Linking Natural Hazard Models and Public Policy Making– The Case of Typhoon/Flood Insurance

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Outline

- Background
  - Hazards and Frequencies
  - Impacts on Insurance
- Typhoon-Flood Insurance Policy
  - Model Assessment
  - Policy Design
- Concluding Remarks

1970~2006 Typhoons with High Rainfall

Rank	Year	Typhoon name	Date	Average rainfall (mm)
1	1987	Lynn	10/22 ~ 10/27	1050.4
2	2001	Nari	09/08 ~ 09/19	1032.4
3	2005	Haitang	07/16 ~ 07/20	922.0
4	1996	Herb	07/29 ~ 08/01	887.7
5	1973	Nora	10/07 ~ 10/10	825.5
6	1978	Ora	10/11 ~ 10/14	805.6
7	2004	Mindulle	06/28 ~ 07/03	709.0
8	2000	XangSang	10/30 ~ 11/01	698.5
9	1998	Zeb	10/13 ~ 10/17	665.2
10	2001	Lekima	09/23 ~ 09/28	651.8

Frequency

- On average, **4.8 typhoons** every year
- **3.5 of which caused damages**

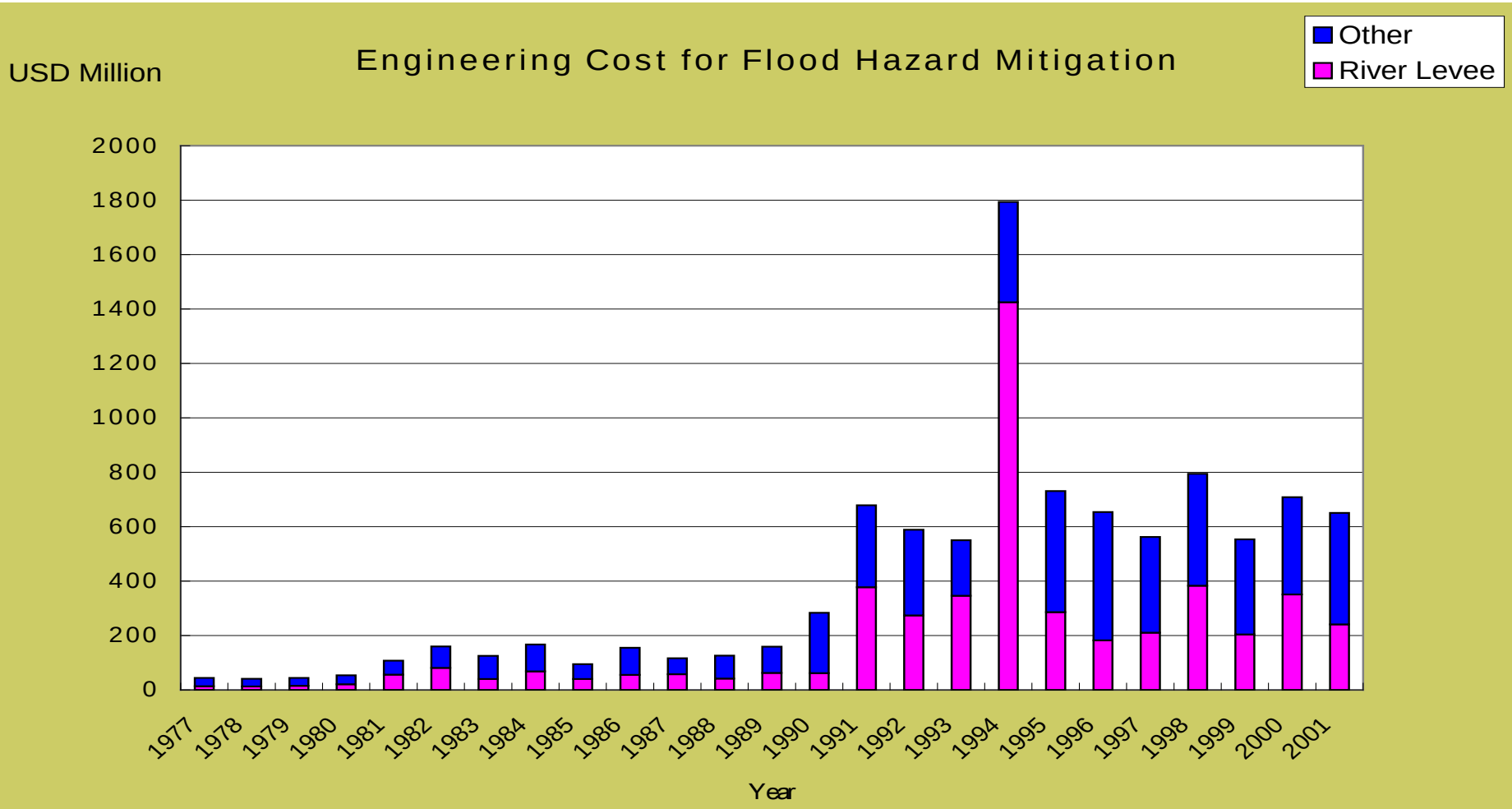
Table 1 Occurrences of Typhoons in Chinese Taipei, 1972 ~ 2004

