Hydro Québec Production

Une division d'Hydro-Québec

Health risk assessment related to mercury exposure from consumption of fish from a proposed hydroelectric complex

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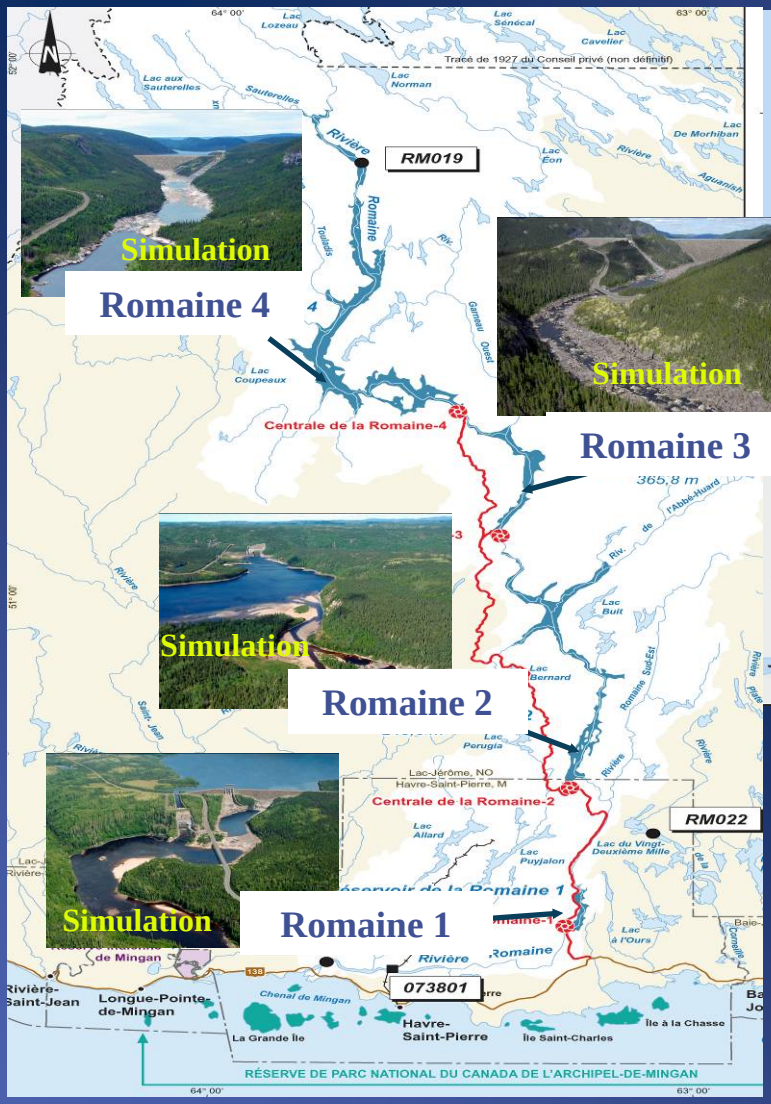
Mercury and Reservoirs

- Reservoir impoundment causes temporary increases of mercury levels in fish (10 to 30 years)
- Maximum levels in new reservoirs reach 0.5 mg kg^{-1} (ww) in non-piscivorous species and 2.0 to 4.0 mg kg^{-1} (ww) in piscivorous species
- Potential health risk to fish consumers
- A reduction of fish consumption is also a public health concern

Mercury and Reservoir Projects

- Hydroelectric projects subjected to EIAs and public hearings
- Building permits are awarded with the condition that mercury health risk management and communication programs for fish consumers be established
- Need for a Health Risk Assessment Method

Romaine Complex Project



4 Power houses
4 Reservoirs

- **Total Installed capacity : 1 500 MW**
- **Terrestrial flooded area : 220 km^2**

Health Risk Assessment

- Approach
  - Determine current Hg exposure of local populations
    - Current sources of Hg in diet of local populations
    - Current Hg levels in main sources of mercury
  - Determine future exposure of local populations
    - Future mercury levels in sources of mercury affected by the project
    - Fish consumption scenarios
    - Declared intention of fishing in reservoirs
  - Determine additional health risk by comparing future exposure with recognized health effect thresholds

