Catastrophe Risk Assessment and Management

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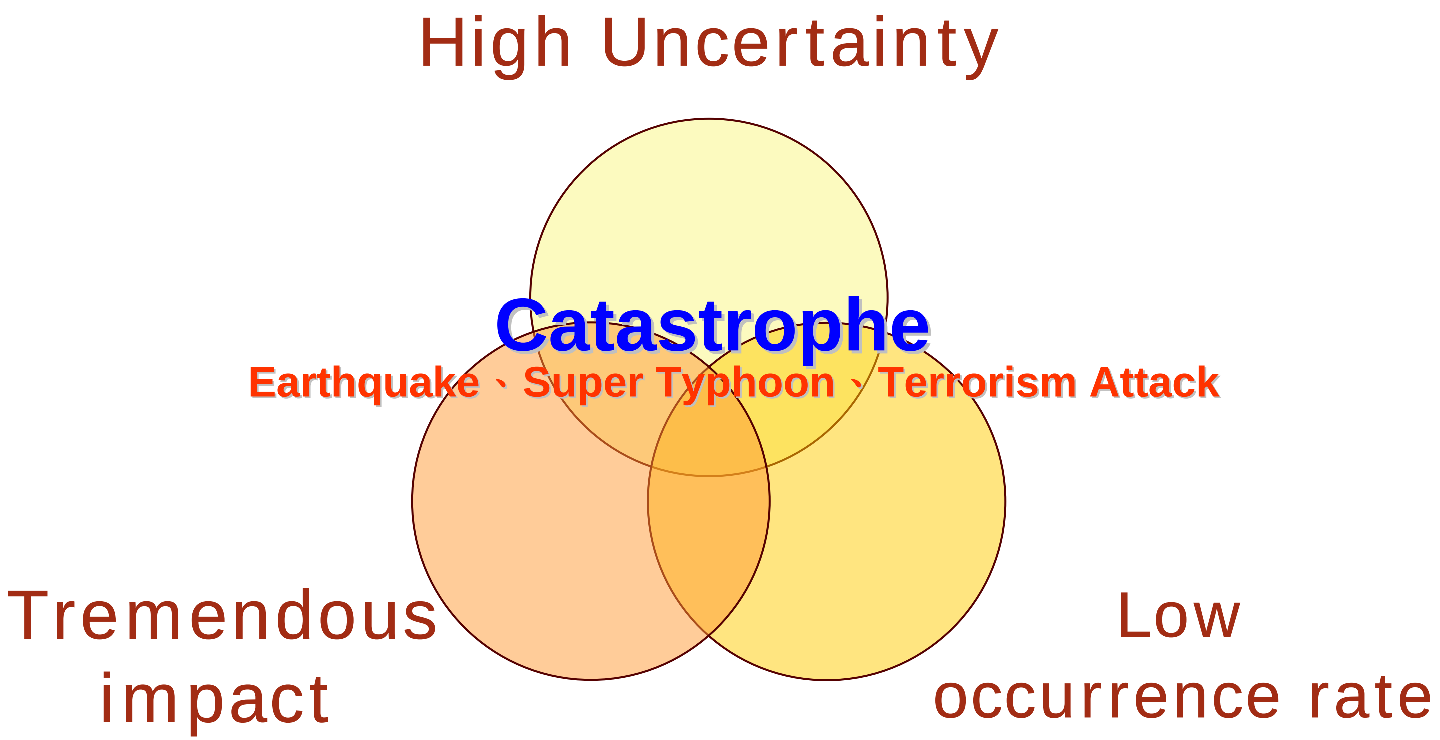
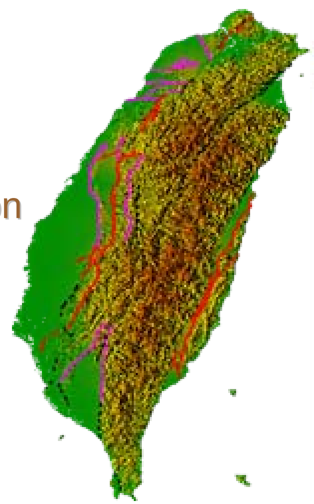
Characteristics of Catastrophe Event



