Theme 4.5 “Assessing and planning for the socioeconomic impacts of floods”

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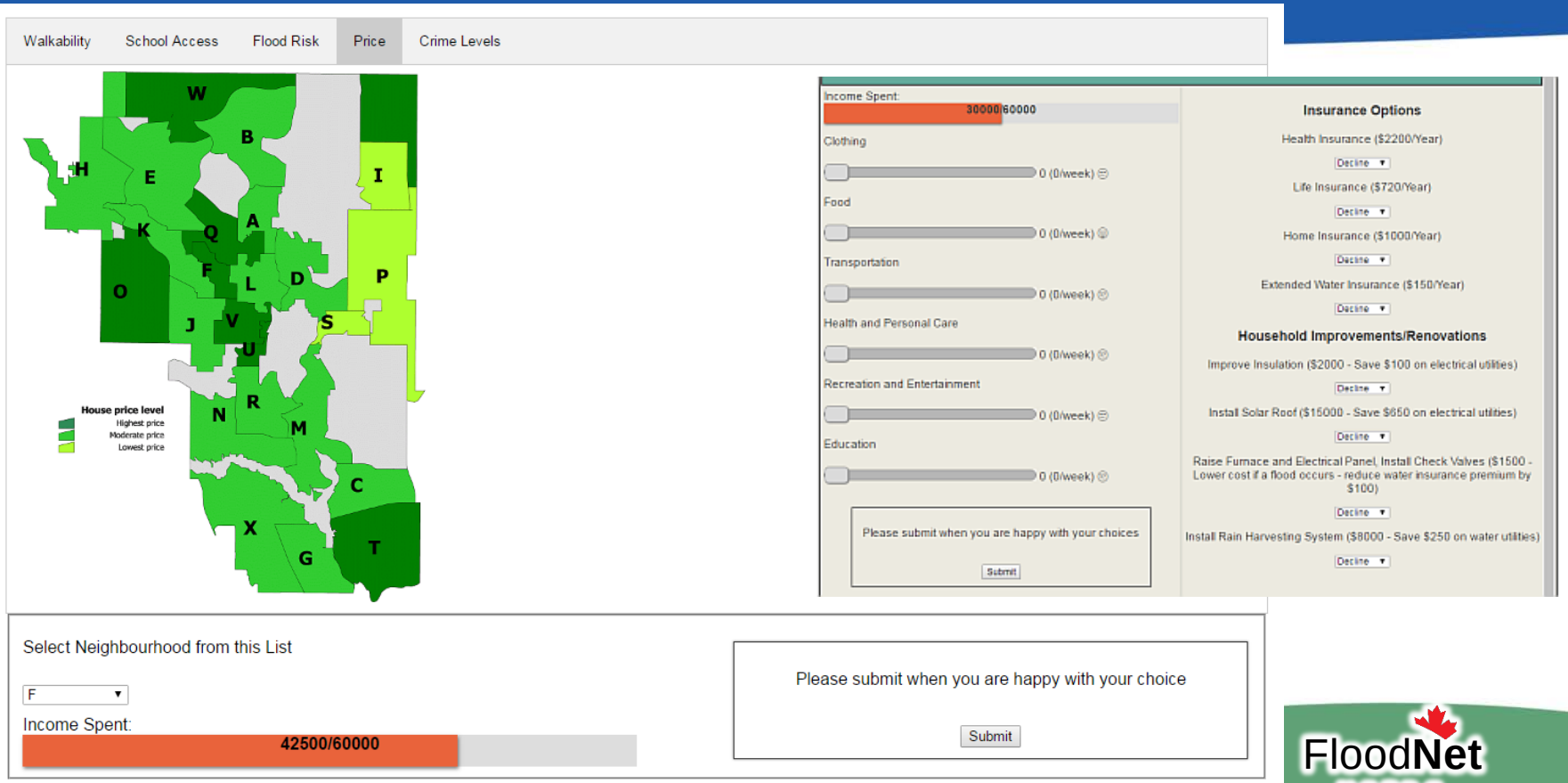
4-5 Projects updates

