The Typhoon-Flood Risk Assessment and Flood Insurance Program in Taiwan

Ching-Cheng Chang

Institute of Economics , Academia Sinica

Outline

- Review of event
- Risk assessment and modeling
- Design of an insurance scheme

No of invading typhoon per year

Mean—3.7

STD—1.7

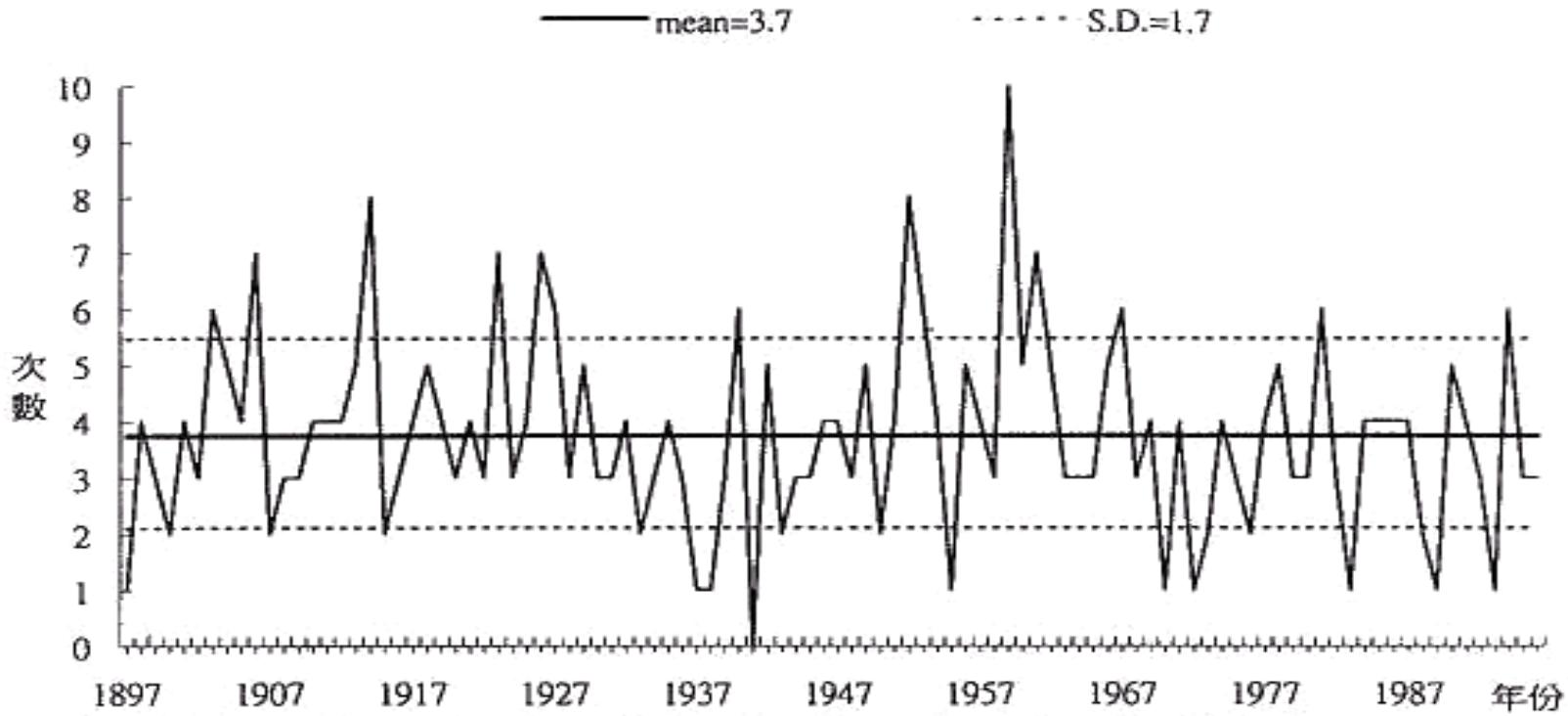


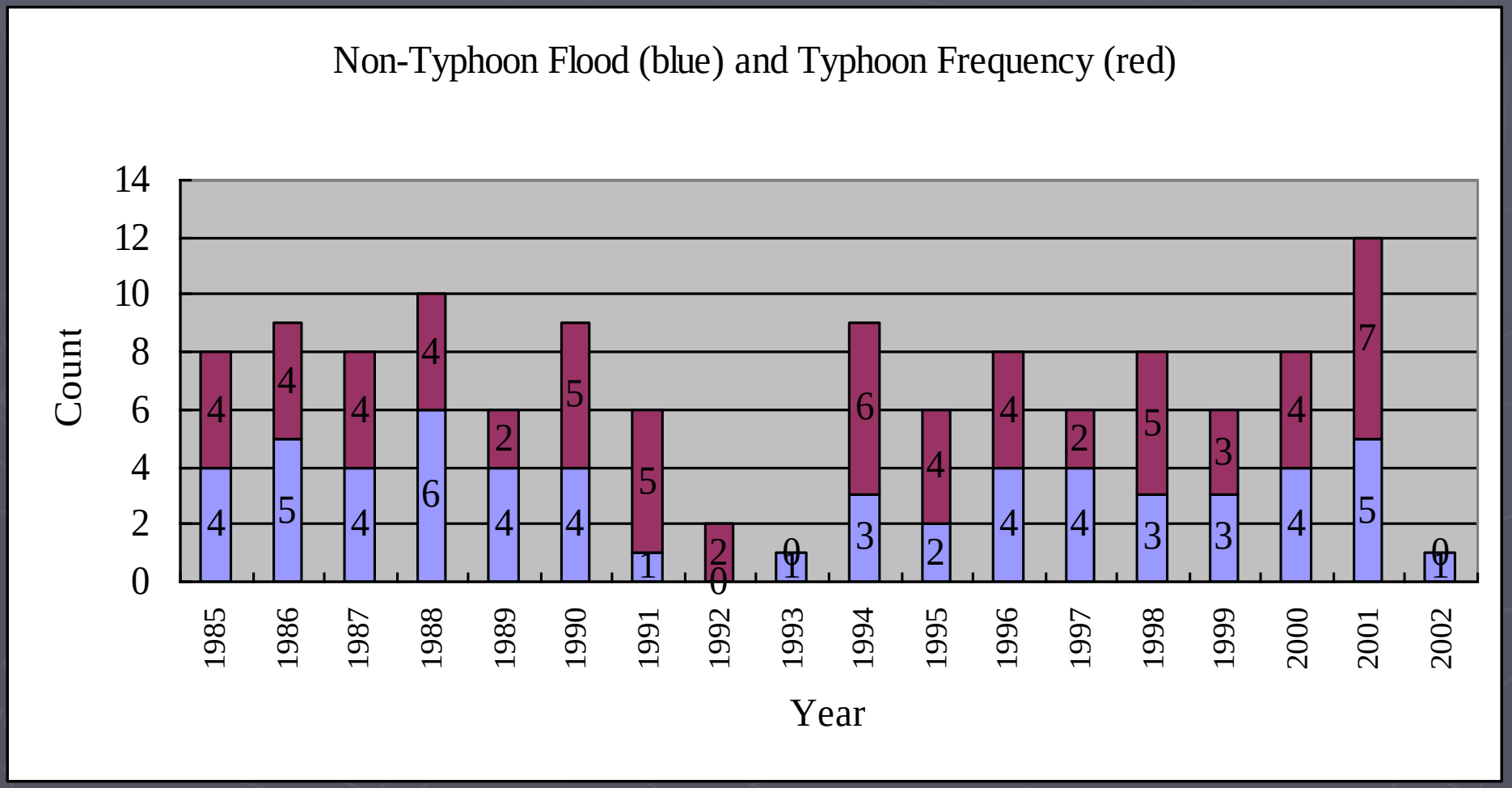
圖 5 過去一百年來(1897-1996)每年侵台颱風次數、平均值及其標準偏差(斷線)分布圖。

Fig.5 Time series of the yearly total invading typhoons in 1897-1996. (The grand mean is indicated by the thick solid line, and the standard deviation the dashed lines.)

