
CONSIDERATIONS FOR A NATIONAL FLOOD INSURANCE PROGRAM IN CANADA

ICLR FRIDAY FORUMS
FEBRUARY 9TH, 2024

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UQÀM

I. RESEARCH PROJECT

About

- Canadian flood risk-sharing models in the face of climate change;
 - With M. Bourdeau-Brien (Laval), J. Thistlethwaite (Waterloo) and D. Henstra (Waterloo);
- **Research partnership:**
 - Public Safety Canada (PS) and Insurance Bureau of Canada (IBC);
 - >\$600K over 3 years, funded by NSERC Alliance, PS PDCCP and IBC;

I. RESEARCH PROJECT

Timeline

- **Follows** from the work of the Task Force on Flood Insurance and Relocation;
- **2022-2023** Actuarial and financial analyses under the present climate;
 - Work from Gabriel Morin and Jacob Chenette;
 - Papers under preparation;
- **2024-2025:** Revisit actuarial and financial analyses for future climates;
 - Under way;

OUTLINE

- ~~1. Research project;~~
2. Financial management of flooding in Canada;
3. Flood risk in Canada;
4. Annual costs of a mature plan;
5. Capitalization of a new plan;
6. Moving towards flood resilience (Conclusion);

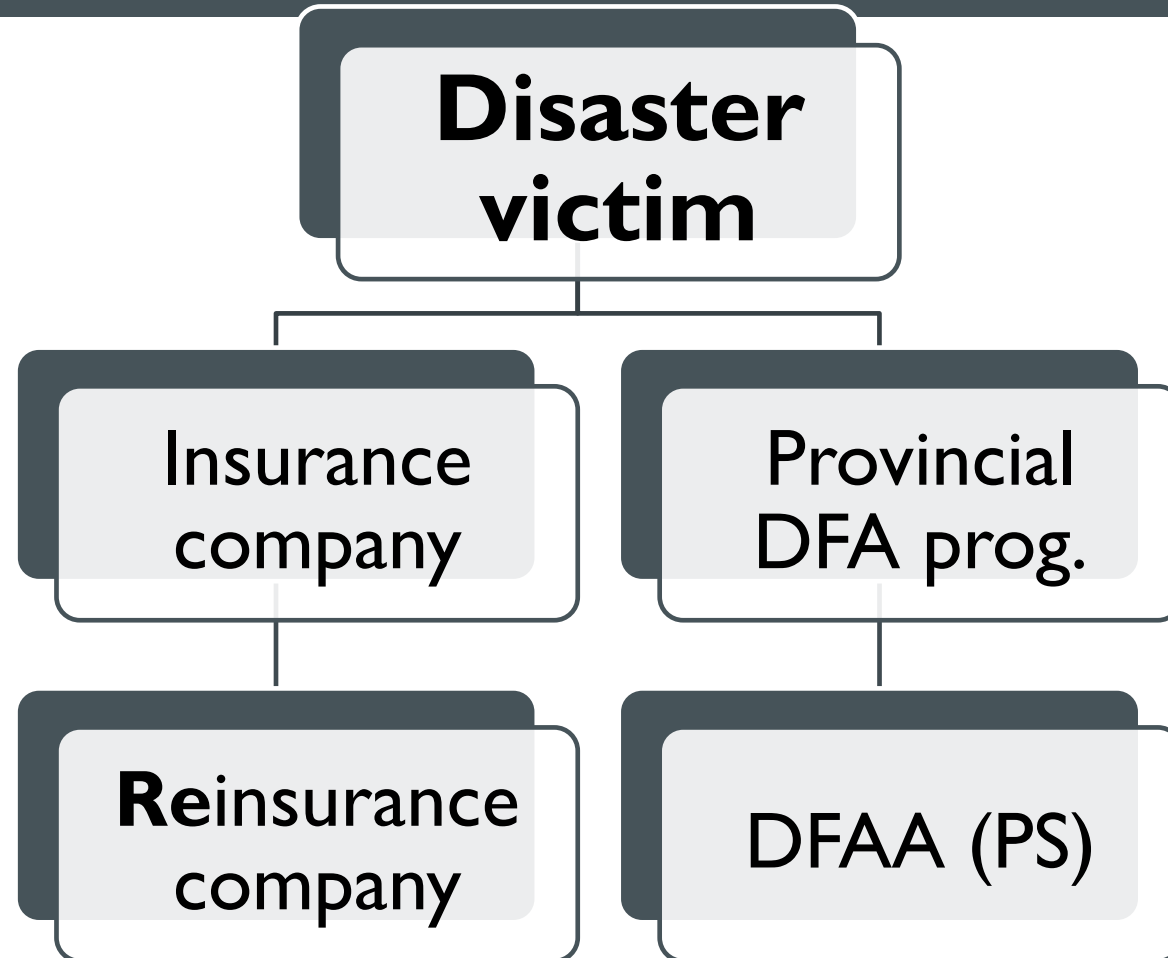
2. FINANCIAL MANAGEMENT OF FLOODING IN CANADA