History loss data is not enough !!. → Application of Engineering Model

Risk = Hazard * Vulnerability * Exposure

Risk Information



Hazard

RISK

Vulnerability

Exposure

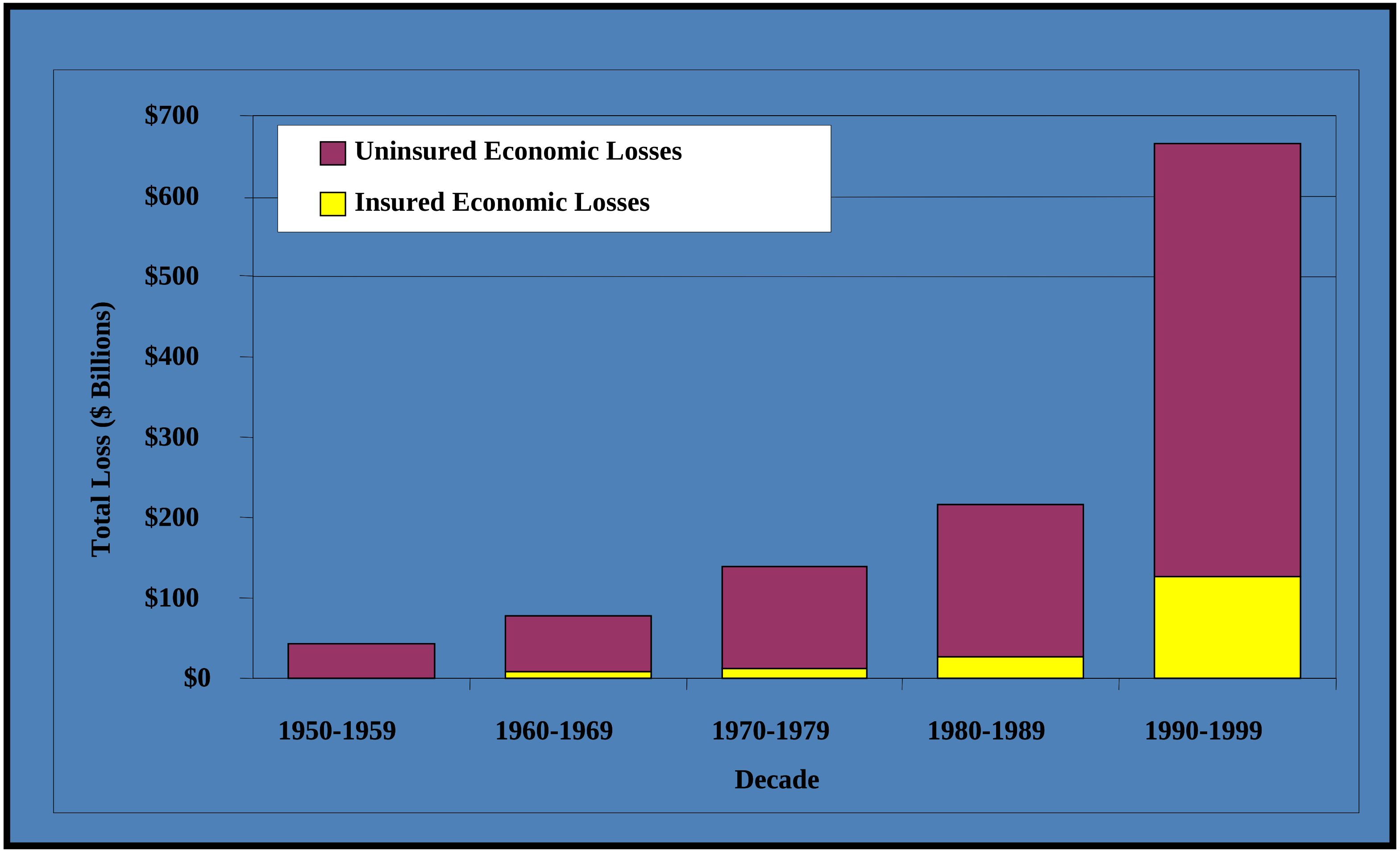
Risk Management

Retention

Mitigation

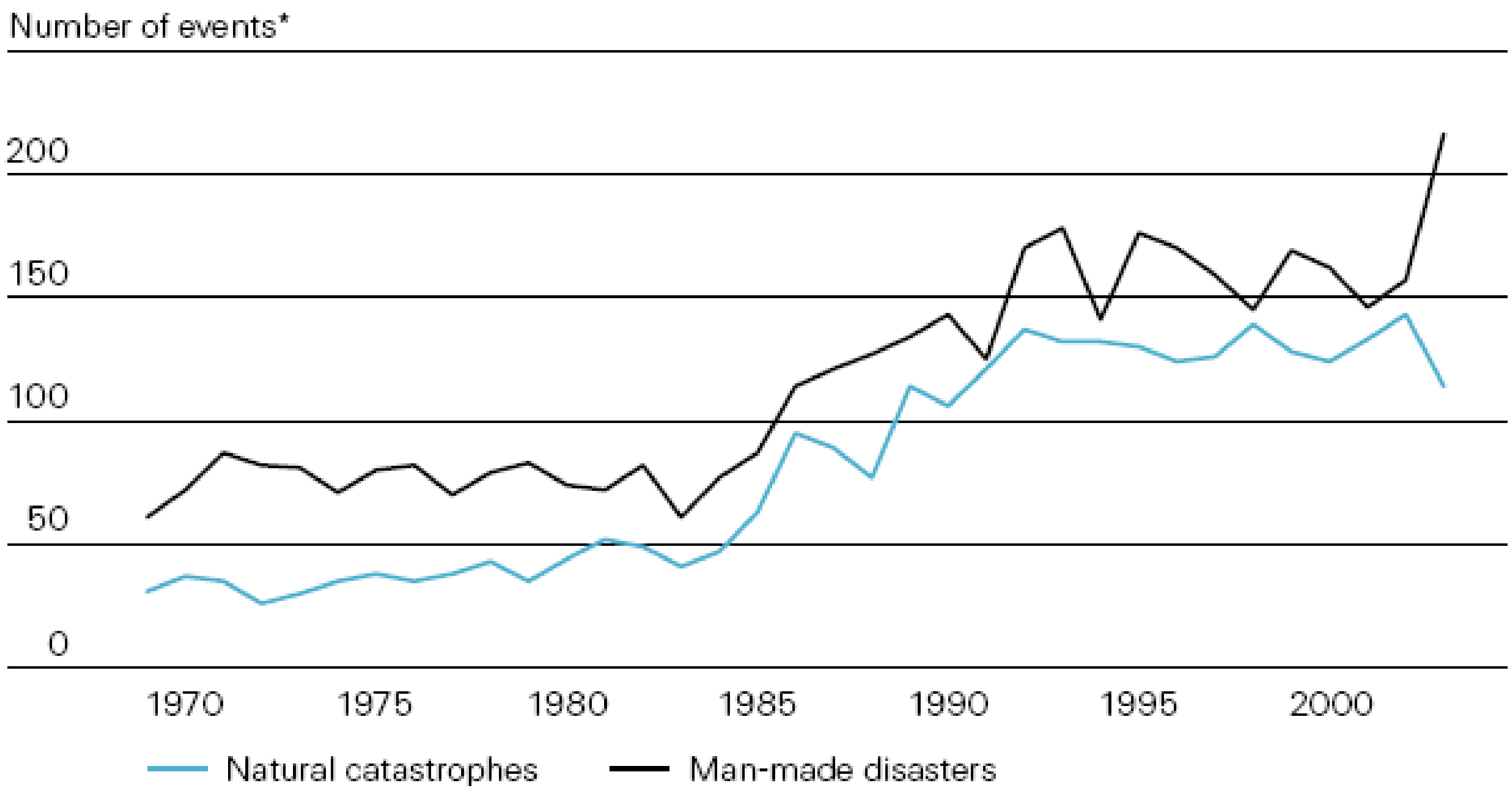
Transfer

Background-Loss of global natural catastrophe incident (10 Year)