- **Flood decision experiment**
  - Understand decisions about flood risk mitigation
  - Empirical model to understand range of household decisions in communities at different risk levels
- **Socioeconomic changes in high flood risk zones**
  - How have demographic and socioeconomic characteristics of residents in higher flood risk areas changed over time in Calgary, Winnipeg and Hamilton? Are there patterns of moral hazard?
  - 1991 to 2016
  - Model the effect of exogenous shocks (including floods, mitigation infrastructure and policy changes)
- ***Willingness to buy***
  - *Will enough households buy insurance? What contribution can the current insurance regime make to managing flood risk?*
- **Transportation network robustness to flood events**

1. Flood decision experiment



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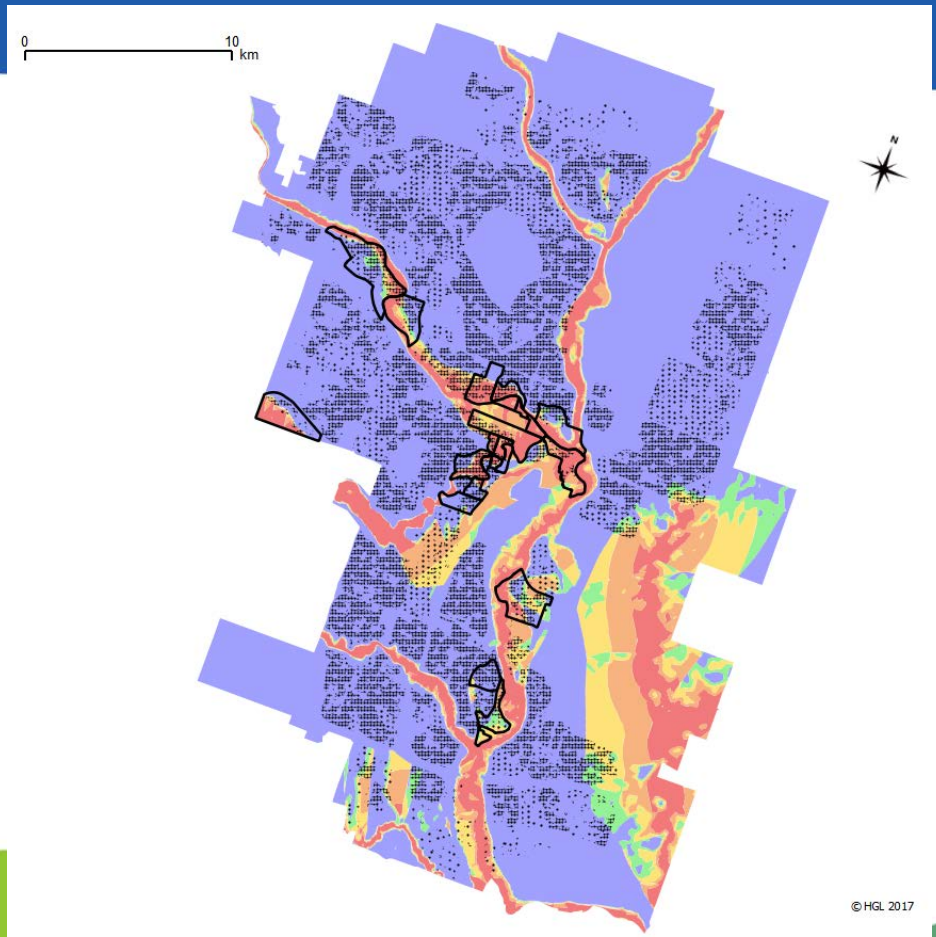
2. Socio-economic changes to flood risk zones



- Hazard levels from Elshorbagy et al., 2017
- Private dwelling counts (2011 Census of Canada clipped with City of Calgary residential land-use data)

Hazard Level	Dwellings
5 (severe)	13,786 (4%)
4 (high)	14,829 (4%)
3 (medium)	12,726 (4%)
2 (low)	9,192 (3%)
1 (very low)	279,185 (85%)

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2. Socio-economic changes to flood risk zones

	Average Income (2011 dollars)		Average dwelling value (2011 dollars)		% Owned	
	2011(NHS)	2006	2011(NHS)	2006	2011	2006
5 (Severe)	$143,827	$73,096	$552,101	$486,580	54.60%	46.80%
4 (High)	$104,893	$50,164	$410,857	$347,872	61.30%	49.70%
3 (Medium)	$88,195	$44,870	$360,308	$313,720	57.70%	47.70%
2 (Low)	$99,733	$52,100	$385,829	$350,875	68.90%	60.80%
1 (Very low)	$116,075	$51,350	$448,607	$396,408	79.00%	74.20%