A shared responsibility

- **Municipalities:** land use planning, maintenance of infrastructure;
- **Provinces:** oversight of municipalities, flood mapping (with municipalities), disaster financial assistance (DFA);
- **Federal:** financial support to provinces and municipalities through various programs: National Disaster Mitigation Program (NDMP), National Adaptation Strategy and Disaster Financial Assistance Arrangements (DFAA);
- **Insurers:** sell flood insurance to homeowners;

2. FINANCIAL MANAGEMENT OF FLOODING IN CANADA

Who pays for what in case of flooding?



2. FINANCIAL MANAGEMENT OF FLOODING IN CANADA

Financial assistance from FPT governments

- **Provincial DFA:**

- Last resort financial assistance to homeowners and municipalities;
- Protect home hours prior to flooding, or repair, rebuild, etc. in case of flooding;
- Triggered by province (emergency measures);

- **DFAA:**

- Financial assistance to **provinces** (and territories) in case of major event;
- Cost-sharing formula between province and federal based on population (establishes province's financial capacity);

2. FINANCIAL MANAGEMENT OF FLOODING IN CANADA

Private insurance market

- Overland flood insurance and sewer backup not covered in basic homeowner's insurance → Sold as optional rider;
- Overland flood insurance added since 2015-2016 approx. while sewer backup existed for a while;
- Take-up rate of 60% for comprehensive coverage;
- **Risk-based pricing:**
 - Affordable for low to medium risk;
 - Not offered or not affordable or inadequate coverage (low limit) for those at high risk;

2. FINANCIAL MANAGEMENT OF FLOODING IN CANADA

Recent initiatives

- **Task Force on Flood Insurance and Relocation**

- Public Safety Canada and CMHC;
- Report (August 2022);

- **Federal Budget** (March 2023)

- National Flood Insurance Program
 - Reinsurance Crown corporation;
 - Insurance subsidy program;



Adapting to Rising Flood Risk
An Analysis of Insurance Solutions for Canada
A Report by Canada's Task Force on Flood Insurance and Relocation
August 2022



3. FLOOD RISK IN CANADA

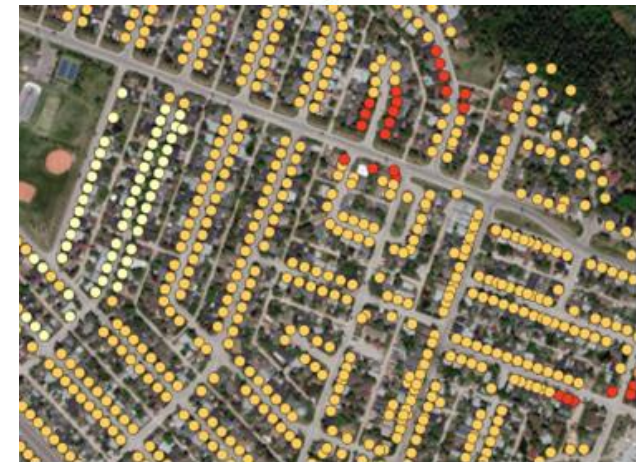
Canadian exposure information | Inputs

- Location and property characteristics for each Canadian home;
- **Statistics Canada – 2021 Census** : information on number of dwellings, dissemination areas/blocks geometries;
- **DMTI Spatial – Address points**: location (lat/lon) of Canadian addresses;
- **Opta – Aggregate exposure information**: aggregate property characteristics such as reconstruction costs, basement info, etc.

