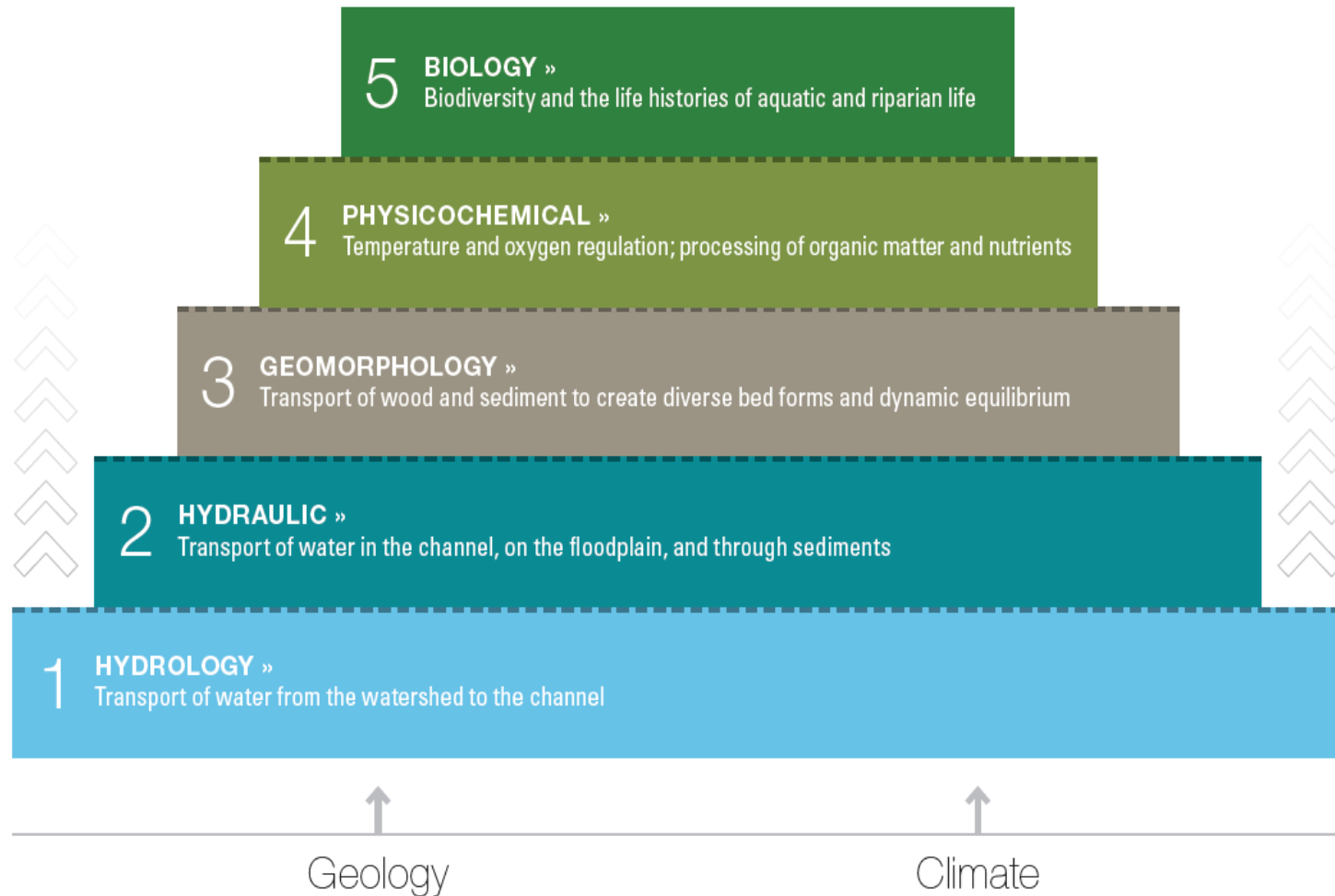


The Economic Value of Establishing Freedom Space for Rivers:

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

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

Sustainable River Management



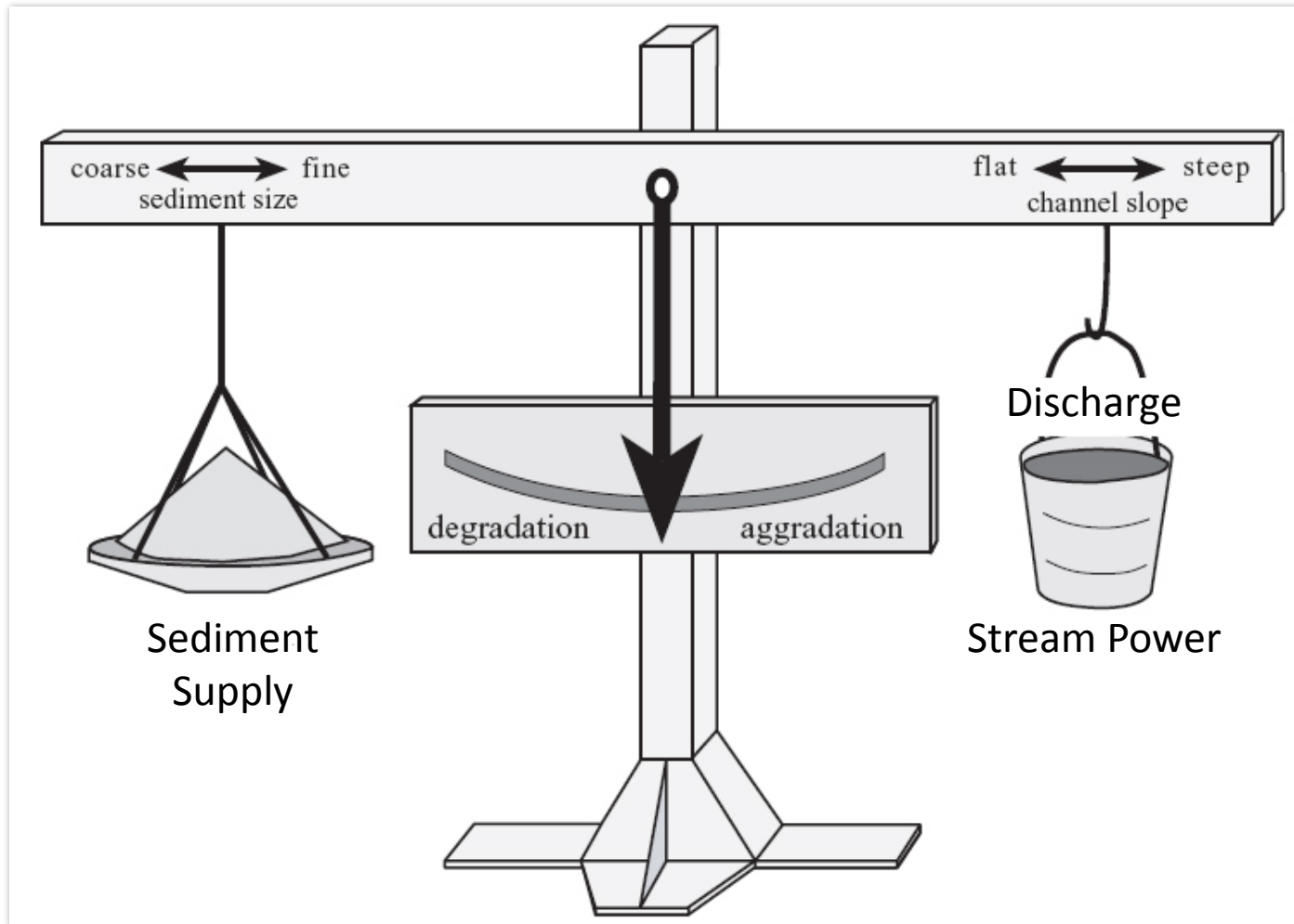


Rivière Sainte-Anne, Parc de la Gaspésie



Ruisseau du Milieu, Montérégie

A delicate balance.....