Evacuated (2013)	$116,550	$55,758	$481,750	$404,130	48.10%	49.40%
Not evacuated	$114,980	$51,589	$443,577	$392,436	77.90%	72.20%

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3. Willingness to buy insurance

Insurers consider the estimated annual loss and add profit and expenses. As a new product, loading on flood insurance is relatively high with reports that the average amount is between 1.5 and 2 times the annual loss. Hypothetical insurance premiums were calculated based on these loading factors and annualized damages. The average annual full-coverage premium for all residential houses within the 1:1000 year risk area would be between $4,650 and $6,200 but vary greatly with risk. Within the 1:50 year risk area, it would average between $15,000 and $20,000.

For all possible insurance options, the required premium would be a perpetual cost. It would also likely be a perpetually increasing cost as the quantity and value of at-risk properties increases. Given the costs and level of uncertainty, insurance for high risk of flood damages is not a viable option for property owners. It may remain an option for individual purchase once the risk has been mitigated to an acceptable level through structural or regulatory options. In other words, insurance should not be relied upon to achieve the acceptable level of protection.

$4650 - $6200 *annual premiums in 1 in 1000 year risk area*
$15000 - $20000 *annual premiums in 1 in 50 year risk area*

"Given the costs and level of uncertainty, insurance for high risk of flood damages is not a viable option for property owners"

Flood Mitigation Options Assessment, 2017
IBI Group and Golder Associates

3. Willingness to buy insurance

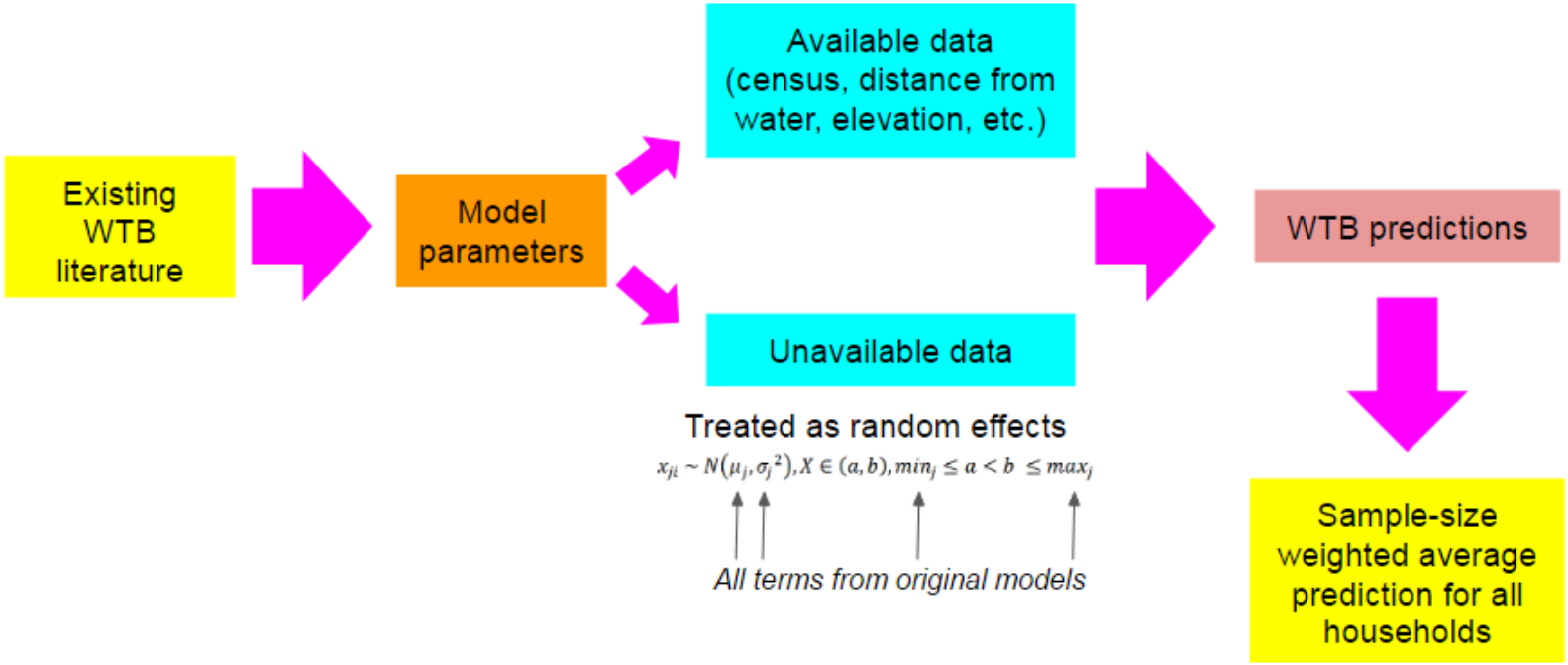
- How does WTB insurance vary in Calgary?
  - What is WTB in high and low risk areas?
- Does the variability in WTB present a challenge or opportunity for insurers?
  - Is cross-subsidization within city possible?
- Can insurance reduce household flood risk vulnerability?