3. FLOOD RISK IN CANADA

Canadian exposure information | Steps

1. Assign appropriate number of each dwelling type from StatsCan 2021 Census per DA;
2. Locate (lat/lon) each property with DMTI Address Points;
3. (Randomly) Assign property characteristics with Opta;



3. FLOOD RISK IN CANADA

Canadian exposure information | Assumptions

- Focus on buildings Code I-4 from StatsCan:
 - Single-detached house, semi-detached house, row house, apartment or flat in a duplex;
 - MDU, mobile homes and other dwellings are all **excluded**;
 - **About 10M homes** (9.9M exactly);
- Assign first floor elevation (FFE) of 1 ft if no basement, 3 ft if basement;
 - 90% of 10M homes in Canada have basement;

3. FLOOD RISK IN CANADA

Flood model

- Provided by KatRisk
 - Fluvial and pluvial flooding;
- Use Canadian exposure information as input;
- **Output:**
 - Average annual loss (AAL) for each of 10M homes;
 - Probabilistic event set at near location level (aggregated per DB);

3. FLOOD RISK IN CANADA

AAL and breakdown per province

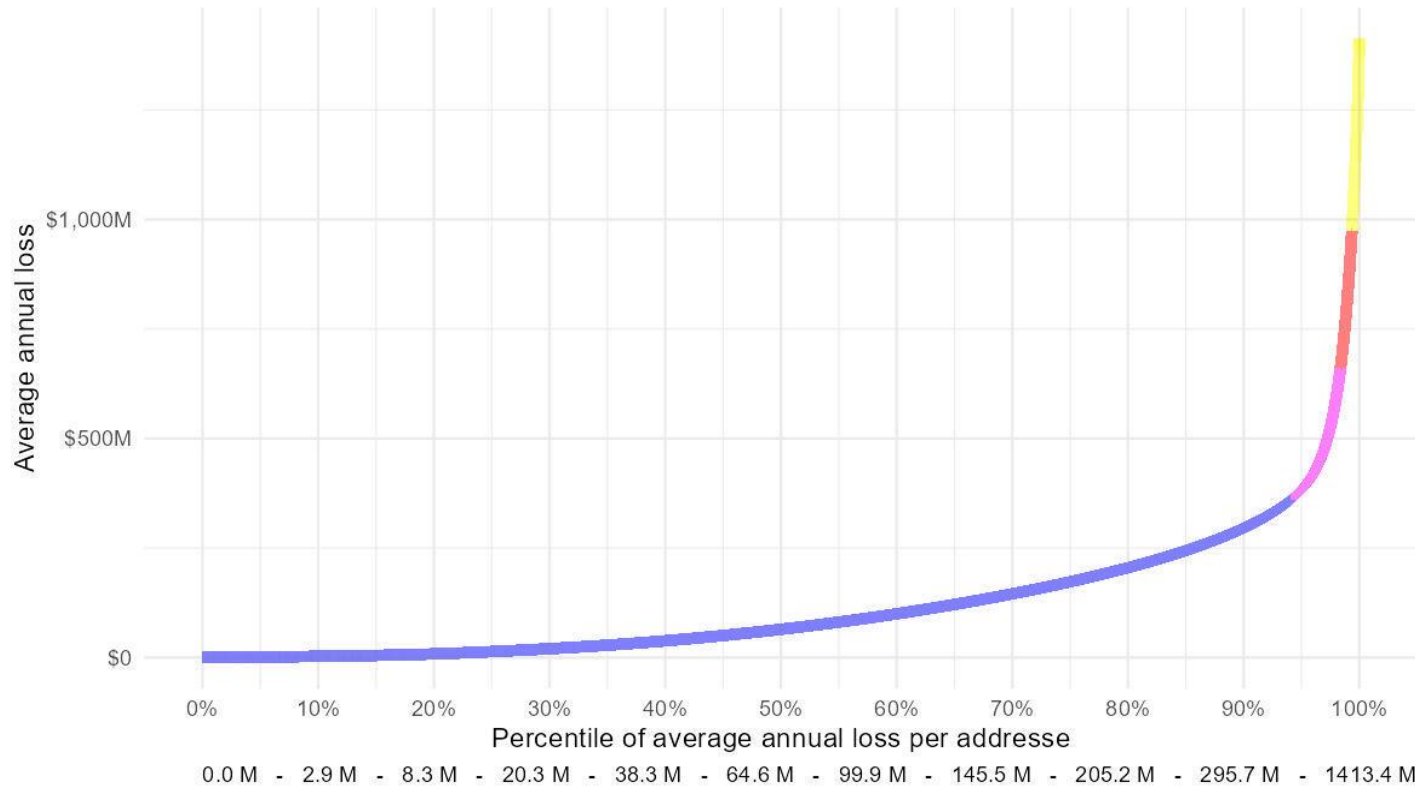
Province	AAL	95th (20-yr)	99th (100-yr)	99.9th (1000-yr)
NL	9 980	33 537	170 458	1 103 169
PE	2 393	8 045	53 672	233 458
NS	18 696	81 235	344 208	1 319 062
NB	34 607	168 067	583 519	1 440 537
QC	387 746	1 851 210	6 192 698	18 375 956
ON	407 830	1 821 714	6 817 956	21 929 873
MB	94 376	296 351	2 204 828	7 560 879
SK	41 888	205 897	656 589	2 157 271
AB	153 114	597 351	2 939 708	9 632 539
BC	268 147	1 258 974	3 537 292	9 675 858
Canada-wide	1 418 776	5 707 636	13 227 199	33 826 713