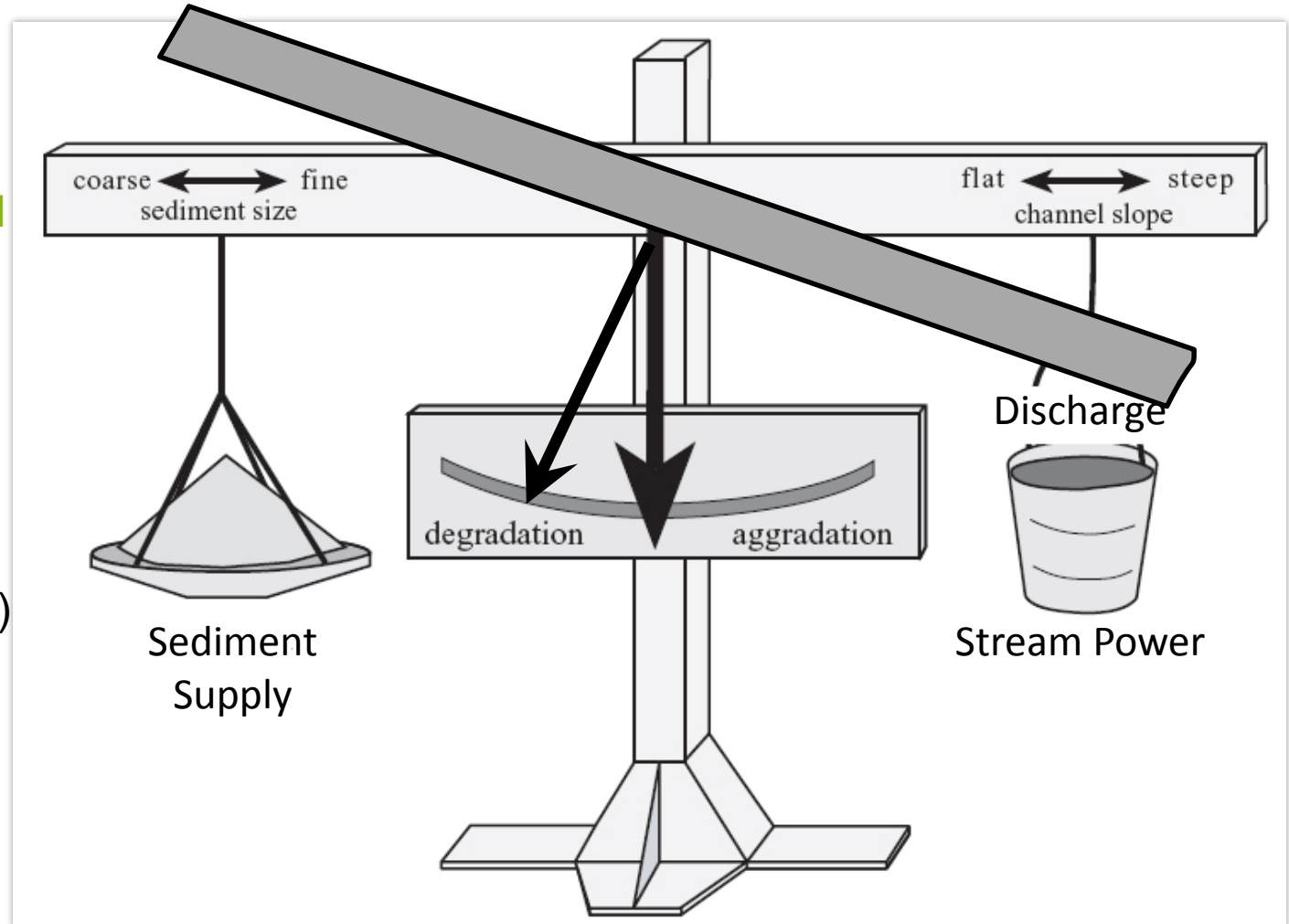


Modèle d'équilibre pour l'aggradation (dépôt) et la dégradation (érosion) des chenaux. À partir d'une figure du USA Bureau of Reclamation basée sur l'équation de Lane (1955). Figure tirée de Blum et Tornquist (2000).

..... sensitive to change!

If...

- We **reduce sediment load** (dam construction, bank protection...)
- We **increase slope** (straightening)
- We **increase discharge** (climate change).....



Our historic approach was not sustainable

August, 1935 -

AMERICAN FORESTS

385

How **DYNAMITE** *streamlines streams*



Straightening of Pequest River in New Jersey by CCC workers stopped its yearly floods. *Explosion of new channel is seen at right. Note temporary dam at left to provide volume of water for scouring blasted channel.*

Explosion of dynamite charge by propagation excavates new channel.

Immediately after explosion, water is entering new channel, whose banks will be smoothed and "stream-lined" by the speedier flow of water.



CROOKED STREAMS are a menace to life and crops in the areas bordering on their banks. The twisting and turning of the channel retards the flow and reduces the capacity of the stream to handle large volumes of water. Floods result. Crops are ruined. Lives are lost. Banks are undermined, causing cave-ins that steal valuable acreage.

In many instances straightening out a stream has doubled its capacity for disposing of run-off water.

DYNAMITE may be used most efficiently and economically in taking the kinks out of a crooked stream. The dynamite is loaded along the length of "cut-off" channel. When fired, the dirt and other debris is heaved high in the air and is scattered over the adjoining territory—leaving practically no spoil-banks. In addition to the material actually thrown out, much dirt is loosened and is later scoured out by the water which rushes swiftly through the straightened channel.

Du Pont Dynamite has straightened many thousands of miles of crooked streams. Du Pont engineers have worked for years to develop the best blasting methods for the cleaning out and straightening of streams. All their data is in a 48-page book, "Ditching with Dynamite." It is for your use. Write for it.

Dynamite can help you do other jobs, too. It can help you build highways, dams; fight soil erosion; work quarries. Du Pont has an explosive for every purpose.