Period	Total occurrence	Average occurrence
1972 ~ 1976	11	2.2
1977 ~ 1981	13	2.6
1982 ~ 1986	16	3.2
1987 ~ 1991	21	4.2
1992 ~ 1996[1]	21	4.2
1997 ~ 2001	23	4.6
2002 ~ 2004[a]	15	5.0

Source: Ministry of the Interior, National Fire Agency

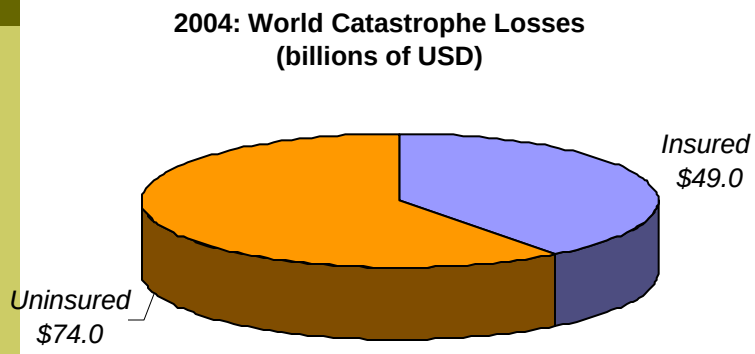
[a] Numbers in this row are 3-year total and average, respectively.

- **Engineering cost increase greatly since 1991, ½ are spent for building river levees**



Source: Teng et al (2006), Natural Hazards 37: 191-207.