in thousands \$

3. FLOOD RISK IN CANADA

Distribution of AAL per homeowner

Total average annual loss across Canada ranked by percentile



Flood risk heavily **concentrated** in few homeowners

- 39% of risk in top 1%
- 78% of risk in top 10%

3. FLOOD RISK IN CANADA

Distribution of AAL per homeowner, broken down by province

Prov.	AAL (\$)	Overall		Top 10% of AAL (\$123)		Top 1% of AAL (\$3,508)	
		Number of residential properties (thousands)	AAL per property (\$)	Number of residential properties (count and %)		Number of residential properties (count and %)	
NL	9 979 697	145,6	68,55	5 667	3,89%	608	0,42%
PE	2 393 293	51,0	46,90	1 697	3,33%	108	0,21%
NS	18 695 706	317,8	58,83	12 135	3,82%	924	0,29%
NB	34 606 557	263,5	131,33	18 370	6,97%	3 058	1,16%
QC	387 745 587	2 232,9	173,65	229 683	10,29%	28 495	1,28%
ON	407 830 054	3 780,4	107,88	287 734	7,61%	26 466	0,70%
MB	94 375 643	343,8	274,48	98 559	28,66%	6 007	1,75%
SK	41 888 106	322,3	129,96	29 000	9,00%	2 242	0,70%
AB	153 114 154	1 213,3	126,19	98 745	8,14%	9 687	0,80%
BC	268 147 480	1 146,3	233,92	202 326	17,65%	20 796	1,81%

4. ANNUAL COSTS OF A MATURE PLAN

Assumptions

- 2020 reference year;
- **Loss costs:**
 - Average annual insured losses (AAIL): building and contents after deductible and limit;
 - Additional living expenses (ALE): 30%;
- Loss adjustment expenses (ALAE and ULAE): 10%;
- (International) Reinsurance: to be computed from event set;
- Overhead, commissions, and other fixed expenses: \$400M;

