The Economic Value of Establishing Freedom Space for Rivers:

Joanna Eyquem (AECOM), Pascale Biron (University of Concordia) and Claude Desjardins (Ouranos)

a) What is Freedom Space?
b) How is it Economical?

Climate Change Driver for Sustainable Management

“You cannot step twice into the same river.”
– Heraclitus (Greek philosopher)

Géomorphologie fluviale – fouillez dans notre boite à outils!!

Rivière Sainte-Anne, Parc de la Gaspésie

Ruisseau du Milieu, Montérégie

Historic approach was not/is not sustainable
Sustainable River Management

A Missing Link

Flood Risk Mapping... not Erosion Risk Mapping

River Management Around the World

UK
France
Spain
Vermont

Freedom Space (Espace de liberté) in Quebec

Different Degrees of Freedom!

– L1 (Minimal Level):
  - Frequent flooding AND/OR
  - At risk of erosion based on observed and extrapolated bank erosion AND/OR
  - Riparian wetlands

– L2 (Functional Level):
  - Frequent flooding AND/OR
  - At risk of long-term erosion, based on the meander belt width

– L3 (Rare Level):
  - Rare floods with minor erosion risk

Freedom Space Mapping for Three Case Studies
a) What is Freedom Space?
b) How is it Economical?

Cost-Benefit Analysis
- 50 Years
- Discount Rate of 4% Sensitivity analysis with rates of 2% et 6%
- Based on Freedom Space Level L1 (Minimal Level)

Costs
- Loss of right of construction
- Loss of right of cultivation

Vs Benefits
- Reduced bank protection costs
- Reduced damages caused by flooding
- Wetland protection
- Enhanced riparian zone

Costs: Loss of Right of Construction
- Future construction only
- Urban areas:
  - Yamaska Sud Est: Cowanville, Lac Brome, Brome et Sutton
  - de la Roche: Saint-Armand
  - Matane: St-René-de-Matane et Matane

Median value of land:
- 122 400$/ha (Yamaska Sud Est et de la Roche);
- 17 500$/ha (Matane)

Sensitivity analysis of 50% and 75% lower cost

Costs: Loss of Right of Cultivation
- Calculated based on the concept of « easements » used in Vermont
- Forbidden to protect banks, fill or dredge the river.

- Yamaska Sud Est and de la Roche: 3200$/ha
- Matane: 755$/ha

Sensitivity Analysis (6400$ et 1510$/ha)

Benefits: Reduced Bank Protection Costs
- Bank protection broadly estimated at 500$/m
- Based on data from local municipality (MRC Brome-Missisquoi) and consultant experience.
- Maintenance of existing protection not required.
- Additional future protection avoided in zones of active erosion.

Benefits: Reduced Damages Caused by Flooding
- Reduction of damages caused to agricultural crops taken out of the freedom space (no further need to insure harvests in these zones).
- Value based on statistics from Financière Agricole du Québec (2012).
- Potential reduction of damages in urban areas not taken into account (no expropriation).
Benefits: Wetland Ecosystem Services

- Creation of new wetlands (meander cut-offs, ox-bows) over 50 years (2% of value per year) in the freedom space.
  - Services:
    - Buffer to regulated water levels (flood and drought)
    - Filtration of sediments
    - Biodiversity
  - Value from He et al. (2013) on the Yamaska basin: 5,590$/ha/yr adjusted for Matane to 4,950$/ha/yr

Benefits: Riparian Zone Ecosystem Services

- Current width of 3 m increased to 15 m on each bank.
  - Services:
    - Water quality (filtration of sediments, temperature)
    - Pollinisation
    - Regulation of floods
    - Reduced soil erosion
    - Biodiversity
  - Value Transfer from Batker & Schmidt (2012) in Oregon.
    - Used lower value — carbon storage, aesthetic and recreational benefits not included.
    - 958$/ha - Yamaska Sud-Est et de la Roche
    - 908$/ha - Matane

Findings of the Cost-Benefit Analysis

<table>
<thead>
<tr>
<th>Type of Benefit</th>
<th>Number of Projects</th>
<th>Value Transfer from Batker &amp; Schmidt (2012) in Oregon</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water quality</td>
<td>1.5:1</td>
<td>2,31</td>
</tr>
<tr>
<td>Pollinisation</td>
<td>4.8:1</td>
<td>7.1:1</td>
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<tr>
<td>Regulation of floods</td>
<td>3.5:1</td>
<td>5.2:1</td>
</tr>
<tr>
<td>Reduced soil erosion</td>
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</tr>
<tr>
<td>Biodiversity</td>
<td>2.3:1</td>
<td>5.2:1</td>
</tr>
</tbody>
</table>

Discount rate 2% (preferable to take into account ecosystem services that occur on a long-term basis)

Sensitivity Analyses

<table>
<thead>
<tr>
<th>Condition</th>
<th>Conditions most unfavourable to Freedom Space approach</th>
<th>Conditions most favourable to Freedom Space approach</th>
</tr>
</thead>
</table>

Practical Application

Source: Kondolf (2011)
Key Messages

- Sustainable river management in Quebec must take into account natural geomorphological processes.

- Zones at risk of erosion should be incorporated into fluvial risk maps.

- The freedom space approach defines the minimal and functional space required to maintain river integrity.

- Cost-benefit analysis has demonstrated that establishment of at least the minimal freedom space is economically of benefit to society in the long-term.