3. Willingness to buy insurance

- Systematic review
  - Identify suitable analogues for estimating the future of insurance uptake in Calgary
  - Inclusion: revealed flood insurance purchases (data rather than survey questions); probit, logit or linear models with a proportion as dependent variable; model must also include premium price, and complete information for replication
- Combine included WTB models into a price specific predictive models
- Estimate flood protection via insurance under different pricing scenarios
- N=3

	Dependent Variable	Income	Previous flood	Age	Close to water	Sex (Female)	Perceived risk	Price	Education level	Gov't compensation	Own home	Size of household	Peer effect	Objective risk (p)	Protective structures	Gov't responsible	Expected return period	Perceived CC Severity	Perceived CC and floods	Have other insurance	Mortgage
Atreya et al., 2015	**Policies in F.**	+	+	+				-	+		-										
Botzen et al., 2009	WTB sandbags	+	-	-	+	-			+	-						-	-	+	+		
Botzen et al., 2012	WTP insura.	+	-	-	+	-	+		-	-				+			-		+	+	
Botzen et al., 2013(a)	WTP elevation	+			+		+											+			
Botzen et al., 2013(b)	WTP insura.							-													
Browne and Hoyt 2000	**Policies in F.**	+	+					-		+											-
Clark et al., 2002	WTP FCP	+			+									+							
Clark et al. 2005	WTP FCP	+		-	+	-			+		+	-									
Hung 2009	WTB insura.	+	+	+	-	+	-	-	+		+									+	
Kriesel and Landry 2004	**Program Partici.**	+			+			-							+						+
Lo 2013c	Likelihood of I.	+	+				+	-					+								
Lo 2013b	Likelihood of I.	+						-	+			+	+								
Oulahen 2015	WTB Insura.	+	+	-			+		-						+	+		+	+		
Owusu et al., 2015	WTP Protect.	+	+	+			+	-								-					
Petroila et al., 2013	WTB Insura.	+	+		+	-				+		-					-				+
Ren and Wang 2016	WTB Insura.	+	+	+		-			+	-		-	+							+	
Seifert et al., 2013	WTP Insura.		+				+			-											
Vaisanene et al., 2016	WTB Insura.		+	-	-	-	+							-	+						
Zhai and Ikeda 2006	WTP R. Incon.			-		+					+	-									
Zhai et al., 2006	WTP Risk Re.	+	+		+		+ / -														
TOTAL		16	13	10	10	8	9	8	8	6	4	5	3	3	3	3	3	3	3	3	3
+		16	11	4	8	2	7	0	6	2	3	1	3	2	3	1	0	3	3	3	2
-		0	2	6	2	6	1	8	2	4	1	4	0	1	0	2	3	0	0	0	1
Entropy		0.00	0.62	0.97	0.72	0.81	0.63	0.00	0.81	0.92	0.81	0.72	0.00	0.92	0.00	0.92	0.00	0.00	0.00	0.00	0.92