4. ANNUAL COSTS OF A MATURE PLAN

Reinsurance

Threshold (annual losses above given percentile are reinsured)	Pure reinsurance premium (as a % of AAIL)	Approx. gross reinsurance premium (as a % of AAIL)
90%	30%	45-60%
95%	20%	30-40%
99%	6%	9-12%
99.5%	4%	6-8%
99.9%	1%	1.5-2%

4. ANNUAL COSTS OF A MATURE PLAN

Full participation (Numbers in thousands of \$)

	Deductible Limit	5K None	10K None	25K None	5K 300K	10K 300K	25K 300K
Components of the loss costs							
Building and contents (AAIL)		1 195 665	1 084 969	880 494	1 086 739	976 043	771 568
Additional living expenses (ALE)		358 700	325 491	264 148	326 022	292 813	231 470
Total loss costs		1 554 365	1 410 460	1 144 642	1 412 761	1 268 856	1 003 039
Loss Adjustment Expenses (LAE), including Allocated and Unallocated (ALAE and ULAE)							
		155 436	141 046	114 464	141 276	126 886	100 304
Reinsurance premium (with loading of 50%)							
		110 814	99 689	77 655	98 939	87 456	65 665
Overhead, commissions and other fixed expenses							
		400 000	400 000	400 000	400 000	400 000	400 000
Total annual costs for mature plan without margin							
		2 220 616	2 051 195	1 736 762	2 052 976	1 883 197	1 569 007
Total annual costs for mature plan with 10% safety margin							
		2 442 677	2 256 314	1 910 438	2 258 274	2 071 517	1 725 908

4. ANNUAL COSTS OF A MATURE PLAN

Risk profiles – Different participation / ceding patterns

% of h/o	Best risk		Worst risk	
	AAL (\$K)	% of \$	AAL (\$K)	% of \$
0,25%	78	0,01%	193 819	13,71%
0,50%	153	0,01%	337 801	23,90%
0,75%	231	0,02%	455 686	32,24%
1,00%	313	0,02%	554 504	39,23%
2,00%	644	0,05%	806 782	57,08%
5,00%	1 801	0,13%	1 024 759	72,50%
10,00%	4 083	0,29%	1 107 722	78,37%
20,00%	9 019	0,64%	1 196 316	84,64%
80,00%	217 079	15,36%	1 404 376	99,36%
90,00%	305 673	21,63%	1 409 312	99,71%
95,00%	388 636	27,50%	1 411 594	99,87%
98,00%	606 613	42,92%	1 412 751	99,95%
99,00%	858 891	60,77%	1 413 083	99,98%
99,25%	957 709	67,76%	1 413 164	99,98%
99,50%	1 075 594	76,10%	1 413 243	99,99%
99,75%	1 219 577	86,29%	1 413 318	99,99%
100,00%	1 413 395	100,00%	1 413 395	100,00%

- We did the same with AAIL (with deductibles and limit);
- We also investigated affordability thresholds;

5. CAPITALIZATION OF A NEW PLAN

Background

- Model **cash flow uncertainty** for 30 years to determine how much to set aside and the size of Federal interventions (capital injections, backstop);
- **Determinants:** deductible and limit, risk profile of homeowners, safety margin, investment policy, inflation, political and financial risk tolerance, spatial dependence;
- **Cash flows** (with inflation accounted for):
 - (+) premiums, investment returns, reinsurance payouts;
 - (-) claims, reinsurance premiums, LAE, commission, overhead, etc.;

5. CAPITALIZATION OF A NEW PLAN

Effect of policy terms under full participation

Required capital (in millions) for fixed ruin probability (left column) for various policy terms