Insured versus Un-insured Losses- Global Perspective



Source: Sigma No. 1/2005, Swiss Re

Potential market for private insurers

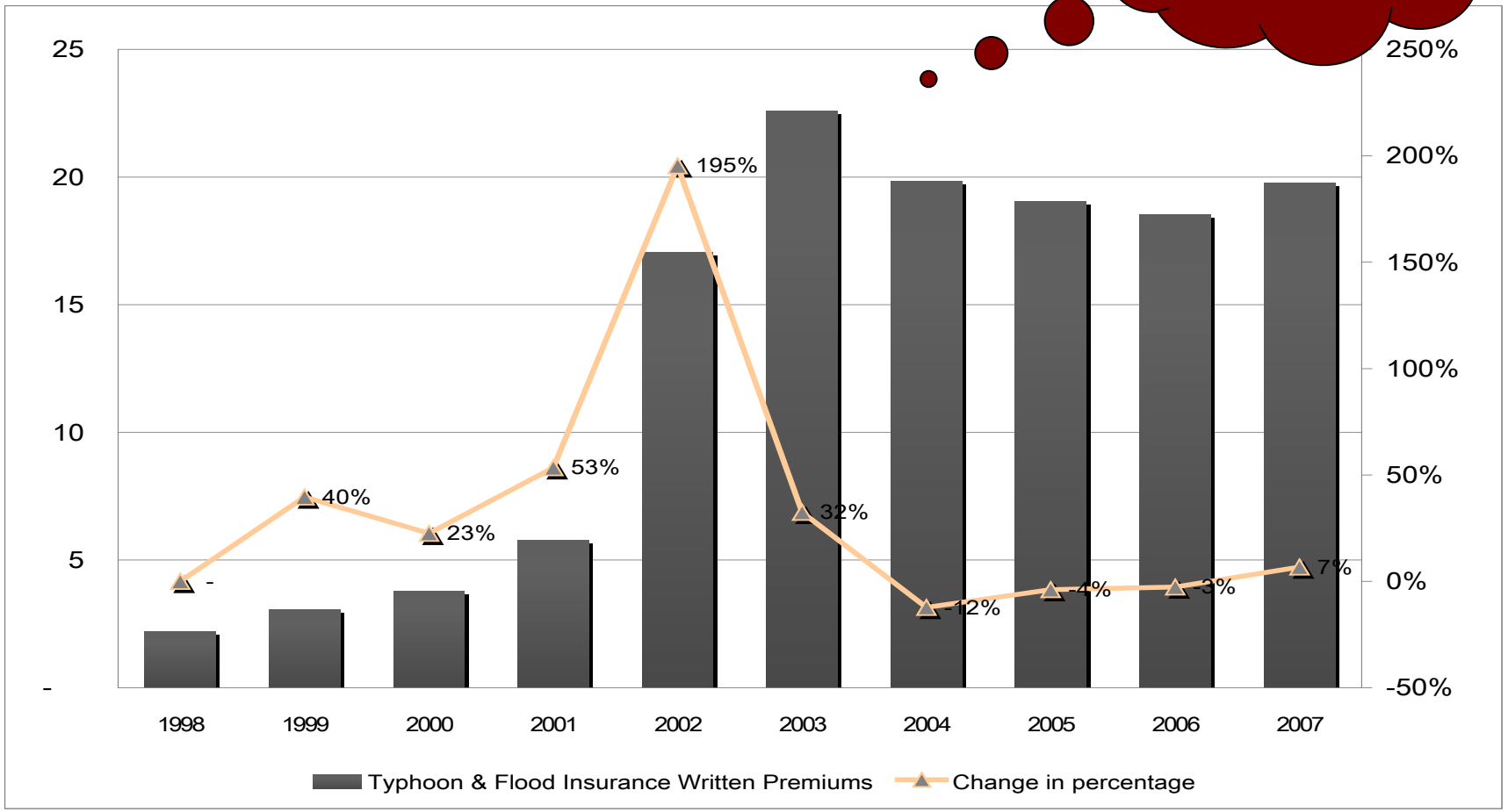
- **In 2004 many of the natural catastrophes happened in developed insurance markets, rendering the ratio of insured/uninsured at 66%.**
- **In 2005, insured losses rise to record levels due to Katrina and Rita**
- **But the above ratio may not change dramatically due to an also dramatic rise of uninsured losses in Pakistan, Guatemala, Indonesia, …, etc.**

Source: **James Vickers, "Public-Private Partnerships in Catastrophe Risk Financing:** A Reinsurance Market Perspective." **Willis Re International, 2005**

Written Premium/Growth, 1998-2007

- Below NT $6 billion dollars before 2001
- Reaches NT $17 billions dollars in 2002,
- Growth rate in 2004-2006 is negative.

Take up rate
Residential: 0.02%
Commercial: 27%



I. Natural Hazard Modeling

Stochastic Events module

Hazard Module

Vulnerability Module

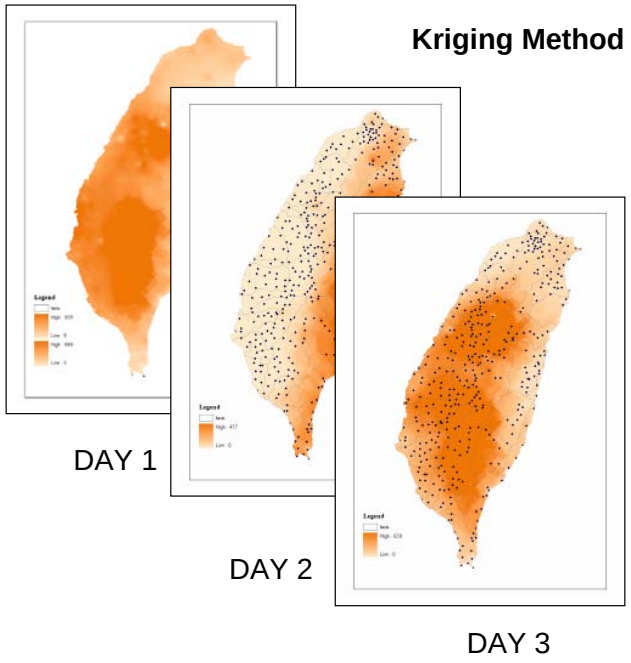
Financial Loss Module

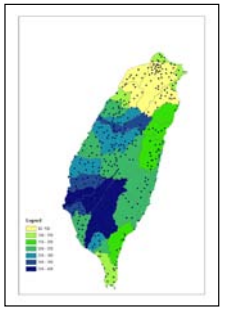
Stochastic Event Module

Event-Based Database

Rainfall data (1961~2006)