Source: Munich Re (2002)
Topics: Natural Catastrophes 2002

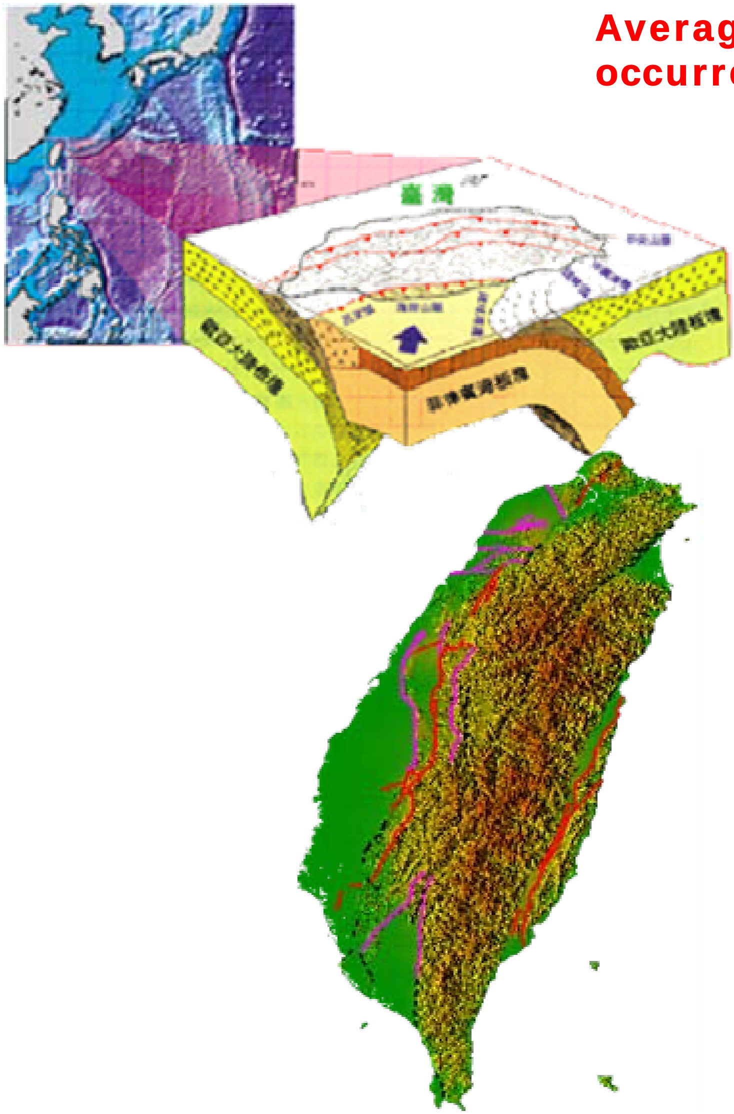
Number of events 1970 - 2004

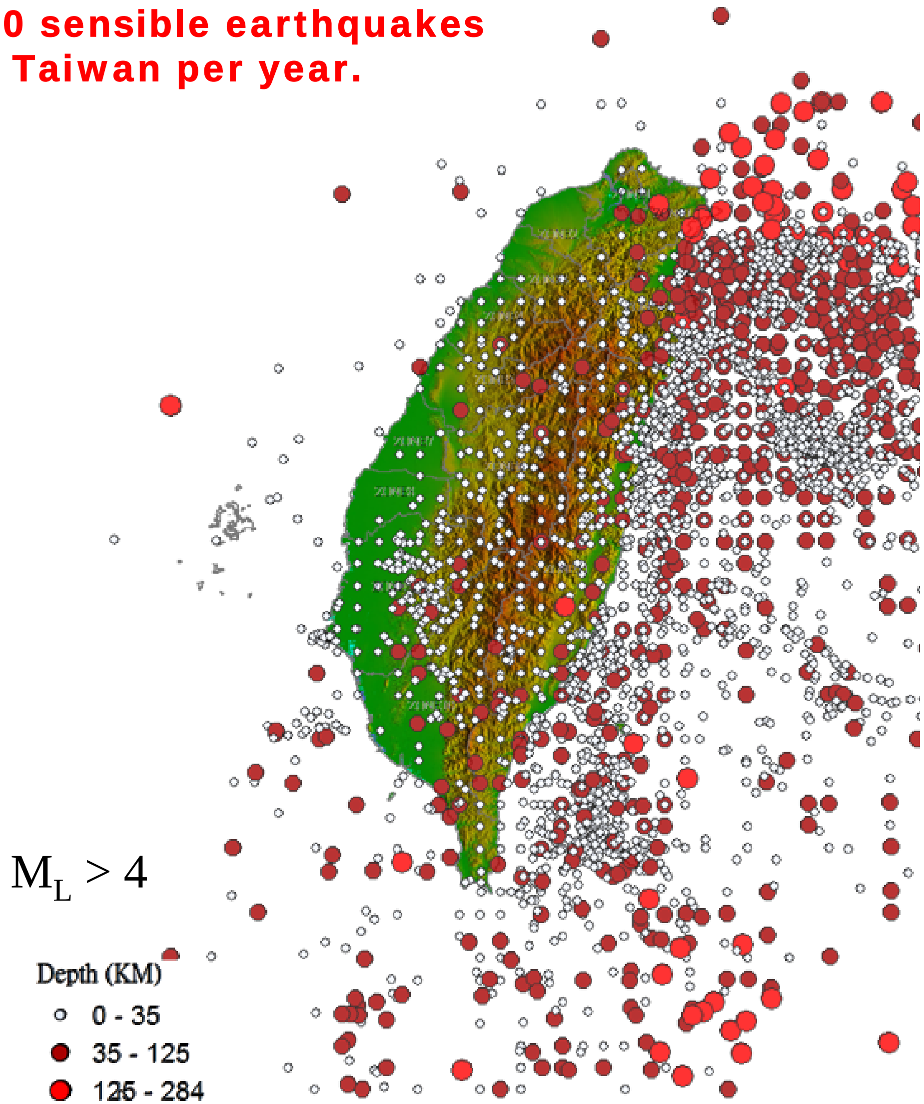


Source: Swiss Re Sigma Report (2005)

Background

Average 200 sensible earthquakes occurred in Taiwan per year.

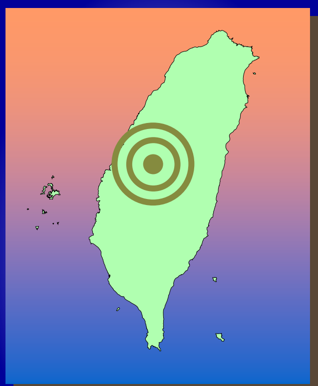




Background

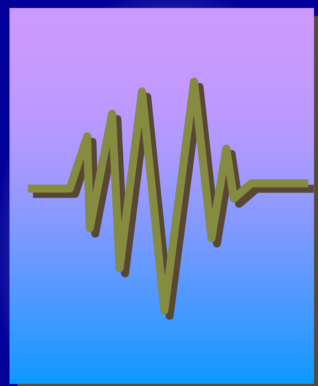
- **Chi-Chi Earthquake struck Taiwan and caused severe damage**
  - **September 21, 1999**
  - **More than 13,000 injuries**
  - **Destruction of more than 50,000 buildings**
  - **US$ 11.5 billion economic loss**

Earthquake Loss Model Framework



Define Earthquake

Stochastic Event



Assess Ground Shaking

Hazard Analysis

Calculate Damage

Vulnerability Analysis

Quantify Financial Loss

Financial Analysis

Build Event Loss Table

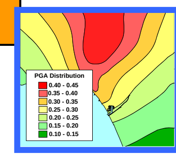
Portfolio

Structural, Content, and BI Losses Considered

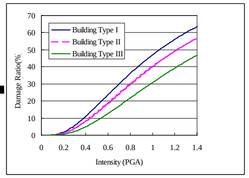
Stochastic Event generator → Event Table

Hazard Analysis procedure ← Magnitude & Hypocenter

Vulnerability Analysis procedure



Intensity



Policy conditions
Deductible, Limit

17,710 hypothetical earthquake events

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

Build Exceeding Probability Curve

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)

$$\lambda = \sum_i \lambda_i$$

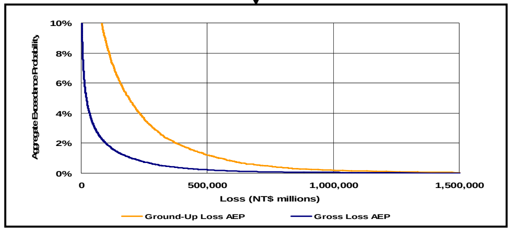
Poisson Model

How many times?

(Monte Carlo Simulation)