E. I. du Pont de Nemours & Co., Inc.
Explosives Department
6167 du Pont Building
Wilmington, Del.



River Derwent, Yorkshire, 1935



Crooked streams are a menace to life and crops in the areas bordering their banks

A Québécois Example

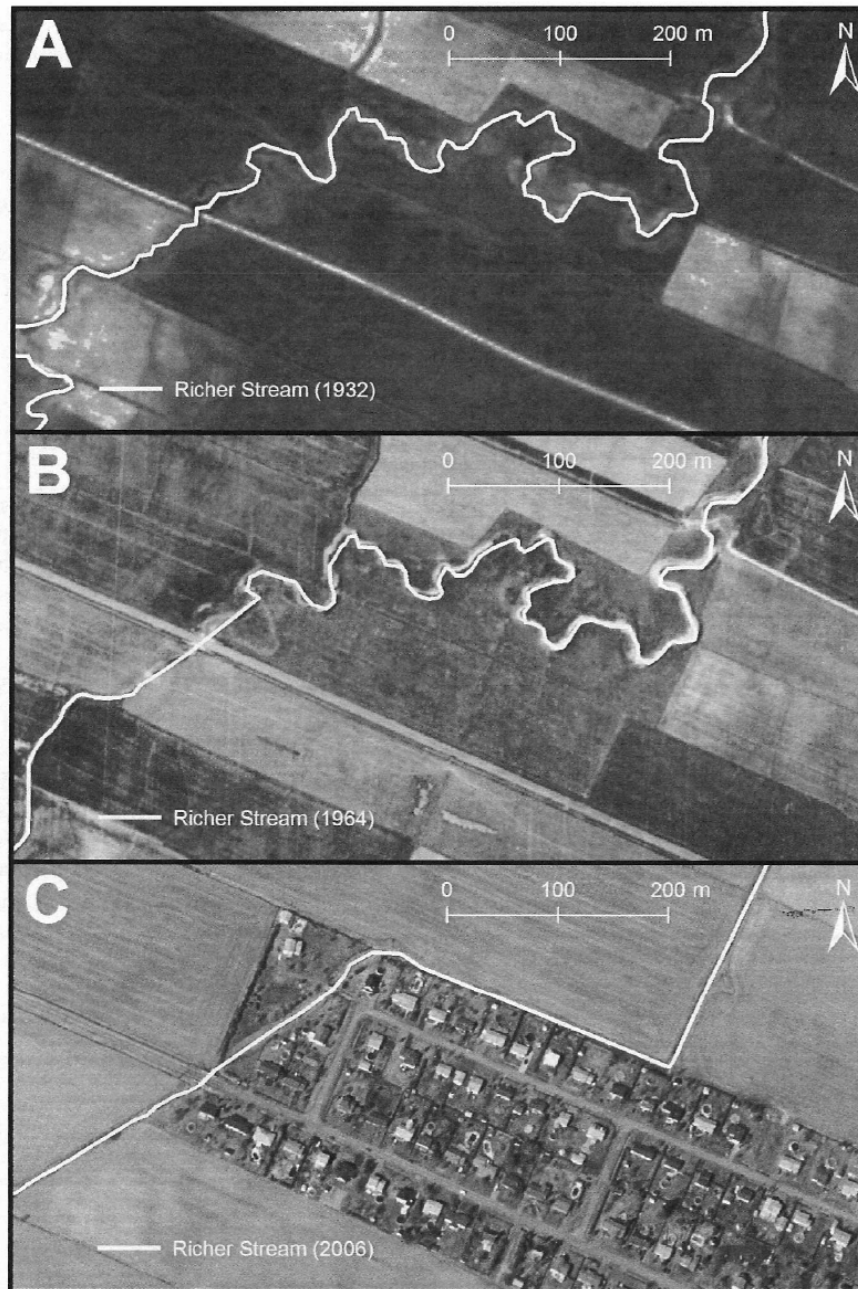
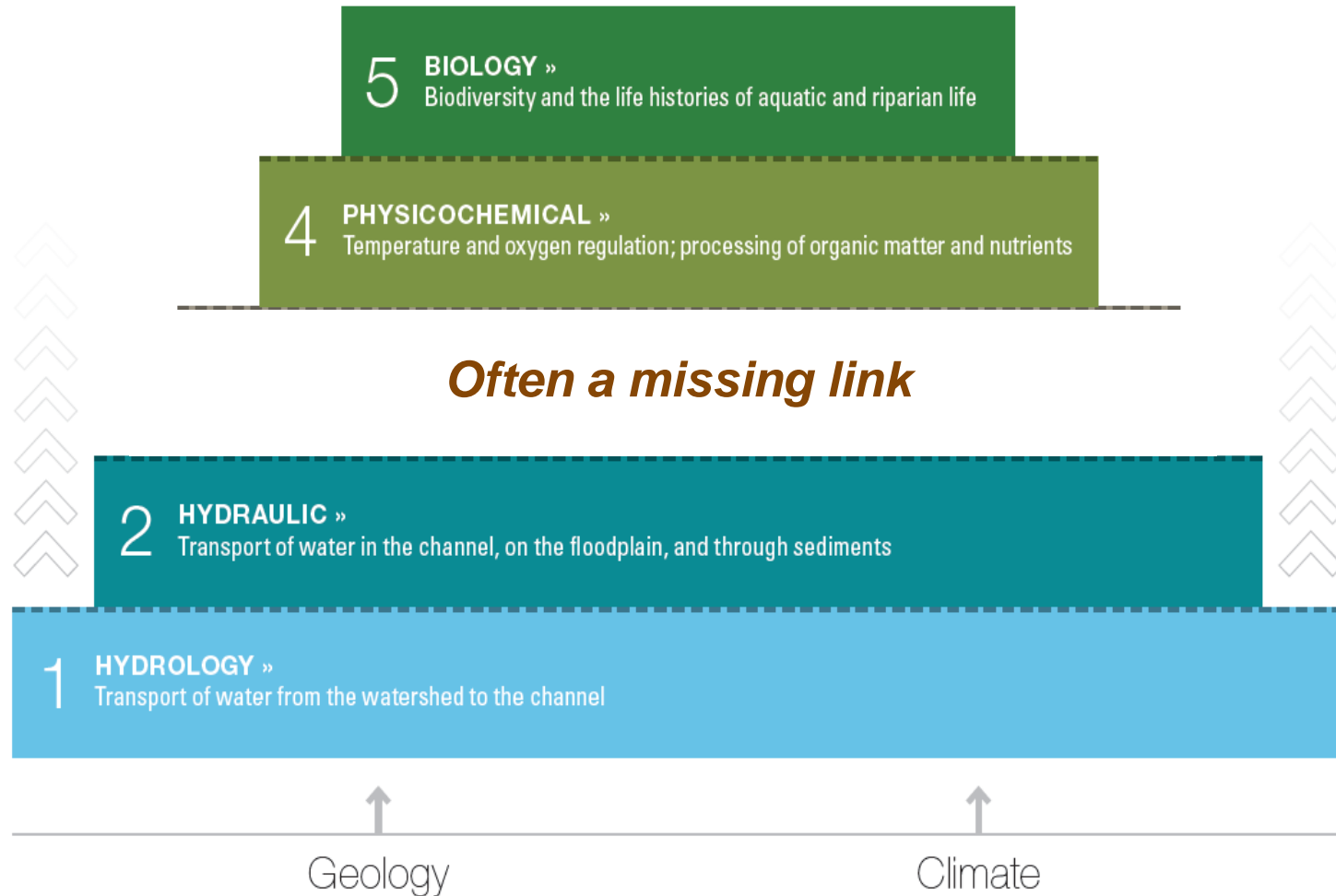
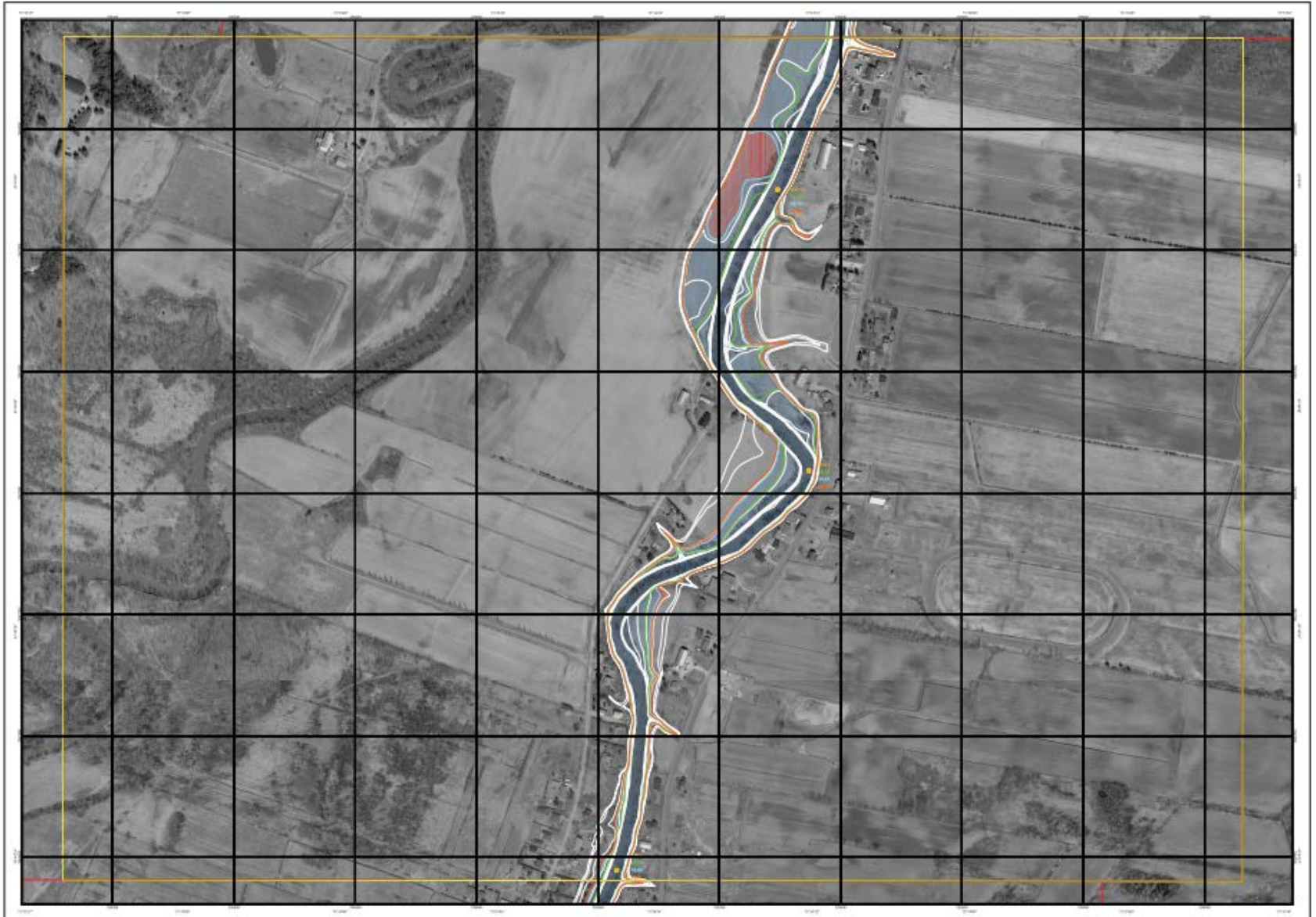