224 Typhoons & 98 Rainstorms = 322 Major rainfall events

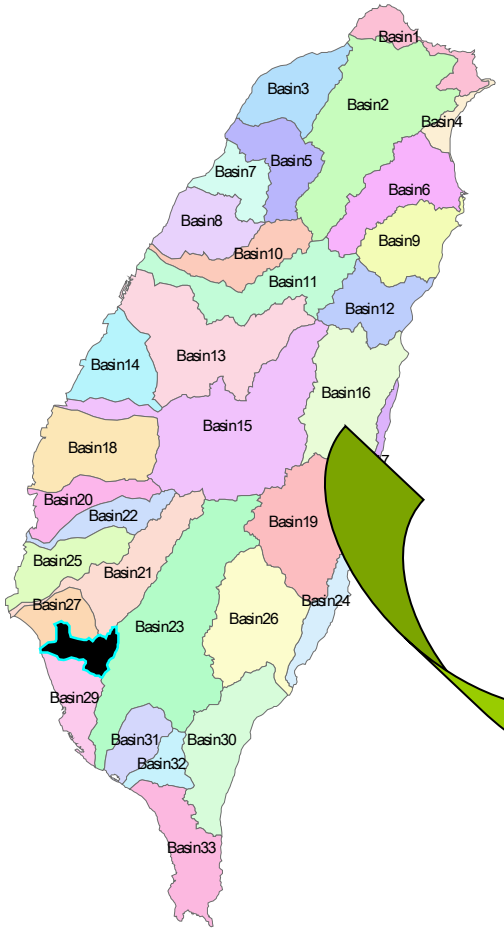




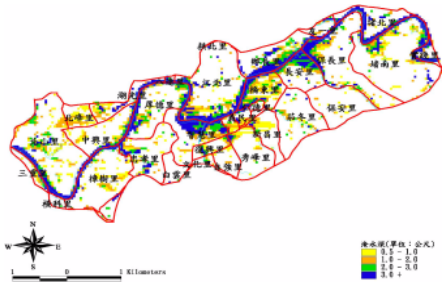
Event Basin Maximum Daily Rainfall table

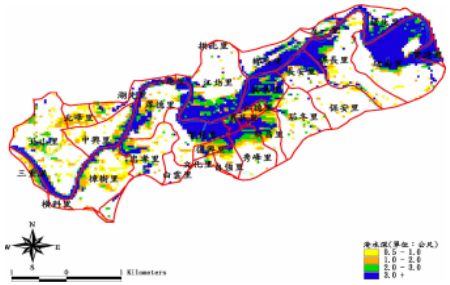
ID	Rate	Basin 1 (mm)	....	Basin 33 (mm)
1	0.01	145	...	678
2	0.02	245	...	54
...	....	....	...	...
322	0.03	33	.....	232