Aggregate & Occurrence loss Simulation

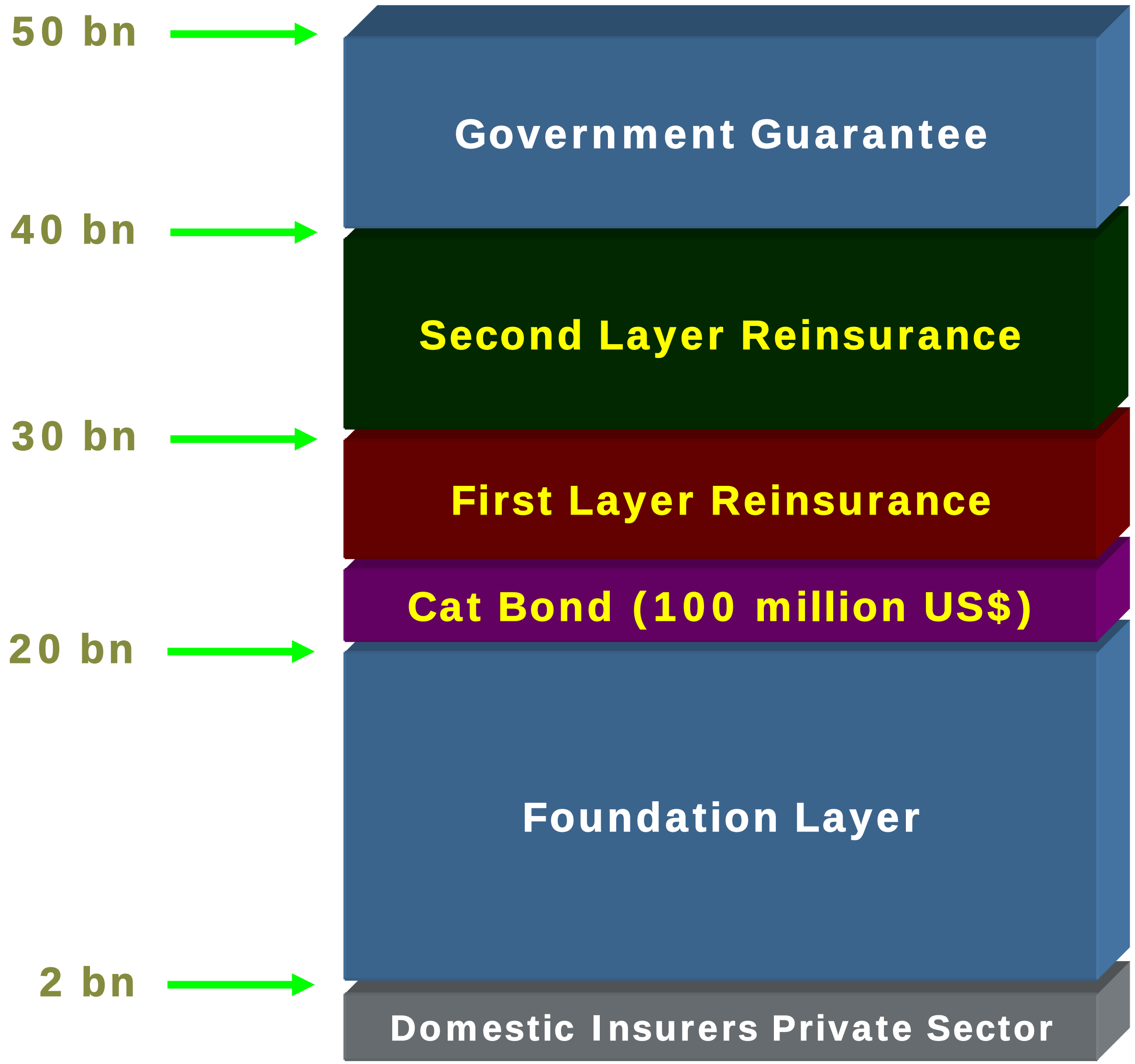
(Monte Carlo Simulation)



Taiwan Residential Earthquake Insurance Pool - TREIP

- **Became effective starting April 1, 2002**
  - EQECAT provides the analysis
- **Standard policy terms**
  - Fixed premium NT$ 1,459 proportion to the policy limit
  - The contract limit for direct physical damage is fixed as pre-agreed replacement cost subject to a maximum of NT$ 1.2 million.
  - Policies also cover additional NT$ 180,000 for contingent living expense.
  - The maximum available under TREIP is NT$ 50 billion per event. If loss exceed this amount, policyholder will receive pro rata payments.
  - Binary payout; if a constructive total loss occurs, the policyholder is entitled to a payout of the entire policy limit.

Risk Sharing Structure of TREIP (NT$)



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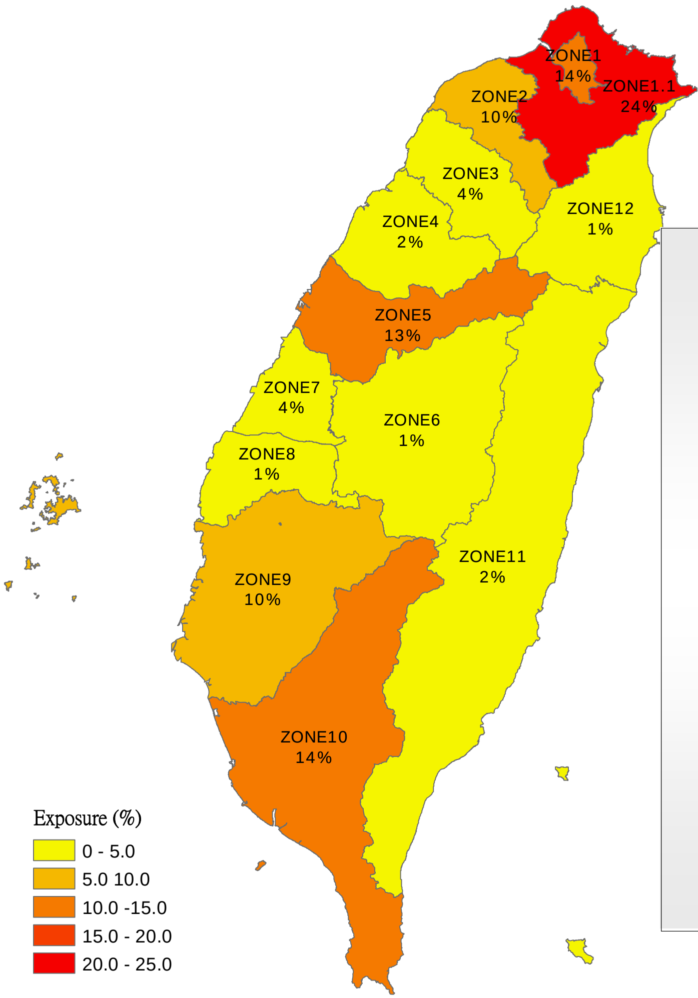
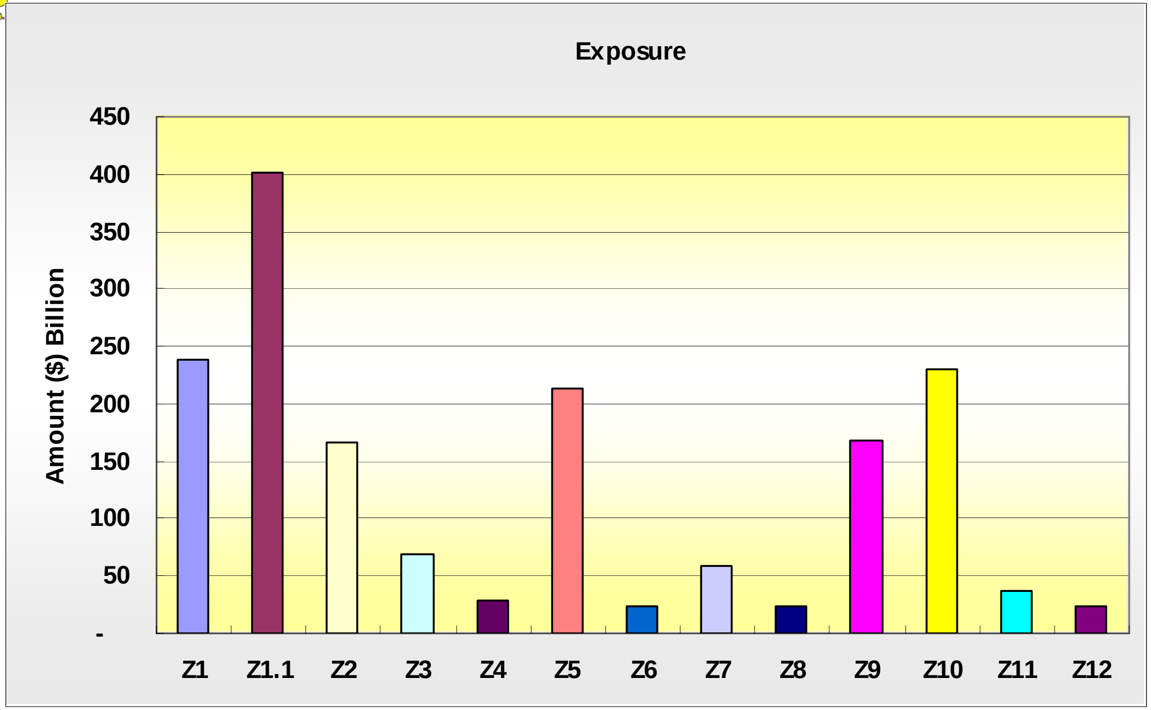
Data Collection of TREIP