Health Risk Assessment

- **Current mercury exposure**
  - Mercury in hair analysis
    - 3 local populations
      - Havre-Saint-Pierre (N = 94)
      - Longue-pointe-de-Mingan (N = 60)
      - Mingan (Innu) (N = 36)
    - Targeted groups
      - General population, Fishers, Non fishers
      - Men, women, women (18- 39 years old)

Health Risk Assessment

- **Current sources of mercury in diet**
  - Questionnaire
    - Store-bought food
    - Consumption of local fish and wildlife
    - Harvest area
    - ***Proportion of project-affected Hg sources***
- **Current Hg levels in diet**
  - Sport or subsistence fishing and hunting
  - Store-bought (Restaurant and grocery)

Current Proportion of Mercury Sources in the Diet of the 3 Local Populations

	Current sources of Hg	Ekuanitshit (%)	Havre-Saint-Pierre (%)	Longue-Pointe-de-Mingan (%)
A	Non-piscivorous fish from affected areas	1.1	0.6	0.0
B	Non-piscivorous fish from unaffected areas	24.1	9.5	16.9
C	Piscivorous fish from affected areas	2.0	0.2	0.0
D	Piscivorous fish from unaffected areas	5.1	1.2	1.2
E	Local marine fish and seafood (unaffected)	5.3	3.8	3.4
F	Waterfowl from affected areas	0.2	0.0	0.0
G	Waterfowl from unaffected areas	39.6	0.9	0.7
H	Marine mammals (unaffected)	3.2	24.4	5.8
I	Store or restaurant fish and seafood (unaffected)	19.3	59.4	72.0
Total sources		**100**	**100**	**100**
Proportion of affected sources (1)		**3.3**	**0.8**	**0**

1: Only sources A, C and F are affected by the project

Mercury Exposure of Local Populations

- **Future mercury exposure**

$$\text{Future Hg Exposure (ppm in hair)} = \text{Current Hg Exposure (ppm in hair)} \times \frac{\text{Future avg [Hg] in diet (µg/g)}}{\text{Current avg [Hg] in diet (µg/g)}}$$

- **Considering :**
  - Future mercury levels in affected mercury sources (reservoir Hg in fish model)
  - 3 consumption scenarios

Current Exposure

Current average [Hg] in diet

$$[Hg_{avg}]_{Diet} = \left(\sum_{i=A}^{I} \sum_{j=1}^{n} [Hg_{xy}] \right) \div Nb_{meals}$$

Where :

for *i* = A to I significant sources of Hg

for j = 1 to n meals consumed by each participant

Hg_{xy} = Hg concentration in x species from y location consumed (µg/g)

Nb meals = Total number of meals of each participant

Future Mercury Exposure

- **Consumption scenarios**
  - No change in consumption habits
    - Only [Hg] of affected sources (A,C,F) change in

$$[Hg_{avg}]_{Diet} = \left(\sum_{i=A}^{I} \sum_{j=1}^{n} [Hg_{xy}] \right) \div Nb_{meals}$$

