RESTORING DEGRADED URBAN RIVERS IN THE QUEBEC POLICY CONTEXT

PROPOSING NON-STRUCTURAL SOLUTIONS AND CONVINCING DECISION MAKERS

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NATURAL CHANNELS CONFERENCE,
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A little history

• 1855 – 2006 :
  o Municipalities or any local authority have more or less full authority on stream interventions, without any official guide lines to follow
  o An individual right to land drainage is generally recognised

• 2006:
  o Restructuration of the stream management policies
  o Full power is given to the MRCs (Municipalité Régionale de Comté).
  o MRCs are dealing with the consequences of past interventions, politics, public demands and ministry rules
A little history

- **1960s:** massive subsidies from the Agricultural Ministry to linearized agricultural streams and improve field drainage
- **More or less 30 000 km of streams linearized/straightened**
- **Consequences**
  - High peak discharge
  - Bank erosion
  - Loss of habitat
  - Loss of biodiversity
  - Low water quality
  - Inundation downstream

Richer creek, Montérégie
1932 stream center line (green) over the 2006 aerial picture (Rousseau, 2010)
A little history

• 1990s: Water management by sector and by administrative territories do not work...

• Municipalities being at the center of stream management, the separation between politicians and managers is thin...leading sometimes to unsustainable stream interventions

• 2002: Politique Nationale de l’eau (National Water Policy)
  o Reinforcement of environmental laws
  o 33 Watershed Agencies created (now 40)
    – Budget: about 60 000 $ / year
    – No enforcement power
    – Means: Information, conciliation, education
**Stream management in Quebec**

- Protected spaces in Quebec
  - 0-20 years flooding zone
  - 0-100 years flooding zone
  - *(Not including ice jams...)*
  - Riparian zone
    - 10 to 15 m depending on the bank slope
    - 3 m in agricultural zone
  - Landslide risk zones

- Not available for all streams
- Delimitation methods often very minimalists leading to unprecise cartography
- Plans to improve soon
• Channel erosion zone – not regulated
  o Freedom space methodology has been developed by academia in collaboration with consultants
  o Increasing knowledge among practitioners and decision makers
  o Some local initiative when rivers are very active
  o Difficulties to create regulations at the municipal level – need for a provincial policy

Biron et al 2015
In parallel, what about hydrogeomorphology consulting?

- Most stream interventions are designed and executed by engineers, rarely trained in stream dynamics – A LOT OF STRUCTURAL INTERVENTIONS
- No professional association – no regulations for the profession
- Few geomorphologists working exclusively in their field, often hired has environmental generalists
- General knowledge of how river works in the population in very low
• Consequences
  
  o Call for tenders rarely include a geomorphological dimension
  
  o Few prevention and planning ahead for streams
  
  o Difficulties to change the paradigm towards non-structural solutions (i.e. channel design)
Examples of different project illustrating different obstacles and hopes in Quebec stream management:

1- Errors from the past
2- Lack of knowledge on river functions from the politicians
3- Conflict of uses
4- Dealing with uncertainties
5- Sustainable stream interventions
EXAMPLE 1 – Ruisseau Bonhomme Morency

Watershed from 1 km² to 6 km²
EXAMPLE 1

- Stream depth from 30 cm to 30 m

Avant

Après

© Véronique Parent
EXAMPLE 1 – the solution...
EXAMPLE 2 – Décharge Saint-Lazare

- Observed sedimentation in Lake
- City council wants a sediment trap along a stream
- No sediment sourcing
- Superficy should be less than 5000 m² (50x100m)
EXAMPLE 2

- According to 1D modelisation, sediment transport threshold are exceeded for small discharges (1 and 2 years)
- The sediment trap would fill and/or be inefficient in 1.5 to 8.5 years (3 years average)
- Sediment trap creation – about 1 million $ (if sediment not contaminated)
- Maintenance cost from 18 000 $ to 65 000 $ per year
STREAM PROJECTS – DEALING WITH UNCERTAINTIES

EXAMPLE 3 – Mascouche river

- Liberty space mapping (erosion + inundation)
- Previously existing very basic inundation mapping based on discharge transfer from an nearby basin
- Goals – development planning, existing infrastructures management
- Results: river is quite stable and very mobile over the years (average of few centimeters / year)

BUT....
EXAMPLE 3

- Erosion of the convex bank
- But the main finding was that the previous flooding zone (0-20 years) was underestimated by about 1 m
- And next freshet...
EXAMPLE 4

Saint-Regis watershed ≈ 93 km²
Saint-Lawrence lowlands
Soils composed of clay and silt
EXAMPLE 4

Private land loss (citizen complaints)