Figure 2. Aerial photographs of the residential reach in a) 1932, b) 1964 and c) 2006. Flow is from left to right.

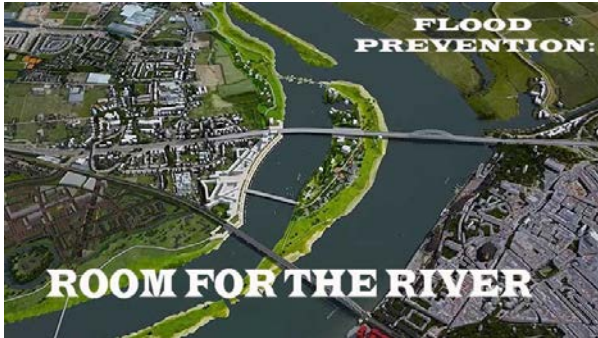
Sustainable River Management



Flood Risk Mapping... not Erosion Risk Mapping



River Management Around the World



Netherlands

Making space for water

Taking forward a new Government strategy for flood and coastal erosion risk management in England

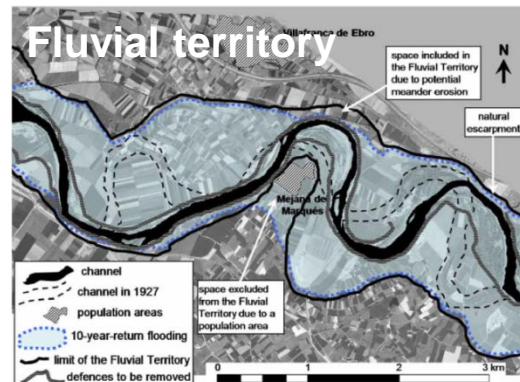
Flooding risk based room...

UK

And more recently erosion...