3. Willingness to buy insurance



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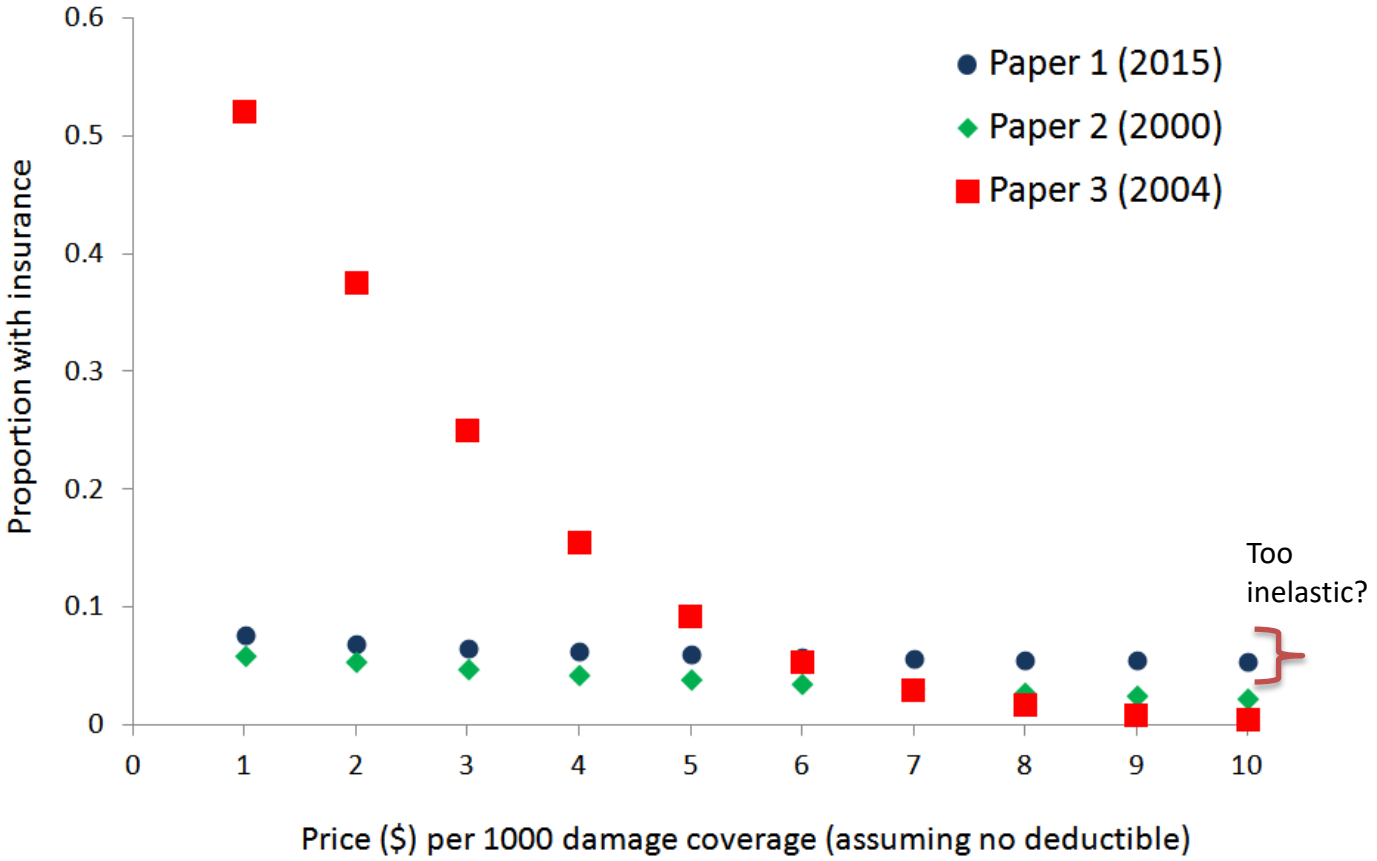
Paper 1 (2015)
Paper 2 (2000)
Paper 3 (2004)
Too inelastic?
Proportion with insurance
0.6
0.5
0.4
0.3
0.2
0.1
0
0
1
2
3
4
5
6
7
8
9
10
Price ($) per 1000 damage coverage (assuming no deductible)