- **Residential earthquake insurance was taken effect since April 1 , 2002.**
  - The effective insurance policies were 1,244,803. until June 30, 2005
  - Liabilities accumulates was 1.6 trillions.
  - The take-up rate is 17.6%
- **TREIP data collection was quite intact, include:**
  - Policy ID
  - Zip Code
  - Building Type
  - Number of stories
  - Year Built
  - Insured amount

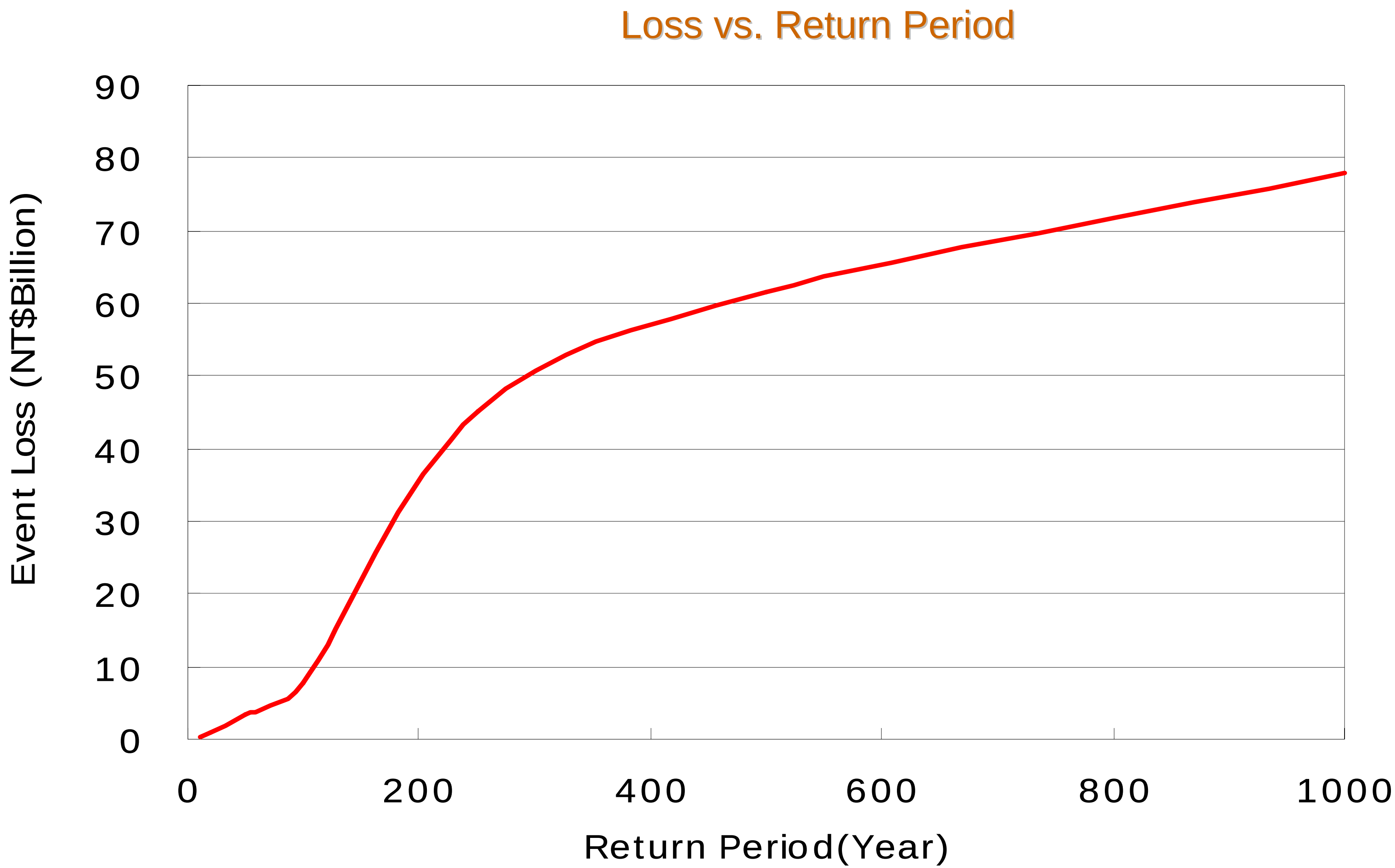
Exposure of TREIP

Policies Distribution

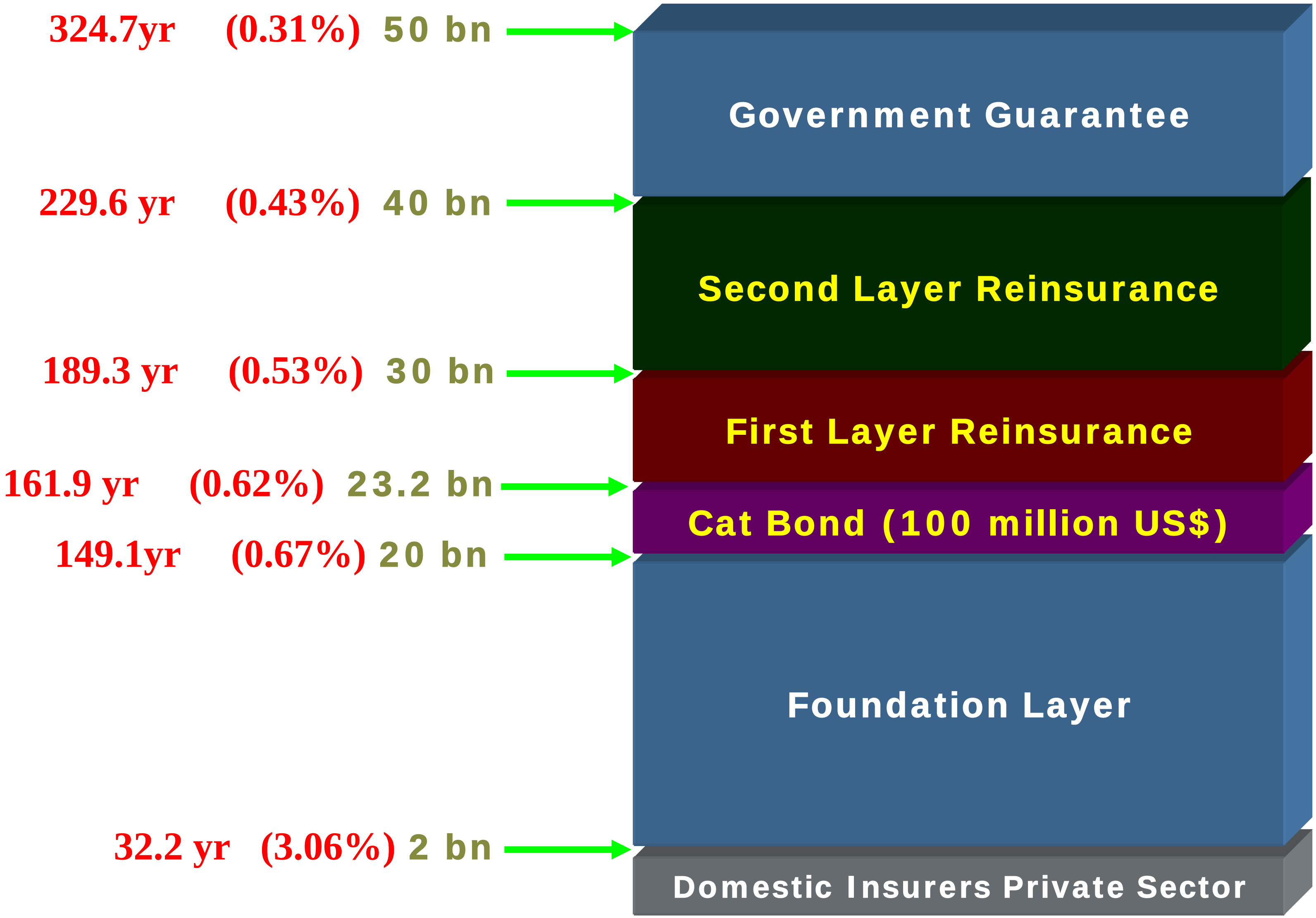




Exceeding Probability Curve of Loss



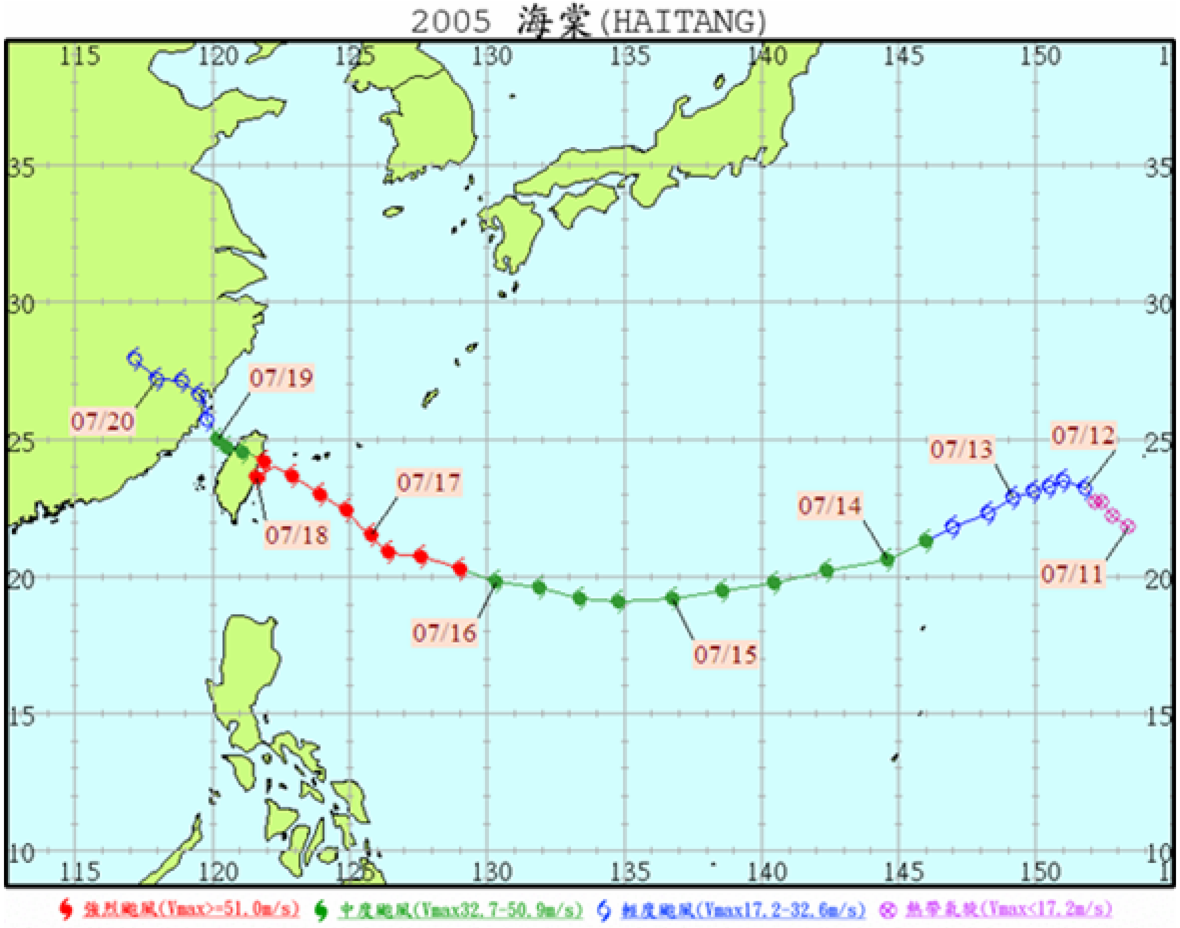
