The Business Case for Disaster Preparation: *Lower Societal Total Cost of Ownership*

A Webinar for the Institute for Catastrophic Loss Reduction
August 23, 2019
Keith Porter, University of Colorado Boulder and SPA Risk LLC
Most Americans are subject to natural hazards

- Flood: 42 million (13%)
- Earthquake: 85 million (26%)
- Hurricane: 127 million (39%)
- Wildfire: 59 million (18%)
“Money spent on reducing the risk of natural hazards is a sound investment. On average, a dollar spent by FEMA on hazard mitigation provides the nation about $4 in future benefits.”
Valuable, but questions remained

- Private-sector retrofit
- Adopt or exceed building codes
- Utilities & transportation
- Other perils
Natural Hazard Mitigation Saves

$2 million USD
3 U.S. government sponsors
4 private-sector sponsors
13 authors
130 participants
70 organizations
20 peer reviewers
800 comments
23 two-page fact sheets
498-page report
Old maps, inaccessible maps

“We found that Canada’s flood maps are low-quality, and they will not help with the decision-making that a property owner will have to make to protect their property from flooding. They’re designed for land use planners, they’re designed for engineers. They’re not designed to help an individual understand the flood risk.” J. Thistlethwaite, U. Waterloo, 4/26/2019

“It never occurred to me, back in 2015, to check whether the home we tried to buy was at risk of flooding. Being near the river was a plus, not a threat. And even if I had checked, it probably wouldn't have done much good. Flood plain maps in Canada are about 25 years out of date.” N. Macdonald, CBC News, 5/14/2019
Options to build better for flood

1988: first floor at base flood elevation (BFE, 1%/year exceedance probability)

2018: first floor at BFE + 1 ft (cost: 1.3%±0.5% of new construction at BFE)

Nothing prevents building higher
Flood retrofit options

- Acquisition of property
- Elevation
- Wet floodproofing of basements
- Elevate air conditioning compressors or heat pumps and relocate ductwork
- Relocate furnaces and water heaters from basements and crawlspaces
Flood code development \( BCR = 6:1 \)

**Benefit: $550 million**

87% – Property: $470
7% – Additional living expenses and direct business interruption: $40
3% – Indirect business interruption: $20
3% – Insurance: $20

Millions 2018 USD

**Cost: $90 million**
Above-code flood design BCR = 5:1

**Benefit: $4.2 billion**

36% – Property: $1,500
22% – Additional living expenses and direct business interruption: $930
11% – Indirect business interruption: $470
7% – Insurance: $300
24% – Casualties and PTSD: $1,000

*Millions 2018 USD*

**Cost: $0.9 billion**
Above-code flood design BCR = 5:1

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*Millions 2018 USD*

**Cost: $0.9 billion**

Cost-effective considering property savings alone
Climate, population, development, & flood control also matter

Wobus et al. (2017) Nat Haz Earth Syst Sci
Options to build better or retrofit for fire

- Clear defensible space of fuel
- Use fire-resistive materials
- Enclose foundation
- Nearby hydrants with good pressure & good access
Adopt 2015 International Wildland-Urban Interface Code
Adopt 2015 International Wildland-Urban Interface Code BCR = 4:1; cost $45,000 per house (mostly for 75 years of vegetation maintenance)

**Benefit: $3.0 billion**

- 70% – Property: $2,100
- 20% – Insurance O&P: $600
- 3% – Additional living expenses & sheltering: $100
- 2% – Indirect business interruption: $50
- 5% – Casualties & PTSD: $150

*Millions 2018 USD*

**Cost: $800 million**
Canadian WUI hazard: ½ that of USA

Average at border: 197

USA average WHP: 425
## Overall BCRs

<table>
<thead>
<tr>
<th>Disaster Type</th>
<th>Adopt Code</th>
<th>Above Code</th>
<th>Building Retrofit</th>
<th>Federal Grants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riverine Flood</td>
<td>6:1</td>
<td>5:1</td>
<td></td>
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<tr>
<td>Hurricane Surge</td>
<td></td>
<td>7:1</td>
<td></td>
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<tr>
<td>Wind</td>
<td>10:1</td>
<td>5:1</td>
<td></td>
<td></td>
</tr>
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<td>12:1</td>
<td>4:1</td>
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<tr>
<td>Wildland-Urban Interface Fire</td>
<td></td>
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<th>Lifeline Retrofit</th>
<th>Federal Grants</th>
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### Investment gaps

The US could invest $0.5 trillion in existing buildings cost effectively.

<table>
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<th>Benefit-Cost Ratio</th>
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<th>ABOVE CODE</th>
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<th>LIFELINE RETROFIT</th>
<th>FEDERAL GRANTS</th>
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<tr>
<td><strong>Overall</strong></td>
<td>$11:1 $1/year</td>
<td>$4:1 $4/year</td>
<td>$520 $0.6</td>
<td>$6:1 $27</td>
<td></td>
<td></td>
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<td><strong>Riverine Flood</strong></td>
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<td>7:1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Wildland-Urban Interface Fire</strong></td>
<td>not applicable</td>
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Mitigation saves; not mitigating costs