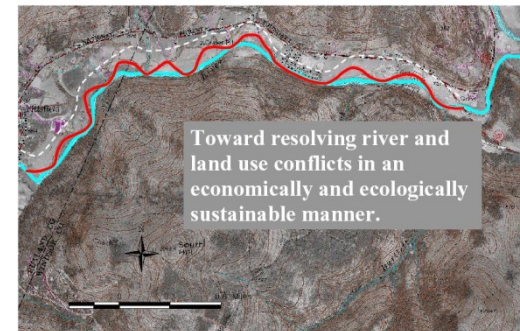


France



Spain

November 20, 2006
 Alternatives for River Corridor Management
 Vermont DEC River Management Program



Vermont

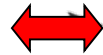
Planning in the River Basin Context in Ontario, Canada



Watershed Management Process

Municipal Planning Processes

Watershed Plans



Official Plans

Growth Strategies

Servicing Master Plans



Subwatershed Studies



Secondary Plans

Servicing Master Plans

Open Space Studies

Transportation Studies



Tribuary Studies



Plans of Subdivision



SWM Plans



Plan of Subdivision

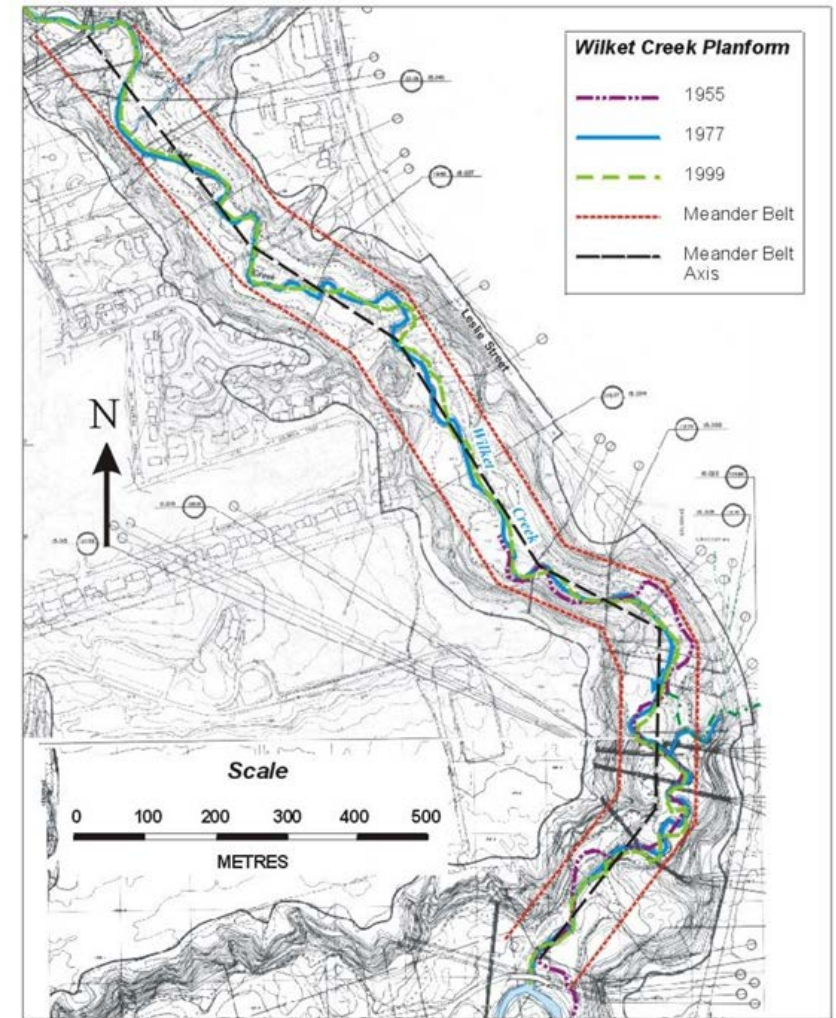
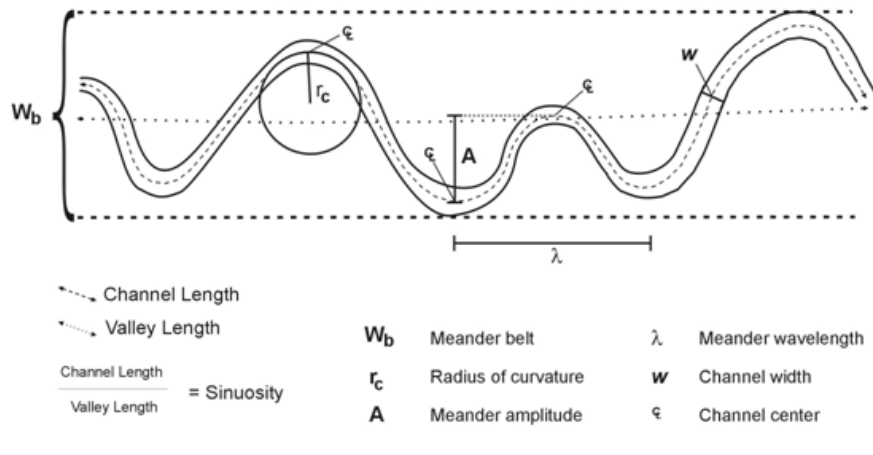


Site Plan



(Ref:
Conservation
Ontario, 2010)

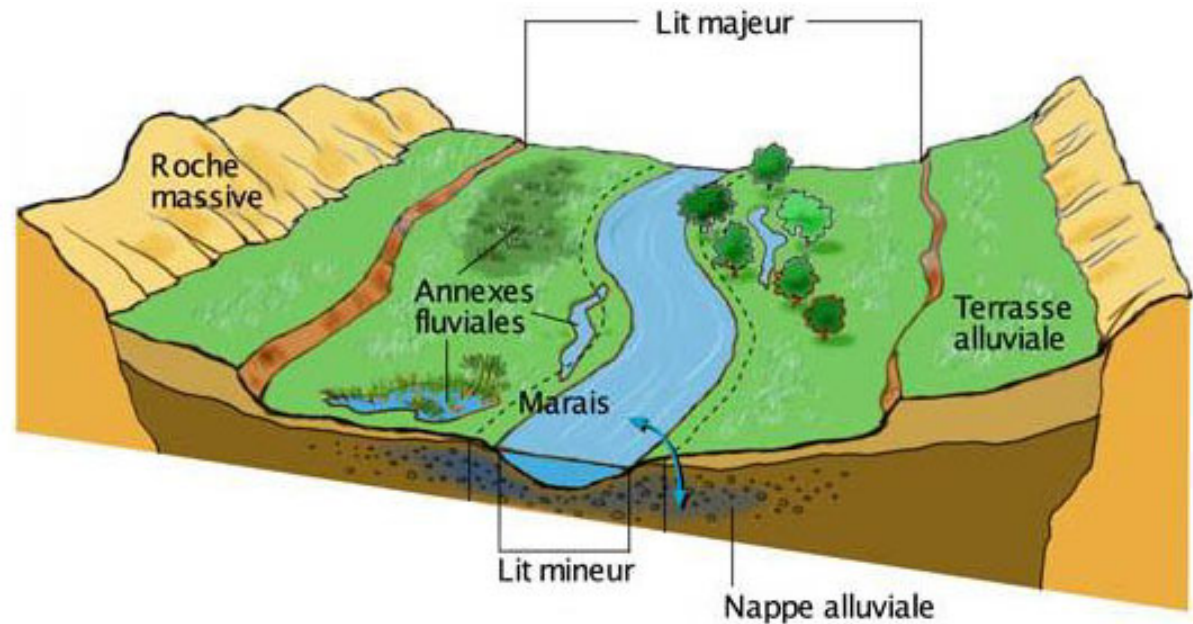
Strategic tool: Definition of « meander belt width »