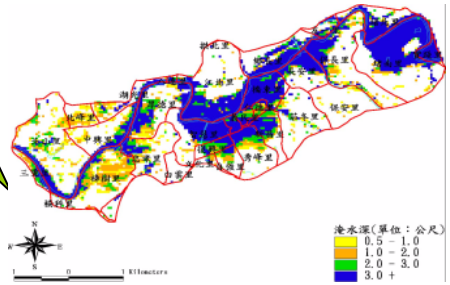
Hazard Module

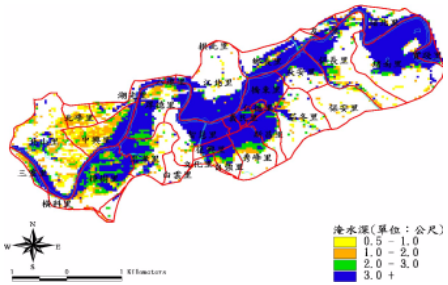


- **Flood Hazard Maps**
  - 33 River Basins
  - 4 Rainfall levels



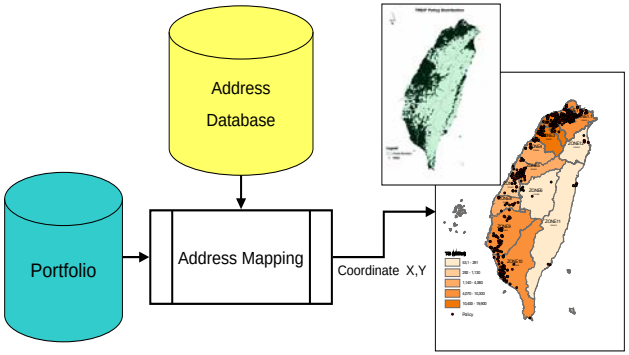




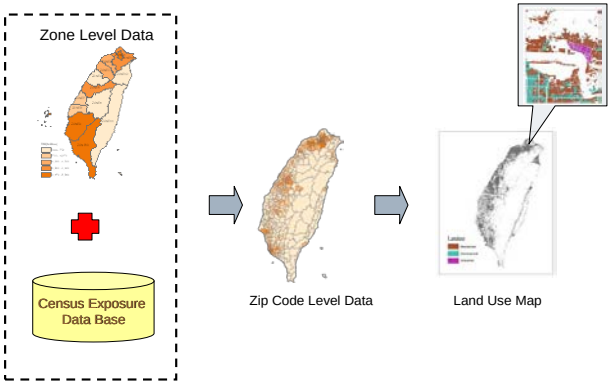


Vulnerability Module

1. Geo-coding Technique

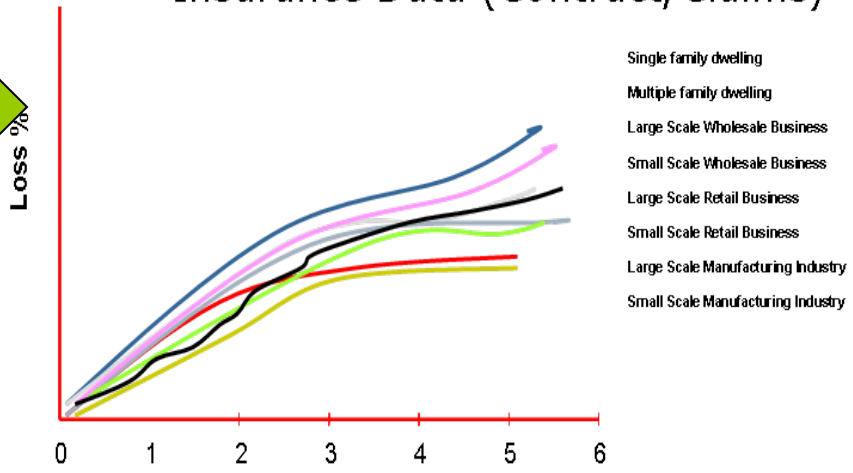


2. Re-distribution of Exposure



3.Vulberbility curve

- **Data Collection**
  - Residential/Industrial Loss Survey
  - Insurance Data (Contract/Claims)



Financial Loss Module

ID	Annual Mean Rate λ_i	Loss$ L_i	CV
#0001	0.010	0.65 Billion	2.00
#0002	0.002	....	....
#0003	....	....	....
....	....	....	....
....	....	....	....

How severe?

Severity Distribution (Loss distribution)

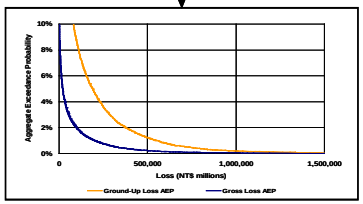
$\lambda = \sum_i \lambda_i$

Poisson Model

Aggregate & Occurrence loss Simulation (Monte Carlo Simulation)

How many times?