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<td>4:1</td>
<td>$1/Year</td>
<td>$4/Year</td>
<td>$520 Billion</td>
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<tr>
<td>Groundwater Infiltration</td>
<td>not applicable</td>
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<td>not applicable</td>
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This means, developers save $4 billion/year and everybody loses $16 billion/year.
U.S. national treasury: $795 million/year less outlay + $125 million/year more tax revenue

**Benefit: $920 million**

- 9% – Exceed common code requirements: $80
- 7% – Meet common code requirements: $67
- 1% – Utilities and transportation: $13
- 83% – Federally funded: $760

Millions 2018 USD
Everyone wins

Code development

Above-code design
Everyone wins, sort of

NATURAL HAZARD MITIGATION SAVES & NEXT STEPS

(Optimal Above-Code Seismic Design)
Co-benefits

(Optimal Above-Code Seismic Design)

BCR = 4.4

BCR = 1.4

BCR = ∞

BCR = ∞

BCR = ∞

BCR = ∞

$3,000

$2,000

$1,000

$-$(1,000)

Developers

Owners

Lenders

Tenants

Communities

Cost

Benefit

Cost

Benefit

Cost

Benefit

Cost

Benefit

($ millions)
Reallocate cost

$3,000
$2,000
$1,000
$(1,000)

BCR = $\infty$

BCR = 1.4

BCR = $\infty$

BCR = 4.4

Cost
Benefit

Developer
Owner
Lender
Tenant
Community

(Optimal Above-Code Seismic Design)
Fair & interests aligned

Cost: (Optimal Above-Code Seismic Design) $1,000
Benefit: $0

BCR = 3.6

Developer
Owner
Lender
Tenant
Community

(millions)

$1,000
$2,000
$3,000

$1,000

$
Can co-benefits be shared back to developers & first owners?

Several stakeholders enjoy co-benefits at no cost

• Lender: lower default risk
• Community: lower indirect business interruption risk, urban search & rescue costs, more-stable tax revenues...
• Insurers: more capacity & ability to diversify
• Tenants: life safety, peace of mind

NIBS’ Resilience Advantage Mortgage proposes financial incentives based on reduced externality

• Lower interest rate to align lender & borrower BCR
• Lower property and income tax
• Lower insurance premium
• ...

[Image: National Institute of Building Sciences]

Residential Resilience Advantage Mortgage
Summary Concept
June 26, 2018
BCRs help, & cost reallocation could also help, but mitigation decisions take place in a broad context

- Intangibles
- Catastrophes
- Recent experience
- Risk attitudes
- Local priorities, sectoral power
- Finance limitations
- Bandwidth, knowledge, & training constraints...
Summary

*Natural Hazard Mitigation Saves* provides new answers

- Code compliance BCR = 11:1
- Above-code design BCR = 4:1
- Private-sector retrofit BCR = soon...
- Utility and transportation infrastructure retrofit BCR = 4:1
- Fire at the wildland-urban interface BCR = 4:1
- Everyone benefits from mitigation on average, in the long run
- We can map where mitigation is most cost effective
- USA’s mitigation investment gap is huge -- $2.3 trillion USD
Conclusions for Canadian insurers

Natural hazard mitigation saves everyone

• Better buildings are affordable
• Better buildings cost a little more, but not building better costs a lot more
• Lagging code cycles & weakening provisions is fiscally imprudent
• Above-code design has a lower lifecycle cost when one considers everyone
• Insurers, lenders, & governments could share co-benefits back to investors, reducing total cost of owning a better building below that of code-minimum
• Methods employed here can be applied to Canadian conditions
• ICLR and SPA Risk LLC are using benefit transfer to apply this study to Canada
Thanks

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Additional material
Is it practical?
50% stronger & stiffer costs <1% more

Harris et al. (2014) designed 6 buildings to 1999 SBC & to 2003 IBC (like $I_e = 1.6$); costs 0-1% more

CUREE-Caltech Woodframe designed one building to IRC & to IO design; costs ~3% more
50% stronger & stiffer costs <1% more

Greater strength & stiffness increases this 2% of construction cost

And doesn’t affect this cost at all
Land can cost a lot

Housing costs: $1000/sf in San Francisco, $600/sf Santa Clara

Of which

$250 is construction

$5 is lateral system materials

$2.50 would buy 50% stronger and stiffer
50% stronger & stiffer costs <1% more

They guess 50% more strength adds on the order of 1% to the construction cost
More evidence we can afford it

50% greater strength here

Is about the same as code level here

1.5 x Seattle = 1.0 x SF or LA
1.5 x Sacramento = 1.0 x SF or LA
2.0 x San Diego = 1.0 x SF or LA
Simmons & Kovacs 2017: “The code had no effect on either home sales or price for new homes in Moore.”

Kevin Simmons
Univ Oklahoma

Paul Kovacs, Institute for Catastrophic Loss Reduction
Flood acquisition BCR = 6:1

**Benefit:** $1,142 billion
- 78% – Property: $887.6 billion
- 15% – Additional living expenses: $172.3 billion
- 5% – Indirect business interruption: $58 billion
- 2% – Deaths & PTSD: $23.9 billion

Billions 2018 USD

**Cost:** $183.9 billion
Benefit categories included

Property damage

Business interruption & additional living expenses

Deaths & injuries

Post-traumatic stress disorder

Public service

Insurance overhead & profit

Pamela Andrade

Timothy Faust

Nick Youngson
Some benefits are hard to quantify
Optimal above-code design maximizes societal benefit.