No of Flood per year

Typhoon—3.6

Non-typhoon—3.2



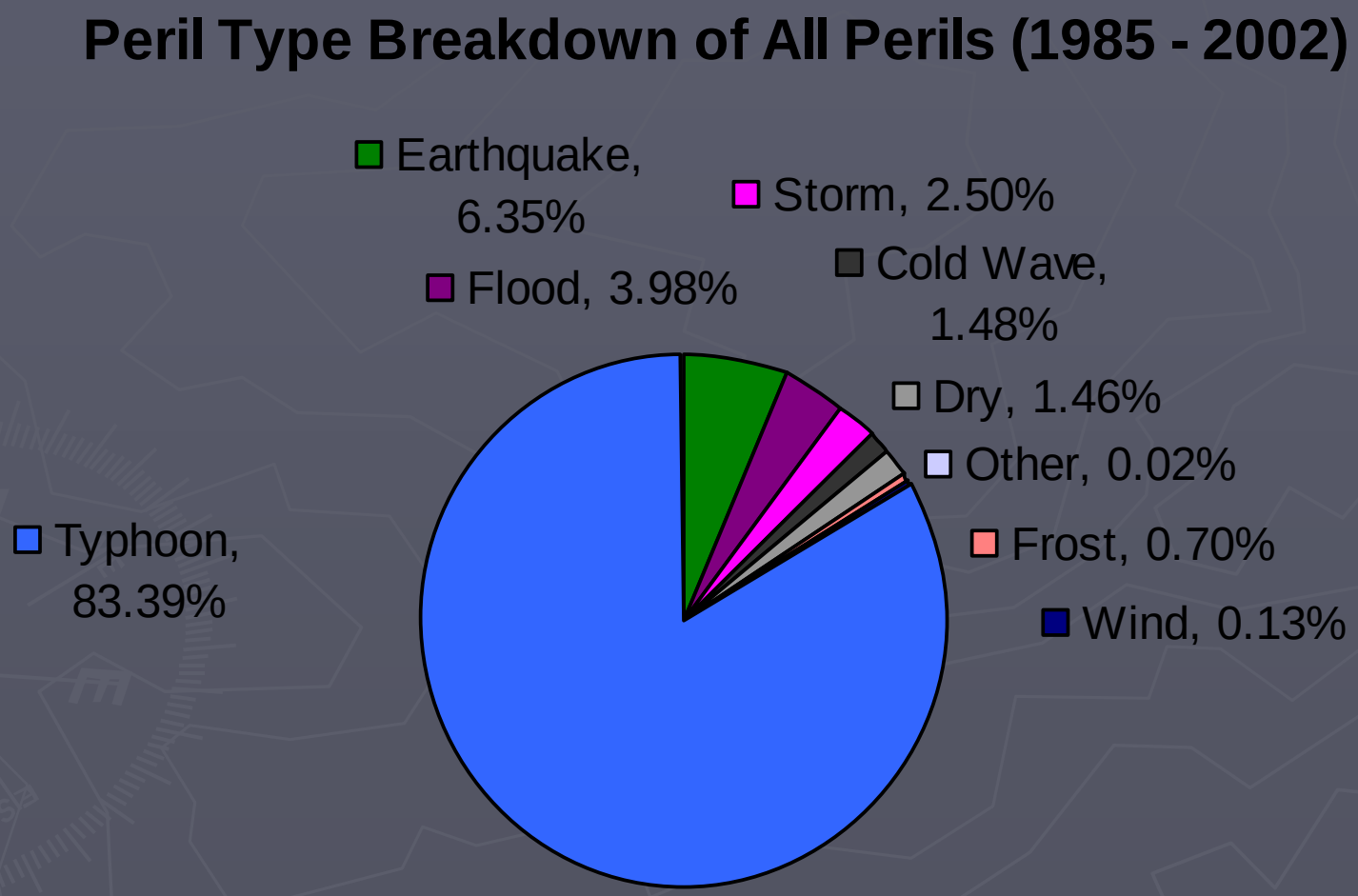
Recent Large Event

Year	Typhoon	Losses
2000	Xangsane	20 Million US$
2001	Toraji	70 Million US$
2001	Nari	5,700 Million US$

Annual Total Losses for All Perils, 1985-2002 (mill NT$)

	Total	Typhoon/flood	% in total
1985	1,659	1,600	96.44%
1986	31,435	30,703	97.67%
1987	9,586	9,492	99.02%
1988	9,902	9,902	100.00%
1989	21,073	20,872	99.05%
1990	21,565	21,565	100.00%
1991	9,336	7,205	77.18%
1992	3,246	3,246	100.00%
1993	1,192	1,192	100.00%
1994	16,496	16,471	99.85%
1995	1,718	1,717	99.95%
1996	39,995	39,390	98.49%
1997	8,440	8,332	98.72%
1998	15,191	13,651	89.86%
1999	27,265	4,296	15.76%
2000	15,857	15,097	95.21%
2001	22,633	22,632	99.99%
2002	10	10	100.00%
Average per year	15,094	13,375	88.61%