Limit Deductible Probability	Required initial capital						Other assumptions:
	None 5K	300K 5K	None 10K	300K 10K	None 25K	300K 25K	
0,5%	58 073	49 396	53 628	45 440	41 450	35 767	<ul style="list-style-type: none"> • Full participation; • Reinsurance at 99-th percentile • Safety margin: low (+10%); • Mean return: 6% or 3% above inflation with vol of 15%
1,0%	47 607	40 569	43 633	39 386	34 573	29 641	
1,5%	41 868	36 338	37 880	34 137	29 904	26 831	
2,0%	38 635	33 468	34 373	30 692	27 556	24 255	
2,5%	35 802	30 885	32 285	28 367	25 354	22 626	
3,0%	33 596	28 978	30 257	26 444	23 628	20 623	
4,0%	29 814	25 870	26 765	23 587	21 283	18 166	
5,0%	27 089	23 383	24 414	21 311	19 221	16 727	

5. CAPITALIZATION OF A NEW PLAN

Effect of risk profiles – Fixed ruin probability of 1%

Required capital (in millions) for 1% ruin probability for various policy terms and risk profiles

Risk profile	Limit Deductible	Required initial capital - Ruin probability at 1%					
		None 5K	300K 5K	None 10K	300K 10K	None 25K	300K 25K
Full participation		47 607	40 569	43 633	39 386	34 573	29 641
BEST	90%	12 072	11 718	8 455	8 577	3 528	3 522
BEST	99%	30 768	28 105	26 159	25 483	17 558	17 105
WORST	1%	18 430	13 967	18 353	13 939	16 998	13 392
WORST	10%	36 558	31 213	35 613	30 658	31 033	26 467
WORST	25%	41 924	35 931	40 073	35 139	33 527	28 381
WORST	50%	46 222	39 574	42 858	38 587	34 476	29 529
WORST	75%	47 518	40 523	43 628	39 373	34 572	29 640

Other assumptions:

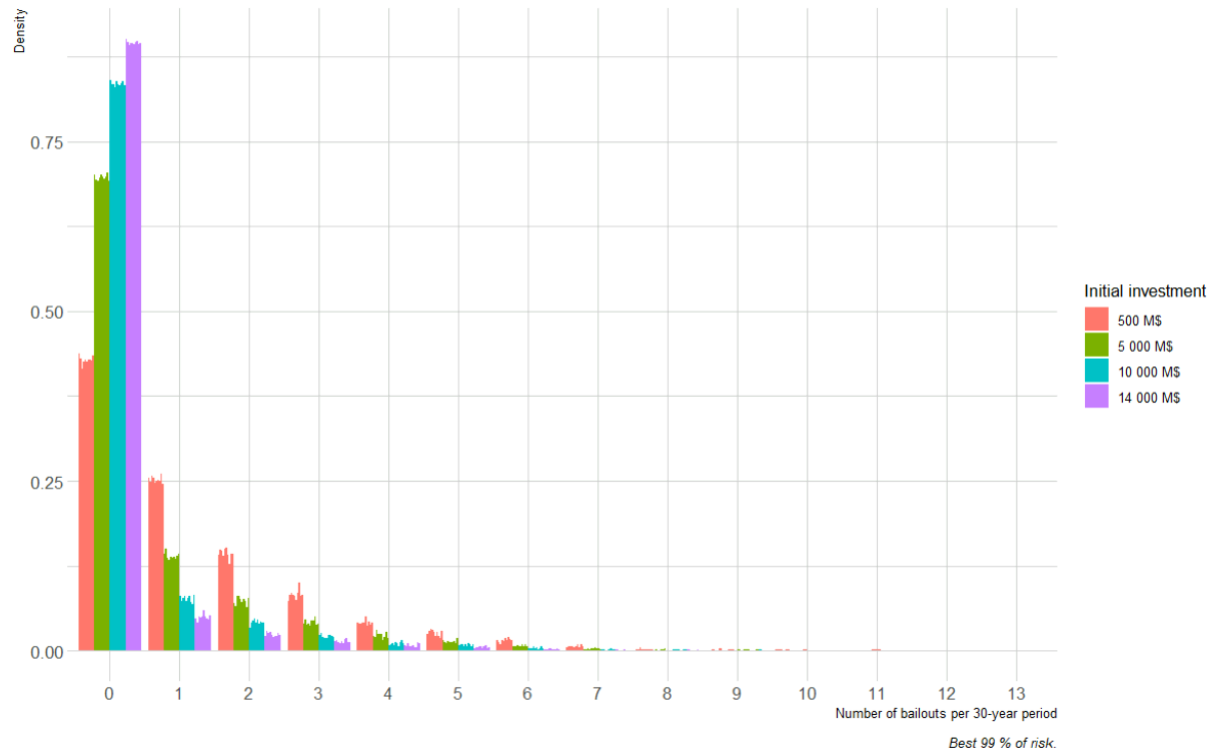
- 1% ruin proba.
- Reinsurance at 99-th percentile
- Safety margin: low (+10%);
- Mean return: 6% or 3% above inflation with vol of 15%