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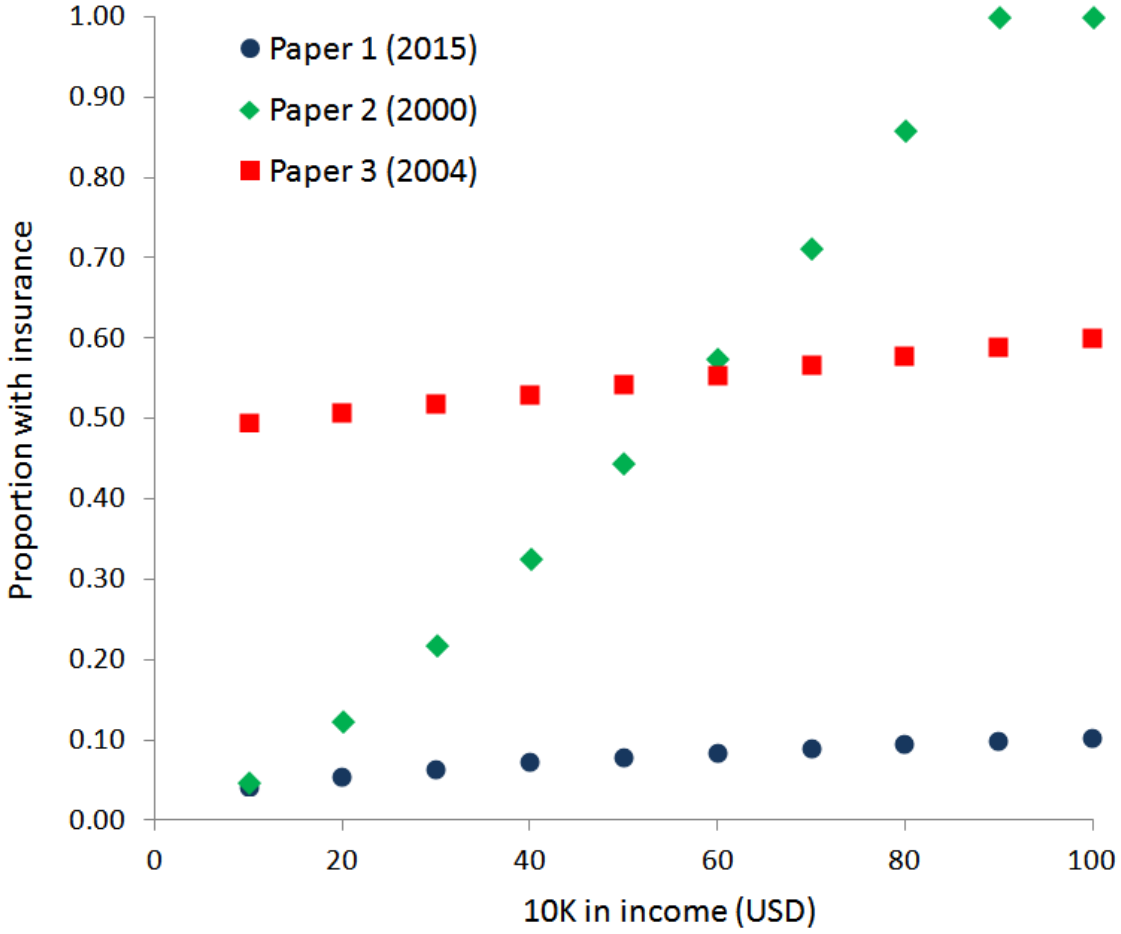
Paper 1 (2015)
Paper 2 (2000)
Paper 3 (2004)
Proportion with insurance
1.00
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
20
40
60
80
100
10K in income (USD)