(Ref: TRCA, 2004)

Freedom Space (Espace de liberté) in Quebec

- Flood Risk +
- Erosion Risk +
- Wetlands



http://www.eau-loire-bretagne.fr/espace_documentaire/documents_en_ligne/guides_milieux_aquatiques/Leau_LB_77.pdf

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):

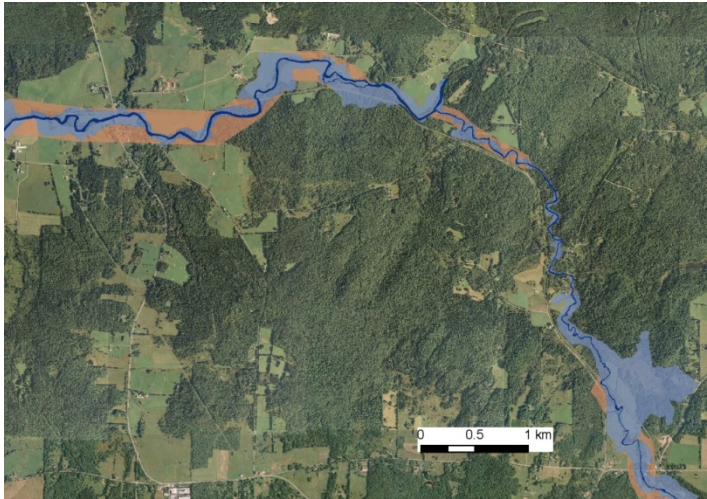
- Frequent flooding AND/OR
- At risk of long-term erosion, based on the meander belt width

– L3 (Rare Level):

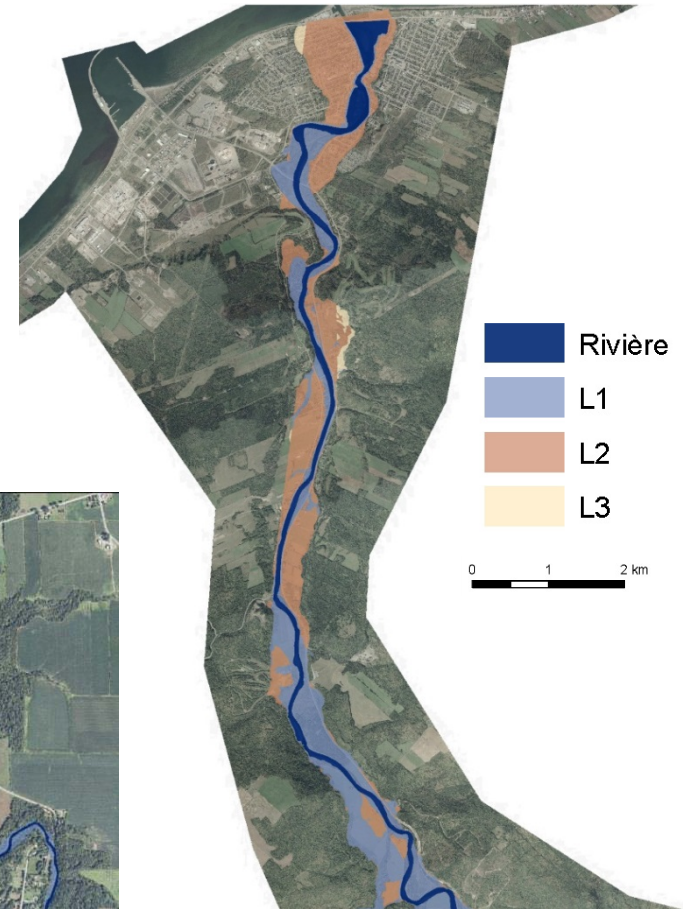
- Rare floods with minor erosion risk

Freedom Space Mapping for Three Case Studies

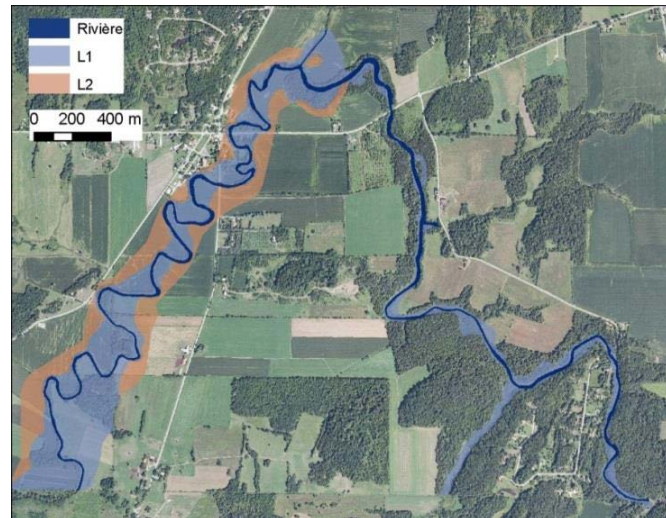
Rivière Yamaska Sud-Est (upstream)



Rivière Matane (downstream)



Rivière de la Roche



- Rivière
- L1
- L2
- L3

- 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)

Mean value less in general
(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)

Easement with financial compensation in 2009 (financed by the “Vermont Rivers Program”) for 5 hectares including 675 m of river

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.



Rivière Matane: Protection typical in the region of Gaspésie

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).



Rivière Yamachiche: Corn without riparian buffer zone

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.

Sensitivity analysis for over 25 years (4% par year)

– Services:

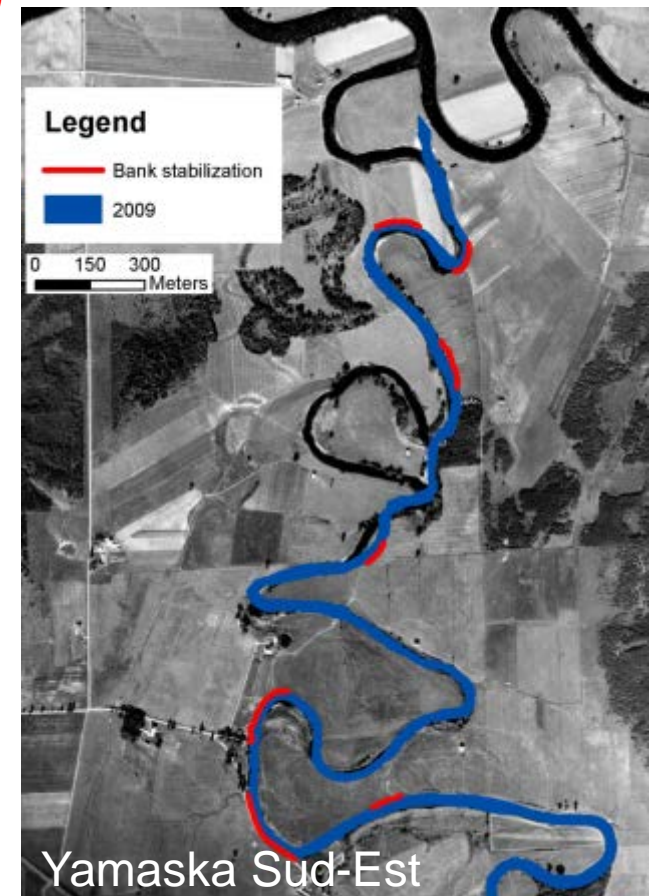
- Buffer to regulated water levels (flood and drought)
- Filtration of sediments
- Biodiversity