(Monte Carlo Simulation)

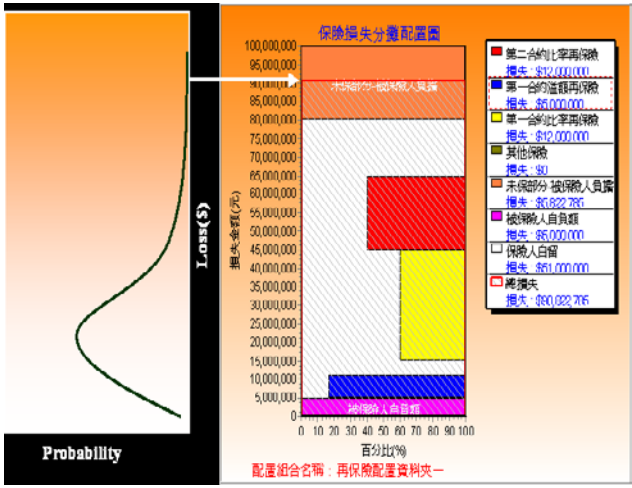


Exceedance probability curve

-- Design insurance contract

-- allocate losses to stakeholders

-- Premium calculation



II. Policy Design

- Policy Options
- Calculate Average Annual Loss (AAL)
- Financing and Claim Layers

Policy Options

- Structural
- Nonstructural
  - Land Use Planning
  - Building Code
  - Disaster Relief
  - **Insurance Program**

Insurance Program

- **Options**
  - **Mandatory purchase**
    - follows US National Flood Insurance Program (NFIP)
  - **Semi-mandatory w/ endorsement to fire policy**
  - **Voluntary with mandatory offer**
    - follows the Florida Hurricane Catastrophe Fund.

Simulated AAL and Pure Premium

ID	Scenarios	AAL (million)	First-floor Building		Fire policy homeowners	
			No of building (million)	Pure premium (NT$)	No of building (million)	Pure premium (NT$)
S1	~ 30cm: no payment, 30cm~: NT$200,000	21,900	3.33	6,577	3.42	6,404
S2	~ 30cm: no payment, 30cm~: NT$150,000	16,500	3.33	4,955	3.42	4,825
S3	~ 30cm: no payment, 30cm~: NT$100,000	10,950	3.33	3,288	3.42	3,202
S4	~ 30cm: no payment, 30cm~100cm:NT$100,000 100 ~ 200cm:NT$150,000 200cm~: NT$200,000	12,300	3.33	3,694	3.42	3,596
S5	~ 50cm: no payment, 50cm~: NT$200,000	12,600	3.33	3,784	3.42	3,684
S6	~ 50cm: no payment, 50cm~: NT$150,000	9,450	3.33	2,838	3.42	2,763
S7	~ 50cm: no payment, 50cm~: NT$100,000	6,300	3.33	1,892	3.42	1,842
S8	~ 50cm: no payment, 50cm~100cm:NT$100,000 100 ~ 200cm:NT$150,000 200cm~: NT$200,000	7,800	3.33	2,342	3.42	2,281
S9	~ 50cm: no payment, 50cm~100cm:NT$50,000 100 ~ 200cm:NT$100,000 200cm~: NT$150,000	4,650	3.33	1,396	3.42	1,360
S10	S5 +only 20-year return period residents participate	12,000	0.37	32,432	0.185	32,432
S11	S8 Only 20-year return period residents will participate	7,200	0.37	19,459	0.185	19,459

Financing and Claim Layers

- Calculate premiums under different assumptions on take-up rate.
- Government's bottom-layer coverage are assumed:
  - They can be viewed as premium subsidy.
- The subsidized premium ranges from **NT$ 140** up to **NT$9,613,** depending on the coverage and take-up rate.

Premiums under four selected scenarios with alternative participation (take-up) rates