Exceeding Probabilities of Risk Sharing Structure



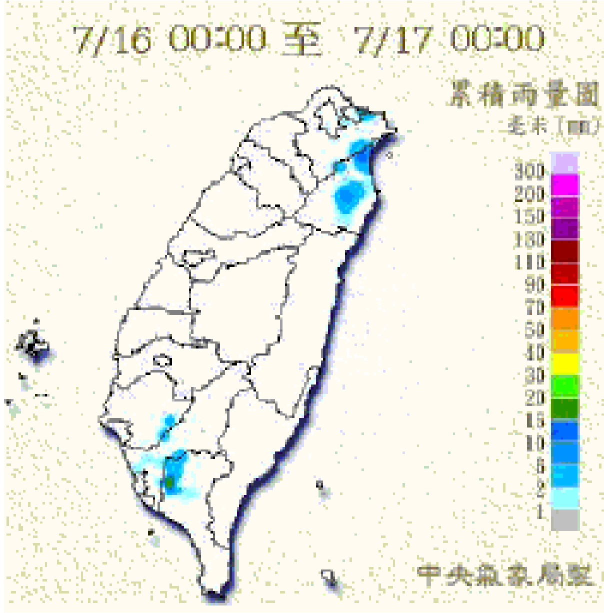
Background - Typhoon definition

Taiwan		Hong Kong		Saffir-Simpson Scale (US)	
Type	Winds (Near center)	Type	Winds (Near center)	Type	Winds (Near center)
Slight Typhoon	62~117 km/hr	Tropical Depression	63 km/hr	Category 1	118-152 km/hr
Moderate Typhoon	117~183 km/hr	Tropical Storm	63-87 km/hr	Category 2	153-176 km/hr
Violent Typhoon	183 km/hr above	Violent Tropical Storm	88-117 km/hr	Category 3	177-207 km/hr
		Typhoon	117 km/hr above	Category 4	208-248 km/hr
				Category 5	249 km/hr above