5. CAPITALIZATION OF A NEW PLAN

Capital injections | Number and size

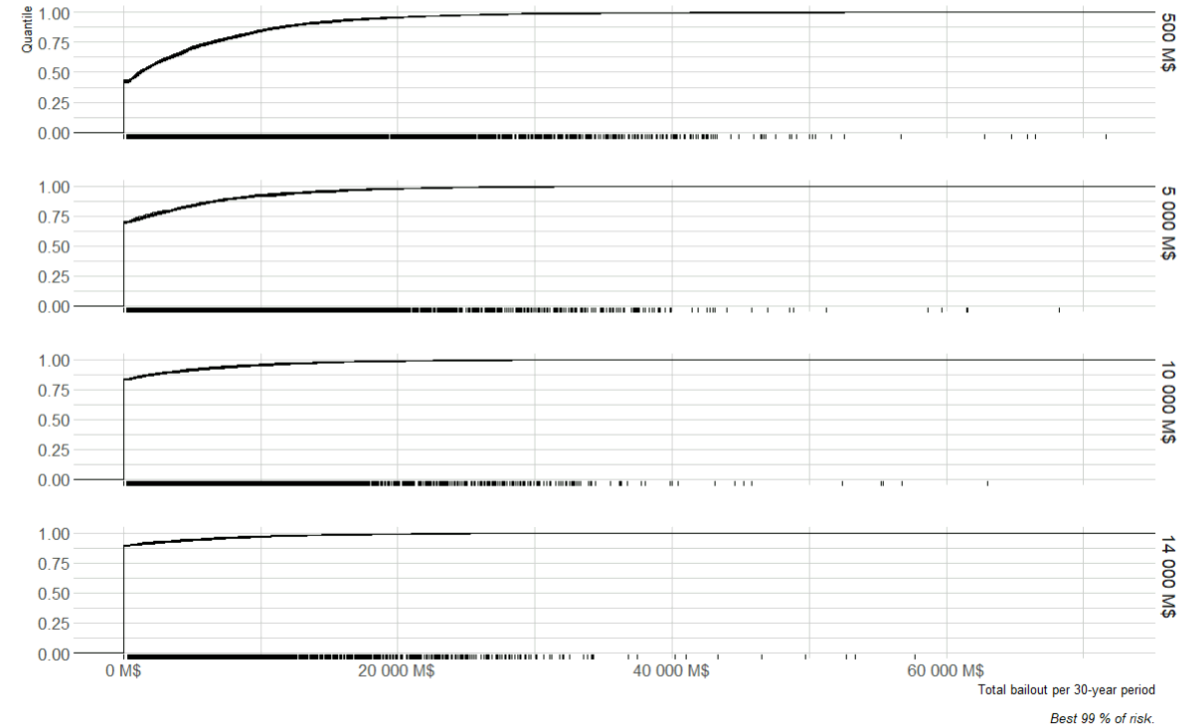
Distribution of the number of capital injections over 30 years

Policy structure: deductible of 5000 and no limit.



Distribution of the total injected amounts over 30 years

Policy structure: deductible of 5000 and no limit.