Scenario	S3			S7			S9			S11		
Take-Up Rate	25%	50%	100%	25%	50%	100%	25%	50%	100%	10%	50%	100%
Content Cover (3.3 Mill. First Floor Households)										**(0.37 Mill. First Floor Households)**		
Estimated Policy#	825,000	1,650,000	3,300,000	825,000	1,650,000	3,300,000	825,000	1,650,000	3,300,000	37,000	185,000	370,000
AAL (NT$ Mill.)	2,738	5,475	10,950	1,575	3,150	6,300	1,163	2,325	4,650	2,160	4,320	4,320
Pure Premium w/o bottom GOV Cover	$3,318	$3,318	$3,318	$1,909	$1,909	$1,909	$1,409	$1,409	$1,409	$58,378	$23,351	$11,676
Living Expense & Electrical & Mechanical Equipment Loss Cover-Limit of NT$ 20,000 (4.3 Mill. 2nd Floor above Households)										**(0.75 Mill. Households)**		
Estimated Policy#	1,075,000	2,150,000	4,300,000	1,075,000	2,150,000	4,300,000	1,075,000	2,150,000	4,300,000	75,000	375,000	750,000
AAL (NT$ Mill.)	324	648	1,296	324	648	1,296	324	648	1,296	605	1,210	1,210
Additional Premium to Include Living expense & Electrical & Mechanical Equipment Loss Cover w/ Limit of NT$20,000	$301	$301	$301	$301	$301	$301	$301	$301	$301	$8,067	$3,227	$1,613
Constructed Total Loss Cover-NT$120 Mill. (7.6 Mill. Households)										**(1.12 Mill. Households)**		
Estimated Policy#	1,900,000	3,800,000	7,600,000	1,900,000	3,800,000	7,600,000	1,900,000	3,800,000	7,600,000	112,000	560,000	1,120,000
AAL (NT$ Mill.)	59	117	234	59	117	234	59	117	234	12	59	117
Additional Premium to Include Constructed Total Loss Cover of NT$120 Mill.	$31	$31	$31	$31	$31	$31	$31	$31	$31	$104	$104	$104
Premium w/o Bottom GOV Cover												
Pure Premium w/o bottom GOV Cover - First-Floor Household	$3,349	$3,349	$3,349	$1,940	$1,940	$1,940	$1,440	$1,440	$1,440	$58,483	$23,456	$11,780
Premium w/ additional cost (15%)	**$3,940**	**$3,940**	**$3,940**	**$2,282**	**$2,282**	**$2,282**	**$1,694**	**$1,694**	**$1,694**	**$68,803**	**$27,595**	**$13,859**
Pure Premium w/o bottom GOV Cover - Other Household	$332	$332	$332	$332	$332	$332	$332	$332	$332	$8,171	$3,331	$1,718
Premium w/ additional cost (15%)	**$391**	**$391**	**$391**	**$391**	**$391**	**$391**	**$391**	**$391**	**$391**	**$9,613**	**$3,919**	**$2,021**
Premium w/ Bottom 1 Billion GOV Cover												
AAL ratio of Bottom 1 bn Layer	30.26%	16.25%	8.49%	44.31%	25.33%	13.35%	48.84%	29.94%	16.65%	40.01%	22.27%	22.27%
Pure Premium w/ bottom GOV Cover of 1 billion - First-Floor Household	$2,336	$2,805	$3,065	$1,080	$1,449	$1,681	$737	$1,009	$1,200	$35,084	$18,232	$9,157
Premium w/ additional cost (15%)	**$2,748**	**$3,300**	**$3,606**	**$1,271**	**$1,704**	**$1,978**	**$867**	**$1,187**	**$1,412**	**$41,275**	**$21,450**	**$10,773**
Pure Premium w/ bottom GOV Cover of NT$1 billion - Other Household	$232	$278	$304	$185	$248	$288	$170	$233	$277	$4,902	$2,589	$1,335
Premium w/ additional cost (15%)	**$273**	**$327**	**$358**	**$218**	**$292**	**$339**	**$200**	**$274**	**$326**	**$5,767**	**$3,046**	**$1,571**
Premium w/ Bottom 1.5 Billion GOV Cover												
AAL ratio of Bottom 1.5 bn Layer	41.85%	23.70%	12.65%	58.19%	35.84%	19.68%	62.04%	40.91%	23.97%	53.08%	31.79%	31.79%
Pure Premium w/ bottom GOV Cover of 1.5 billion of First-Floor Household	$1,947	$2,555	$2,925	$811	$1,245	$1,558	$547	$851	$1,095	$27,440	$15,999	$8,035
Premium w/ additional cost (15%)	**$2,291**	**$3,006**	**$3,442**	**$954**	**$1,464**	**$1,833**	**$643**	**$1,001**	**$1,288**	**$32,283**	**$18,823**	**$9,453**
Pure Premium w/ bottom GOV Cover of NT$1.5 billion - Other Household	$193	$253	$290	$139	$213	$267	$126	$196	$253	$3,834	$2,272	$1,172
Premium w/ additional cost (15%)	**$227**	**$298**	**$341**	**$163**	**$251**	**$314**	**$148**	**$231**	**$297**	**$4,510**	**$2,673**	**$1,378**
Premium w/ Bottom 2 Billion GOV Cover												
AAL ratio of Bottom 2 bn Layer	50.87%	30.41%	16.69%	67.07%	44.36%	25.53%	69.51%	48.94%	30.28%	62.70%	40.01%	40.01%
Pure Premium w/ bottom GOV Cover of 2 billion of First-Floor Household	$1,645	$2,331	$2,790	$639	$1,079	$1,445	$439	$735	$1,004	$21,814	$14,071	$7,067
Premium w/ additional cost (15%)	**$1,936**	**$2,742**	**$3,282**	**$751**	**$1,270**	**$1,699**	**$516**	**$865**	**$1,181**	**$25,664**	**$16,554**	**$8,314**
Pure Premium w/ bottom GOV Cover of NT$2 billion - Other Household	$163	$231	$277	$109	$185	$247	$101	$170	$232	$3,048	$1,998	$1,031
Premium w/ additional cost (15%)	**$192**	**$272**	**$326**	**$129**	**$217**	**$291**	**$119**	**$200**	**$272**	**$3,586**	**$2,351**	**$1,212**
Premium w/ Bottom 3 Billion GOV Cover												
AAL ratio of Bottom 3 bn Layer	64.23%	41.91%	24.31%	79.02%	57.69%	35.97%	79.97%	61.24%	40.99%	75.40%	53.08%	53.08%
Pure Premium w/ bottom GOV Cover of 3 billion of First-Floor Household	$1,198	$1,945	$2,535	$407	$821	$1,242	$288	$558	$850	$14,387	$11,005	$5,527
Premium w/ additional cost (15%)	**$1,409**	**$2,289**	**$2,982**	**$479**	**$966**	**$1,461**	**$339**	**$657**	**$1,000**	**$16,926**	**$12,948**	**$6,503**
Pure Premium w/ bottom GOV Cover of NT$3 billion - Other Household	$119	$193	$251	$70	$141	$213	$67	$129	$196	$2,010	$1,563	$806
Premium w/ additional cost (15%)	**$140**	**$227**	**$296**	**$82**	**$165**	**$250**	**$78**	**$151**	**$231**	**$2,365**	**$1,839**	**$948**