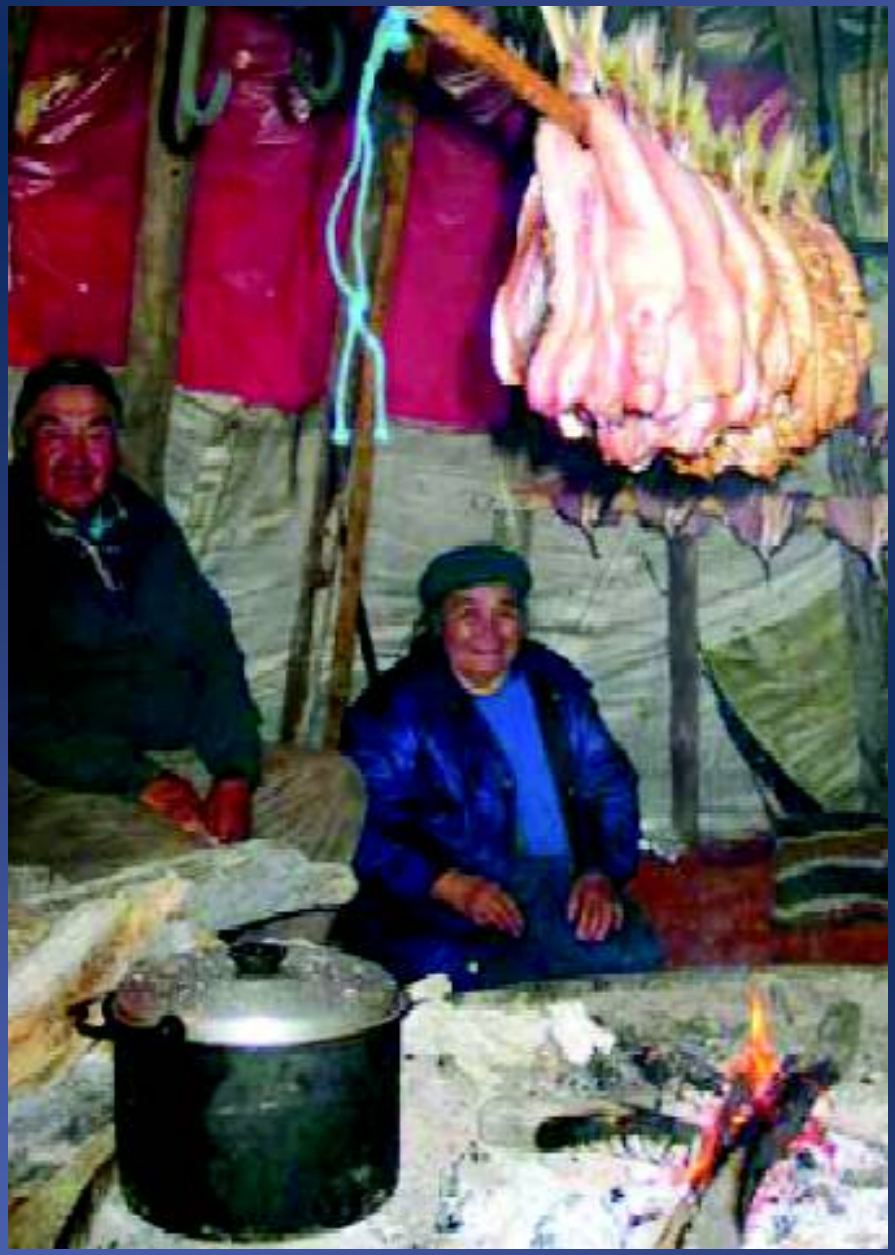
  - Realistic scenario
    - 10 % of trout meals from natural lakes replaced by reservoir fish (70% piscivorous – 30% non piscovorous)
  - Worst case scenario
    - 25 % of trout meals from natural lakes replaced by reservoir fish (70% piscivorous – 30% non-piscovorous)
  - Calculated for each participant of study

Comparison of current and future mercury exposures (mg g-1 in hair) Worst-case scenario

Target group	Innu of Ekuanitshit		Havre-Saint-Pierre		Longue-Pointe-de-Mingan	
	Current Exposure	Future Exposure	Current Exposure	Future Exposure	Current Exposure	Future Exposure
General population	*N = 36*		*N = 94*		*N = 60*	
Average value	**0.48**	**0.81**	**0.85**	**1.21**	**0.70**	**0.99**
Minimum	0.10	0.10	0.10	0.10	0.10	0.10
Maximum	2.00	5.00	4.10	5.20	7.40	7.40
Fishers	*N = 24*		*N = 67*		*N = 35*	
Average value	**0.51**	**0.75**	**0.99**	**1.41**	**0.82**	**1.18**
Minimum	0.10	0.10	0.10	0.14	0.10	0.10
Maximum	1.10	2.10	4.10	5.20	7.40	7.40
Women (18 – 39 years)	*N = 13*		*N = 25*		*N = 9*	
Average value	**0.28**	**0.44**	**0.63**	**0.90**	**0.33**	**0.48**
Minimum	0.10	0.10	0.13	0.13	0.10	0.10
Maximum	0.57	1.30	2.30	4.70	0.62	1.10

Conclusions

- **Approach takes into account :**
  - Current Hg exposure of local populations
  - Main sources of mercury in diet
  - Predicted mercury levels in affected sources in diet
  - Realistic future consumption scenarios
- **For Romaine Hydroelectric complex:**
  - Estimated future exposures remain well below recognised thresholds of potential health effects
  - No additional health risk foreseen, even for worst-case scenario
  - Health risk communication program to be discussed with local Public Health Institutions



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