– 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 recreative benefits not included.
 - 958\$/ha - Yamaska Sud-Est et de la Roche,
 - 908\$/ha - Matane



Findings of the Cost-Benefit Analysis

+2,4 million \$

Type	Catégorie	Valeur (\$ CAD)
Rivière Yamaska Sud-Est		
Coûts	Perte de droit de construction	-2 913 120
	Perte de droit de culture	-1 453 832
	Réductions des coûts de protection – mesures additionnelles	3 269 009
Avantages	Réductions des coûts de protection – mesures existantes	589 260
	Réductions des dommages dus aux inondations (terres agricoles)	142 703
	Augmentation de la superficie des milieux humides	1 499 615
	Création d'une bande riveraine de 15 m	1 241 028
Total		2 375 263

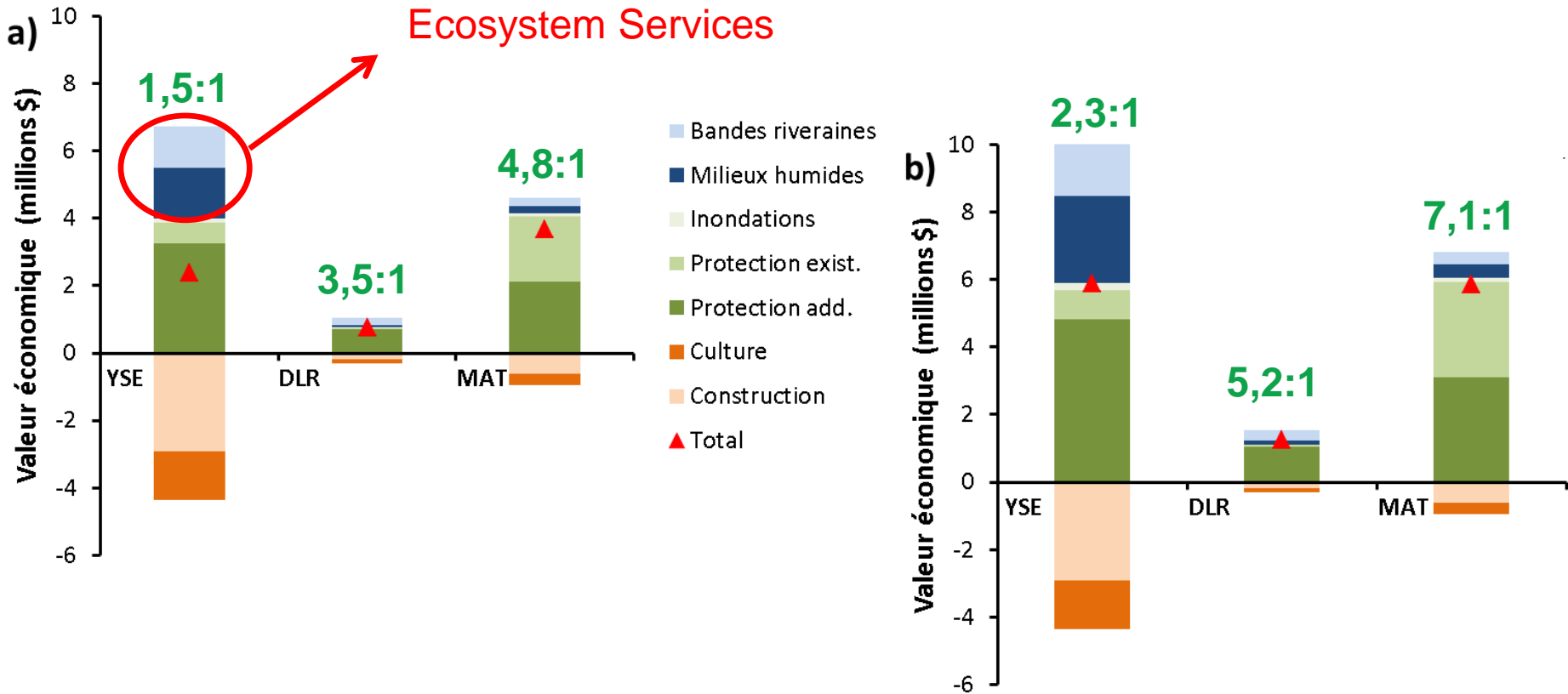
+0,7 million \$

Rivière De La Roche		
Coûts	Perte de droit de construction	-183 600
	Perte de droit de culture	-115 969
	Réductions des coûts de protection – mesures additionnelles	705 487
Avantages	Réductions des coûts de protection – mesures existantes	42 676
	Réductions des dommages dus aux inondations (terres agricoles)	11 298
	Augmentation de la superficie des milieux humides	57 848
	Création d'une bande riveraine de 15 m	228 059
Total		746 799

+3,7 million \$

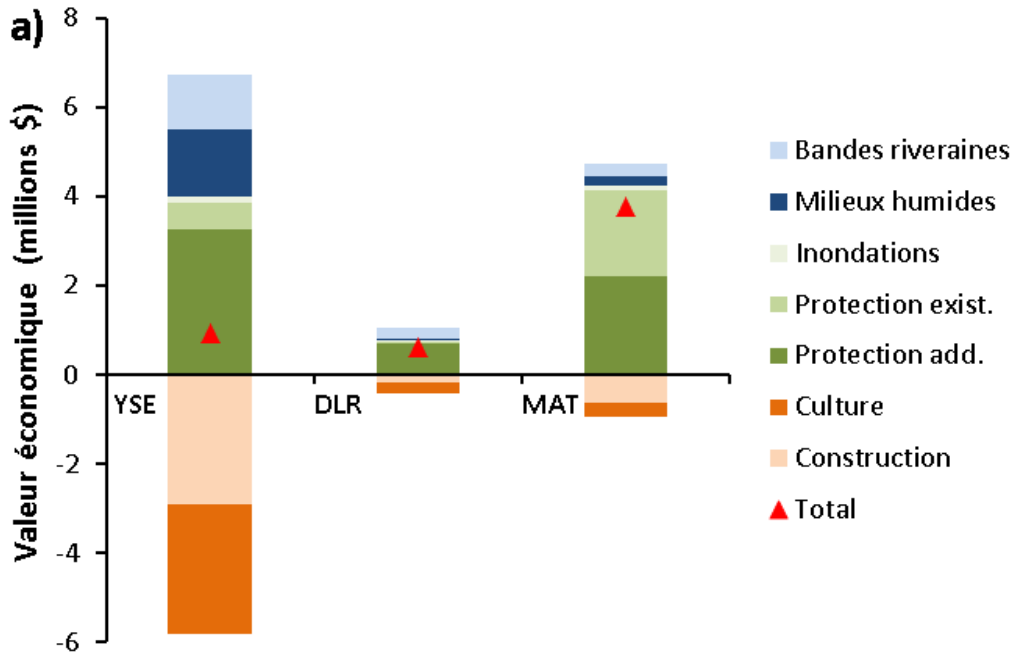
Rivière Matane		
Coûts	Perte de droit de construction	-630 000
	Perte de droit de culture	-330 172
	Réductions des coûts de protection – mesures additionnelles	2 107 479
Avantages	Réductions des coûts de protection – mesures existantes	1 937 764
	Réductions des dommages dus aux inondations (terres agricoles)	90 176
	Augmentation de la superficie des milieux humides	224 587
	Création d'une bande riveraine de 15 m	263 620
Total		3 663 663