5. CAPITALIZATION OF A NEW PLAN

Impact of spatial dependence | Aggregate loss distribution (millions of \$)

	Percentiles			Conditional Tail Expectation		
	95%	99%	99,90%	95%	99%	99,90%
KatRisk (Baseline)	5 708	13 227	33 826	10 874	21 228	44 035
Independence	3 290	5 620	11 459	4 901	8 102	14 219
Moderate tail dependence	5 980	14 012	31 940	11 256	21 714	42 380
Heavy tail dependence	6 212	32 192	92 789	23 012	58 052	122 641

6. MOVING TOWARDS FLOOD RESILIENCE (CONCLUSION)

Key takeaways from actuarial analyses

- Annual recurrent costs of \$1.7 to \$2.4B depending on policy terms (deductible and limit) under full participation;
- Initial capitalization very sensitive to both policy terms and risk profile due to high concentration of risk in the top 10% / 1%;
- Trade-off between high/low initial capital vs low/high capital injections;
- Special care to top 1% of homeowners with 40% of risk → Relocation?

6. MOVING TOWARDS FLOOD RESILIENCE (CONCLUSION)

Current state of affairs (January 2024)

- Through Budget 2023, the Government of Canada announced \$31.7 million in funding for Public Safety Canada and the Canada Mortgage and Housing Corporation to work with the Department of Finance Canada to stand-up a low-cost flood insurance program.
- The program will consist of a federal reinsurance product and affordability subsidy, aimed at protecting households at high-risk of flooding and without access to adequate insurance.
- This is a priority file for the federal government. In terms of next steps, the government will engage with provinces and territories and with industry on establishing the national flood insurance program.
- In parallel to the work on flood insurance, the Department of Finance Canada and Public Safety Canada intend on engaging with industry and other stakeholders on solutions to earthquake insurance and other evolving climate-related insurance market challenges.

6. MOVING TOWARDS FLOOD RESILIENCE (CONCLUSION)

Crown reinsurance corporation

- Powerful tool for financial management of flooding in Canada
 - Foster pooling of risks from natural hazards: flooding now, earthquakes tomorrow?
 - Support insurers, provinces and municipalities for risk management;
 - Depoliticize post-disaster recovery;
 - Encourage best behaviors;
 - Autonomous and viable in the long-run;
 - Fair actuarial funding with Federal backstop;
 - Modelling and expertise to stakeholders;

6. MOVING TOWARDS FLOOD RESILIENCE (CONCLUSION)

Challenges ahead | Climate change

- Climate change will likely put pressure on flood insurance;
- Pluvial vs fluvial flooding
 - Warming atmosphere → Extreme precipitation and severe droughts;
 - Snowmelt dynamics, rain-on-snow;
 - Heavy rain episodes (Summer 2023);
 - Regional discrepancies;
- Balance investments in mitigation and adaptation;
 - Build back better, update and maintain infrastructure;

6. MOVING TOWARDS FLOOD RESILIENCE (CONCLUSION)

Challenges ahead | Moral hazard

- Municipalities are responsible of land use planning;
- Federal pays for major and catastrophic flood events;
- Provinces and municipalities have limited incentives to reduce flood risk;
- Housing crisis will put pressure on FPT and municipalities to build more and quickly;
- Funding scheme could help address moral hazard issues;

6. MOVING TOWARDS FLOOD RESILIENCE (CONCLUSION)

Challenges ahead | Data

- **Hazard:**

- High-resolution DTM not available everywhere;
- Low density of hydrometric and weather stations in some areas;

- **Exposure:**

- Building footprint (often incomplete), property characteristics, first floor elevation;

- **Vulnerability:** linking losses to property characteristics (damage curves)

- Few studies;
- Most data for overland flooding with provinces (and insurers);

QUESTIONS AND DISCUSSION

- **Mathieu Boudreault:** boudreault.mathieu@uqam.ca
- **Short summary:** [Seeing Beyond Risk](#) (Newsletter of the Canadian Institute of Actuaries);