Erosion

Infrastructures instabilities
STREAM PROJECTS – SUSTAINABLE STREAM INTERVENTIONS

EXAMPLE 4

Strem length decreases from 5200 m to 3700 m
Sinuosity decreases from 1.7 to 1.1
Slope increases from 0.0015 to 0.002
**EXAMPLE 4**

<table>
<thead>
<tr>
<th>Année</th>
<th>Pente (%)</th>
<th>Élargissement (m)</th>
<th>Cisaillement N/m²</th>
</tr>
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<tbody>
<tr>
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**Hydraulic changes**

Average shear stress increases by 4 folds over 50 years

Sediment critical threshold for motion is exceeded all along stream for subbankfull discharges
EXAMPLE 4

Severe entrenchment
Stream disconnected from the floodplain
STREAM PROJECTS – SUSTAINABLE STREAM INTERVENTIONS

EXAMPLE 4

- Channelization
- Increase of competent flows
  - Higher shear stress due to entrenchment
- General non-equilibrium
- Channel widening
- Generalized bank erosion

### Installation of two weirs combined with a 2 meter channel widening

Effect on bank hydraulics:

- Flow velocity reduction of ≈ 50 %
- Shear stress reduction of 60-80 %

### Example 4

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• Increasing recognition that implementing non structural solutions avoid repeated costly structural interventions
• A growing knowledge of fluvial processes due the Liberty Space concept promotion by consultants and researchers
• MRC stream managers have grouped in a professional association (annual conference, reference guide, formations, etc...)
• Watershed agencies have more government money and are now well established
• What we need to move forward is a provincial policy about erosion zones
EXAMPLE 3 – Ruisseau Castle

- Observed sedimentation along a stream leading to a famous navigation lake (property values $$$$)
- 2000 – construction of a sediment trap upstream of the navigation strip allowing access to lake (10x100x1m)
- 2015 – Request for maintenance
EXAMPLE 3

Sediment trap

Sedimentation zones
EXAMPLE 3

1933

2012

Légende
Échantillons de sédiments du lit
- Chenal
- Delta
- Dépôt
- Trappe

STREAM PROJECTS – CONFLICT OF USE
EXAMPLE 3

- Sediment trap maintenance authorized

- Ministry requested a follow up in order to determine if the trap as an effect on the sedimentation zones and helps navigation
(A) Reduce flow energy
   1) Hydrologic measures (i.e. detention basin) (Not applicable here)
   2) Hydraulic interventions
      - Structures (ex: weirs/vanes, deflector, riffles, barbs)
      - Geometry (ex: cross section shape)
        - Local (ex: to protect a specific bank)
        - Global (ex: decrease the general slope)

(B) Increase channel/bank resistance
   1) Bank stabilization
   2) Vegetation

-The decision makers choose to integrate those interventions in the creation of linear park along the river that can be flooded.

Jamieson & al 2013
EXAMPLE 5

Stream banks erosion assessment (by LVM in 2012)

<table>
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<th>Erosion</th>
<th>Length</th>
<th>(%)</th>
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<tr>
<td>Critical (red)</td>
<td>443 m</td>
<td>6</td>
</tr>
<tr>
<td>High (orange)</td>
<td>1594 m</td>
<td>22</td>
</tr>
<tr>
<td>Low (yellow)</td>
<td>1774 m</td>
<td>25</td>
</tr>
<tr>
<td>None (green)</td>
<td>2252 m</td>
<td>31</td>
</tr>
<tr>
<td>Stabilized (black)</td>
<td>1142 m</td>
<td>16</td>
</tr>
<tr>
<td>Total</td>
<td>7205 m</td>
<td>100</td>
</tr>
</tbody>
</table>

Legende
LVM_2012
Type_erosi
- aucune erosion
- erosion critique
- erosion moyenne
- faible erosion
- stabiliser
Understanding the river dynamics helped to convince city managers to proceed with a global approach to the erosion problem. However, there is still work to do in standardizing this approach in accordance with public safety needs and the available narrow river corridors.

Challenges to a global approach:

- Geometry modifications – tree cutting?
- Instream structures – ice cover?
- Management of private land loss – controlling local interventions?
A little history

• Nowadays:
  o MRCs and cities have to comply to different rules edicted by a plethora of Ministeries:
    – Federal: Fisheries and Oceans Canada, Environment and Climate Change Canada, Transport Canada
    – Provincial: MDDELCC (Environment), CEHQ (water survey bureau) MTQ (Transport), MFFP (Forestry and Fauna), MAPAQ (Agriculture), MAMOT (Municipalities), MSP (Public safety)
  o MRCs are dealing with the consequences of past interventions, politics and public demands