Findings of the Cost-Benefit Analysis

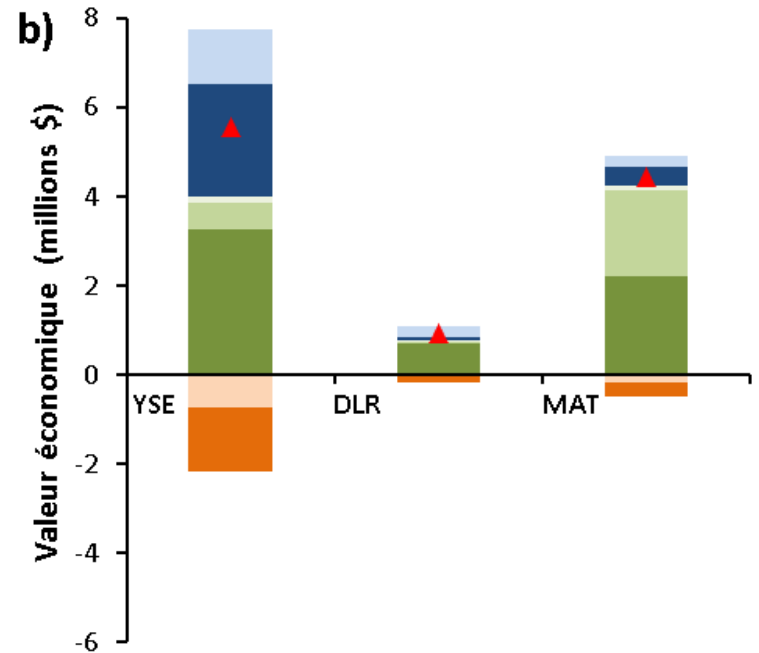


Discount rate 2% (preferable to take into account ecosystem services that occur on a long-term basis)

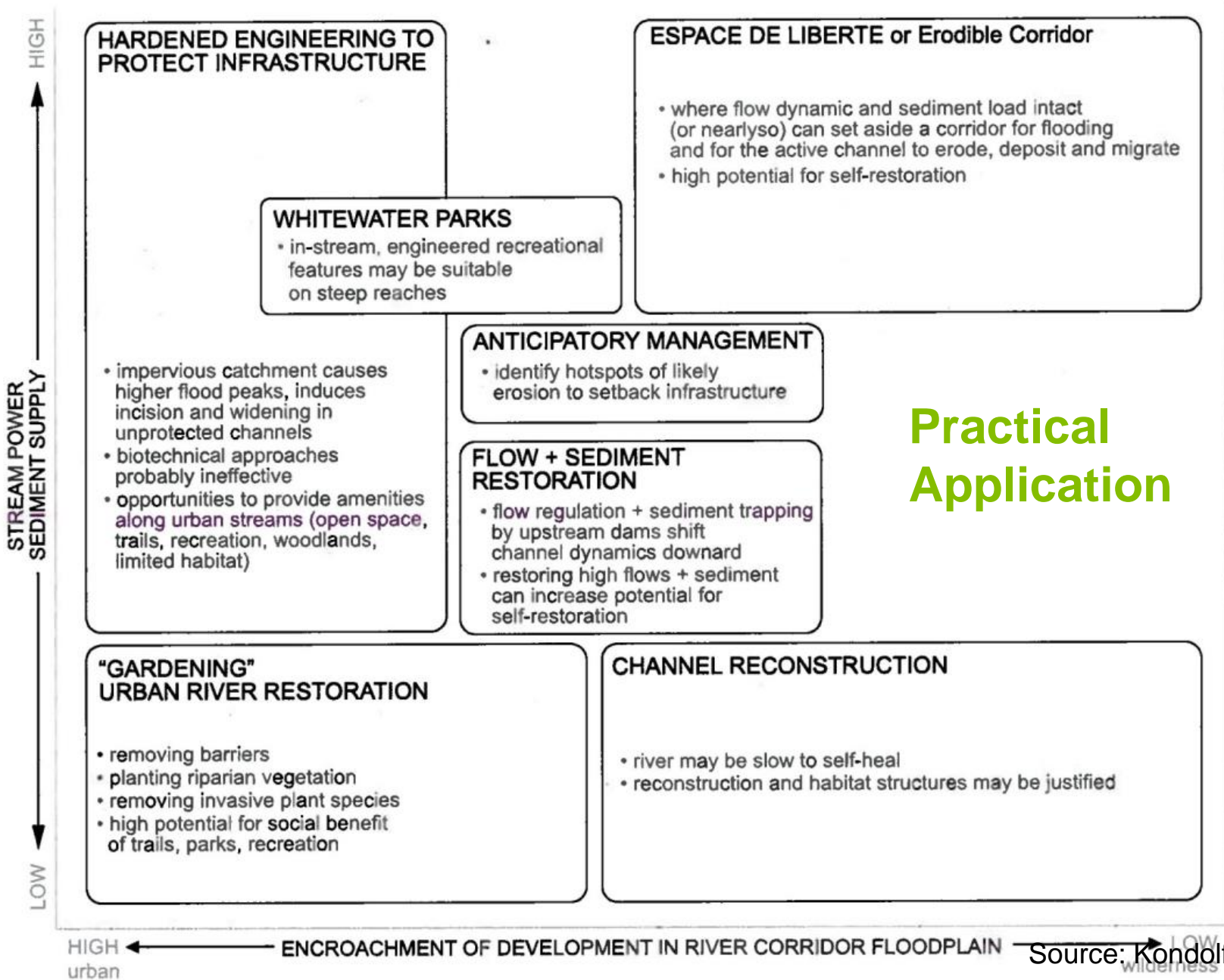
Sensitivity Analyses



Conditions most ***unfavourable*** to Freedom Space approach



Conditions most ***favourable*** to Freedom Space approach



Key Messages

- Sustainable river management must take into account **natural geomorphological processes**.
- Practical tools are available to define **zones at risk of erosion**, and could 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.

Freedom Space for Rivers: A win-win-win approach!

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