climate change adaptation & dykeland management

• Need however to better address agricultural value, & MR policy & process
Conclusions and Future Directions

- Expand cost benefit analysis per ‘marshbody’ & include additional direct & indirect costing variables
- Shifting the culture and ‘buy-in’ - continue to engage stakeholders
- Need for a test site to demonstrate viability of option

Importance of continuum of engineering standards and inclusion of local traditional knowledge & multidisciplinary teams
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Funding:
Challenges for Adaptation

Legislative boundaries determined based on historical MHW values and arable land

Marshlands boundary ‘Tregothic’ within Town of Windsor

van Proosdij, 2013
Moving Forward

- Ecosystem based adaptation solutions to climate change impacts

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