Characteristics of HAITANG Typhoon

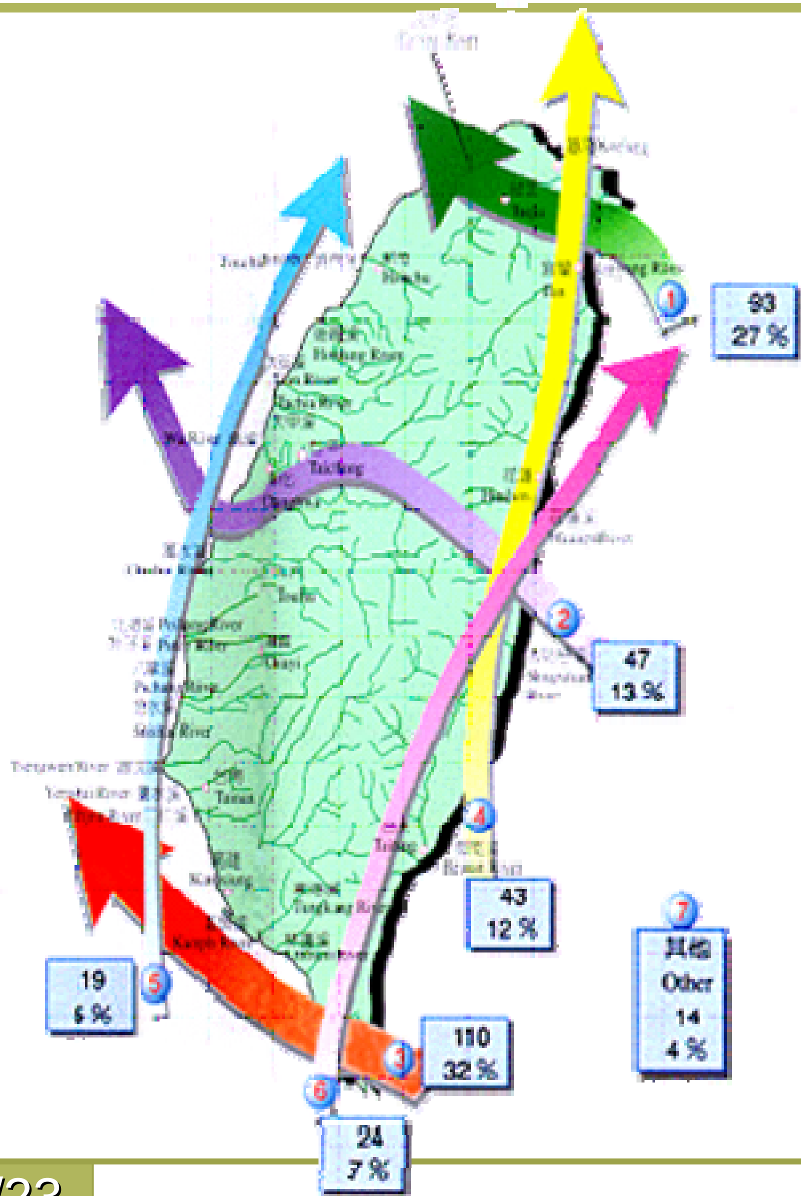


Max Winds (m/s)	53
Max Winds (mph)	119.25
TYPE (TW)	Violent Typhoon
TYPE (US)	Category 3



Data from Central Weather Bureau

Statistics of Typhoon track



Track 1 : 27%

Track 2 : 13%

Track 3 : 32%

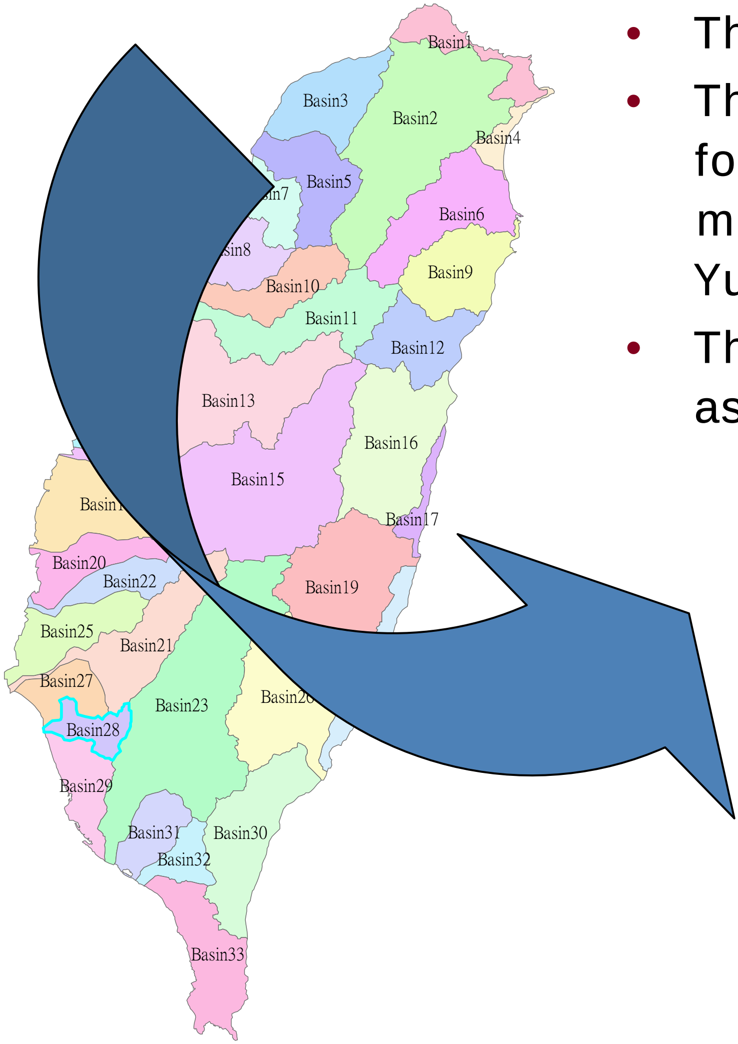
Track 4 : 12%

Track 5 : 6%

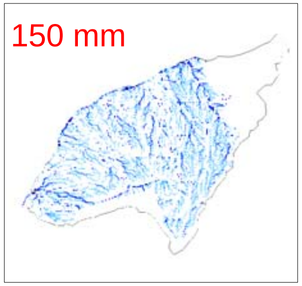
Track 6 : 7%

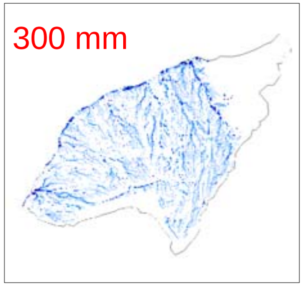
Track 7 : 4%

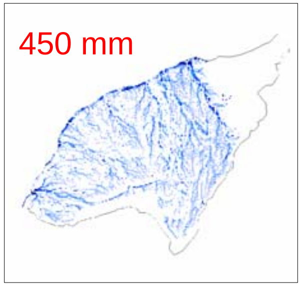
Flood map-Data from the National Science Council

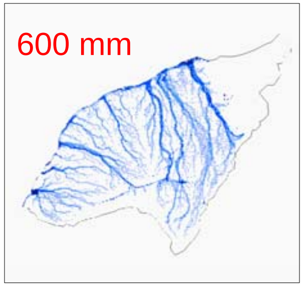


- There are 33 basins in Taiwan.
- The greater part of inundation potential map for each basin are established in 200 × 200 meter resolution. Only Taipei and part of Tao-Yuan areas are 40 × 40 meter resolution.
- There are 4 levels of rainfall for flood map such as 150,300,450,600(mm).(GIS format)









Build Basin Loss Table (Policy Level)

Policy Location

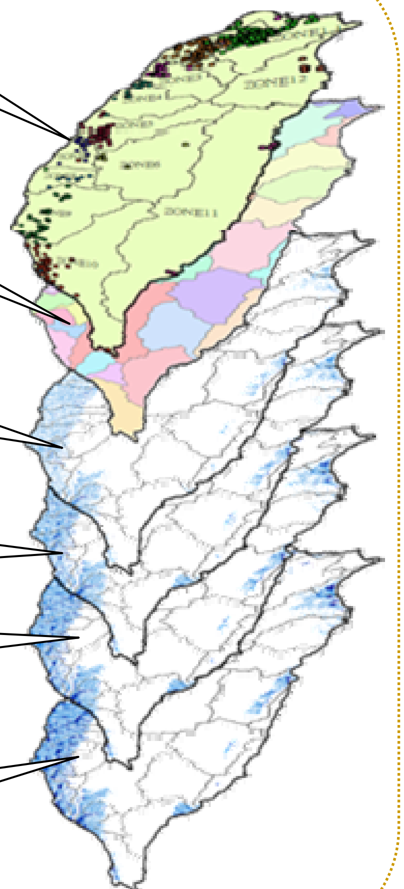
Basin Map

150mm Flood potential map

300mm Flood potential map

450mm Flood potential map

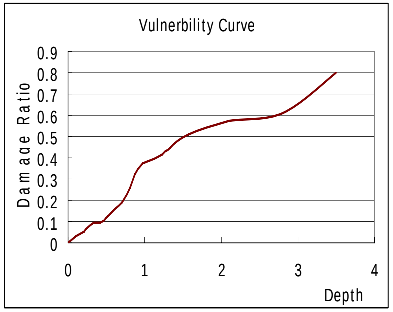
600mm Flood potential map



Hazard Analysis

GIS Tool

Vulnerability Analysis



Portfolio

(Commercial, Residential, Industrial)