Research Team

- **Interdisciplinary Effort**
- **Multiple Agencies Involved**
  - **Domestic**
    - Insurance Bureau (*Financial Supervisory Commission)*
    - Ching-Cheng Chang *(Academia Sinica)*
    - Mong-Ming Lu *(Central Weather Bureau)*
    - Ming-Daw Su *(National Taiwan University)*
    - Wei-Ling Chiang *(National Central University)*
    - Wen-Ko Hsu *(National Central University)*
  - **Foreign**
    - Guy Carpenter, Marsh (*New York*)
    - Catastrophic Modeling Team of RMS (*California*)

Major Findings

- **Significant portion of flood losses uninsured**
- **Government involvement is needed to increase the amount of flood insurance in force**
- **Future Work Needed on Modeling**
  - Predictions and detection of large- scale natural disasters
  - Integrate climate/hydrology/socio-econ database
  - Improve flood hazard maps
  - Collect risk mitigation/ flood exposure data
  - Upgrade/calibrate risk assessment model
  - Design of multi-peril assessment model

Lesson Learned from Katrina on Insuring catastrophic losses

- Hiroaki Tsubokawa (2006) "Insurance issues in catastrophic disasters in Japan: Lessons from the 2005 Hurricane Katrina Disaster" in *A better integrated management of disaster risks: Toward resilient society to emerging disaster risks in mega-cities*, eds. by S. Ikeda, T. Fukuzono, and T. Sato, pp. 193–198.
  - Problems of public insurance program
    - insurance coverage/benefit is limited
    - does not cover incidental costs
    - need for flexible and efficient claim settlement
    - risk evaluation/communication for low-frequent event
    - dangerous for underwriting to reply modeling alone
  - Dilemma
    - Flood insurance is available but expensive
    - Inequalities in society exist
      - Low income residents who are unable to afford high insurance premiums live in high-risk areas
      - Poor people cannot obtain insurance benefits, resulting further delay to reconstruction

THANK YOU

Comment Welcome