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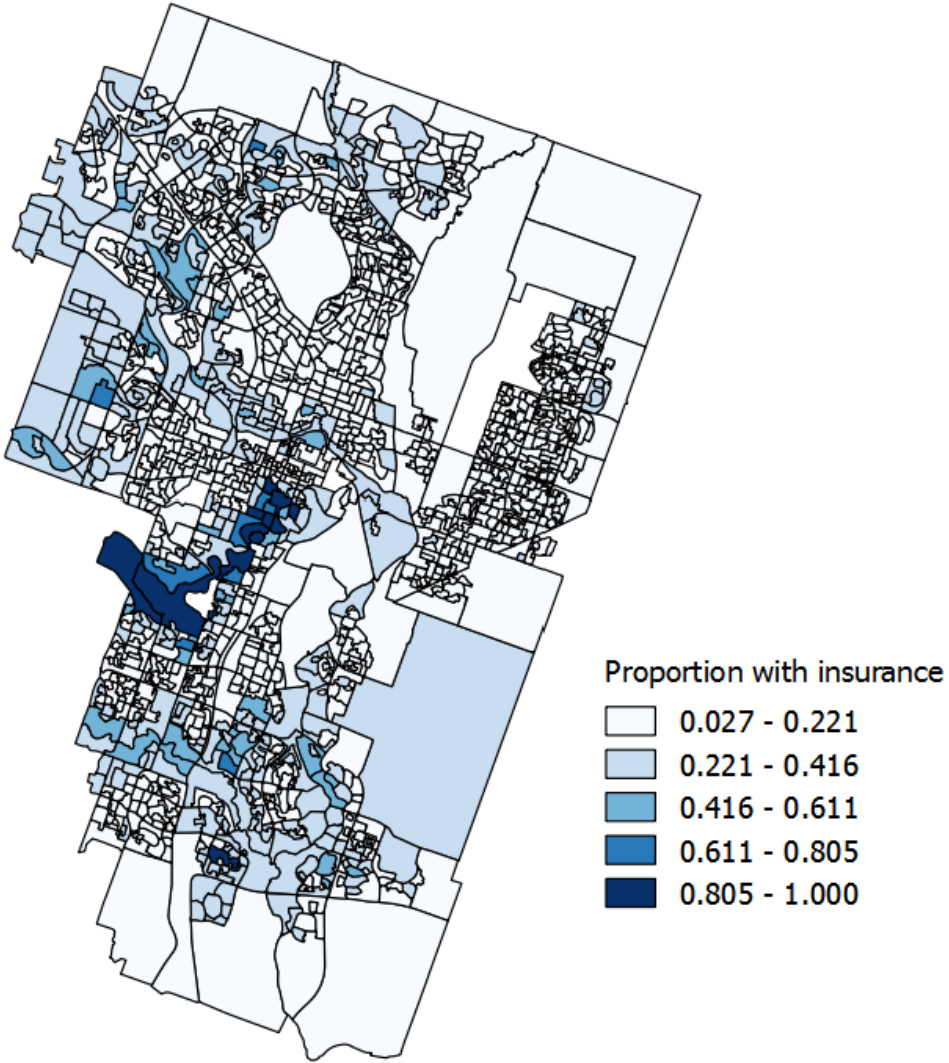

- Flat **$2** per $1000 coverage
- Households insured ~ **77000**
- Total annual revenue from premiums assuming **$25**000 coverage: **$3.9 million**

Hazard Level	Households with insurance (1000s)
5 (severe)	6 (43.5%)
4 (high)	5.5 (37.1%)
3 (medium)	4 (31.4%)
2 (low)	2 (21.8%)
1 (very low)	60 (21.5%)

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- Differentiated premium per $1000 coverage (max $1250/yr)
- Households insured ~ 31000
- Total annual revenue from premiums assuming $25000 coverage: **$38.4 million**

Hazard Level	Households with insurance (1000s)
5 (severe)	2.5 (18.1%)
4 (high)	2 (13.5%)
3 (medium)	1.4 (11.0%)
2 (low)	0.6 (6.5%)
1 (very low)	25 (9.0%)

- Differentiated premium per $1000 coverage (max $5000/yr)
- Households insured ~ 23000
- Total annual revenue from premiums assuming $25000 coverage: **$114 million**

Hazard Level	Households with insurance (1000s)
5 (severe)	1.6 (11.6%)
4 (high)	1.4 (9.4%)
3 (medium)	1 (7.9%)
2 (low)	0.5 (5.4%)
1 (very low)	18 (6.4%)

3. Willingness to buy insurance

- How does WTB insurance vary geographically?
  - **High income areas tend to be at higher risk, and high-income households are more likely to buy insurance**

- Does the geographic variability in WTB present a challenge or opportunity for insurers?
  - Unclear, but based on research from other models it is **possible that very low risk areas could cross-subsidize high risk with inexpensive and bundled premiums**

- Can insurance help reduce household flood risk vulnerability?
  - Current ***real*** pricing is fairly affordable ($50 to $1250/yr depending on insurer, deductible and level of coverage); insurers probably relying on cross-subsidization
  - ***It is possible that insurance premiums and payouts are profitable for industry in the long run but there will still be a need for large disaster relief payouts from government, ceteris paribus***

3. Willingness to buy insurance

- Impact on policy?
  - Insurance system may not indemnify most at risk households for losses, however there are secondary benefits
    - Saves governments *some* money
    - Might reduce moral hazard if premiums are pegged to private risk mitigation
  - Premium subsidies are *probably not* appropriate Calgary
- Next steps
  - Compare to other cities (Winnipeg and Hamilton)
- Find better data on insurance premium price decisions (for insured and noninsured) via administrative data or ***experimental evidence***

Thank you

"I think you misunderstood. The million dollar umbrella policy only covers you for claims involving an umbrella."

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