Policy Conditions

Basin	150MM (Loss, P)	300MM (Loss, P)	450MM (Loss, P)	600MM (Loss, P)	Mean	Stdv
Basin1	(0.1bn,0.1)	(0.2bn,0.3)	(0.4bn,0.8)	(0.7bn,0.9)	14.7	0.6
Basin2	(0.2bn,0.2)	(0.3bn,0.5)	(0.4bn,0.7)	(0.5bn,0.8)	10.8	1.3
… …					… …	… …
Basin33	(0.3bn,0.1)	(0.7bn,0.4)	(0.8bn,0.7)	(1.1bn,0.9)	14.9	1.4

Basin Loss Table

Build Exceeding Probability Curve

Typhoon/Flood Database

@Risk Developer Kit

Frequency Distribution

Poisson Model

How many times?

(Monte Carlo Simulation)

Severity Distribution

Basin	150MM (Loss, P)	300MM (Loss, P)	450MM (Loss, P)	600MM (Loss, P)	Mean	Stdv
	(0.1bn,0.1)	(0.2bn,0.3)	(0.4bn,0.8)	(0.7bn,0.9)	14.7	0.6
	(0.2bn,0.2)	(0.3bn,0.5)	(0.4bn,0.7)	(0.5bn,0.8)	10.8	
					… …	
	(0.3bn,0.1)	(0.7bn,0.4)	(0.8bn,0.7)	(1.1bn,0.9)	14.9	

Basin Loss Table

Correlation Matrix Table

	Basin1	Basin2	… …	Basin33
Basin1	1	0.8		0.23
Basin2	0.33	2		0.14
… …				
Basin33	0.75	0.23		1

Simulated M times

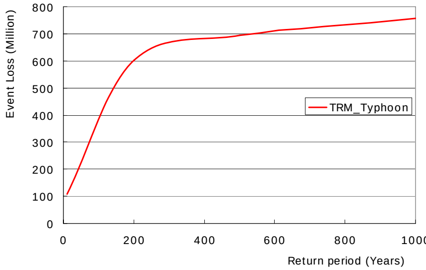
$$L_M = \sum_{i=1}^{N_M} \left(L_{B1,i} + L_{B2,i} + L_{B3,i} + \ldots\ldots + L_{B33,i} \right)$$

N_M : *number of events in* M^{th} *year*

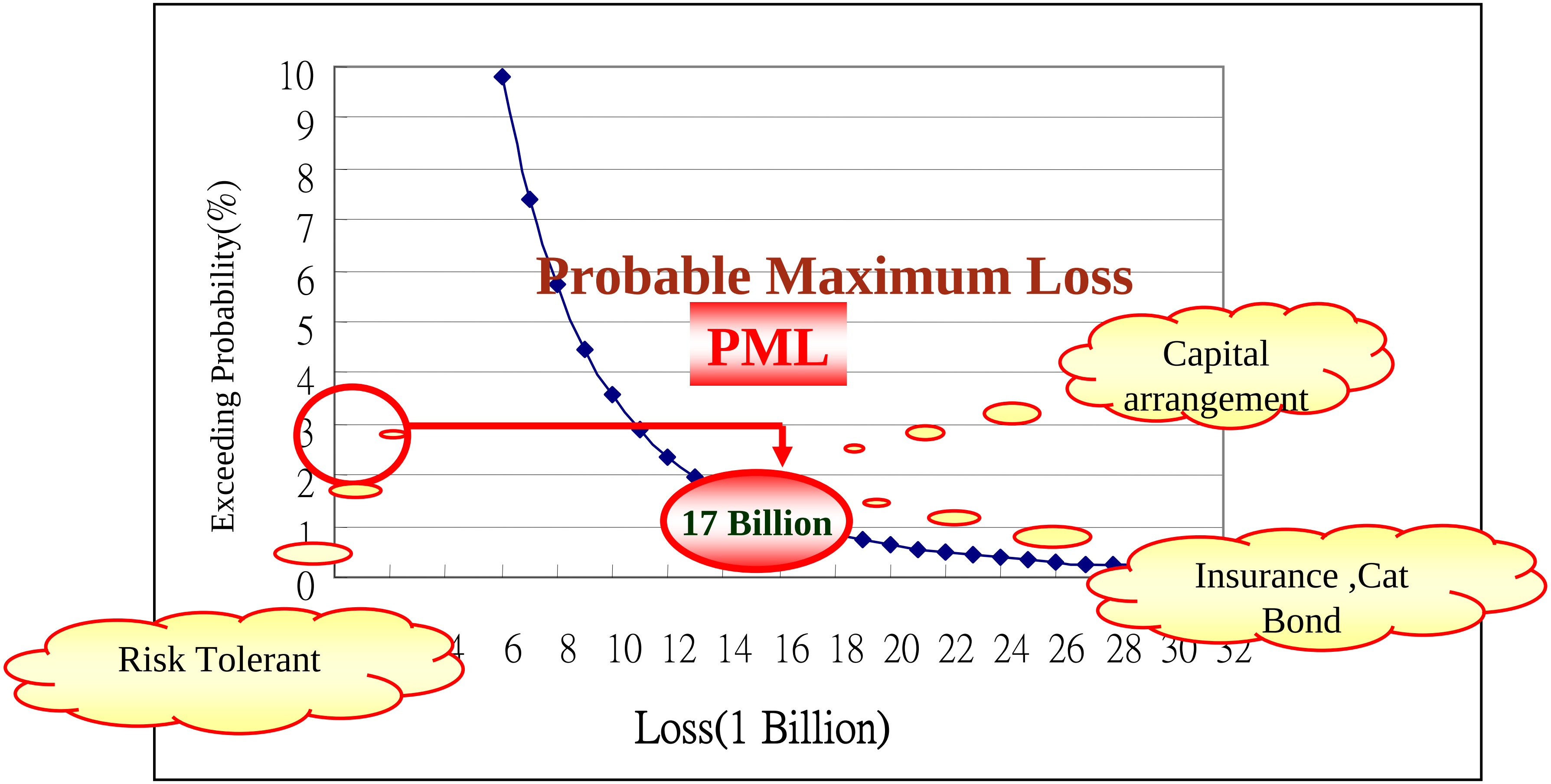
$L_{B?,i}$: *loss of* i^{th} *event of* $B?^{th}$ *basin*

L_M : *aggregate loss in* M^{th} *year*

EP Curve



Application of Loss Exceeding Probability Curve



Summary

- Application:
  - Engineering model can help decision maker to assess the risk and to help developing the management strategy in catastrophe event such as Earthquake or Typhoon.
- Further research :
  - Time – dependent
  - Business interruption

Thank You