Peril Type Breakdown



Sectoral Breakdown

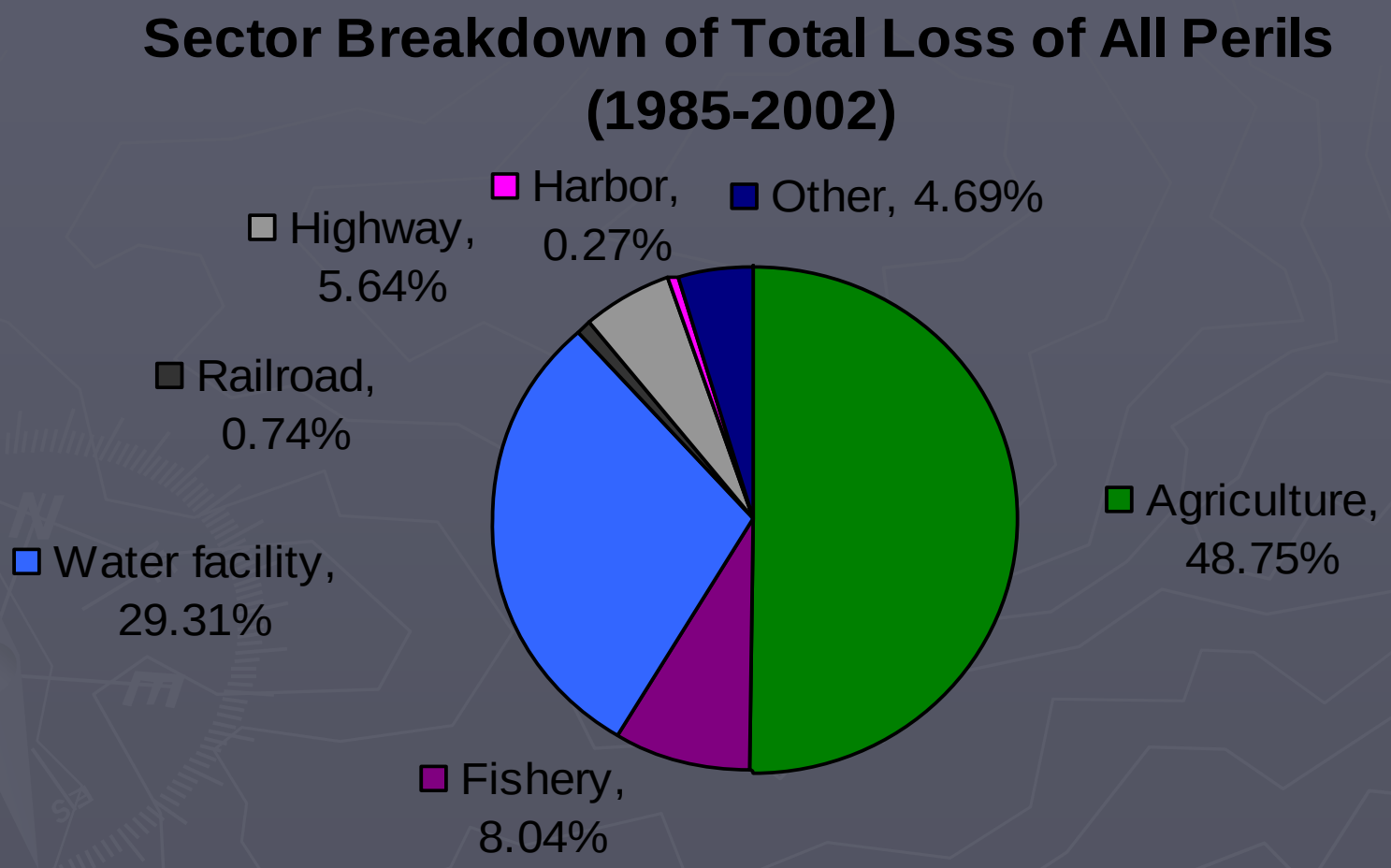


Table 4. Insured Losses of Recent Events (mostly commercial/Industrial)

Year	Amount Insured (Billion NT$)	Contract (no of contract)	Incurred Losses (no of contract)	Incurred Losses (Billion NT$)
1998	390.9	11,429	422	1.48
1999	613.0	12,813	58	0.47
2000	796.9	17,462	895	11.95
2001	608.5	24,750	3,890	91.03
2002	2,169.3	34,674	24	0.27
2003	4,445.6	53,015	134	0.27
2004	5,878.7	52,429	1,081	6.40
2005	7,727.4	59,232	1,828	12.67

Residential Losses-

- Building– 0.5 bill per year
- Content– not clear?

Building

Typhoon, Wind, and Flood			
Year	**No. of total-collapsed houses**	**No. of partial-collapsed houses**	**Estimated cost of total & partial collapsed houses** NT$
1985	33	17	72,153,823
1986*	[illegible]	2,760	1,538,727,067
1987		1,356	1,375,705,172
1988		95	148,674,304
1989	495	809	1,197,503,943
1990	178	322	437,081,661
1991	52	162	141,812,413
1992	12	5	25,992,011
1993	7	61	27,239,628
1994	204	327	492,184,725
1995	12	32	31,606,286
1996	503	881	1,229,110,229
1997	121	28	257,424,880
1998	13	43	35,972,944
1999	-	1	207,936
2000	434	1,725	1,261,132,387
Average per year	**195**	**539**	**517,033,088**

Wayne

Lynn

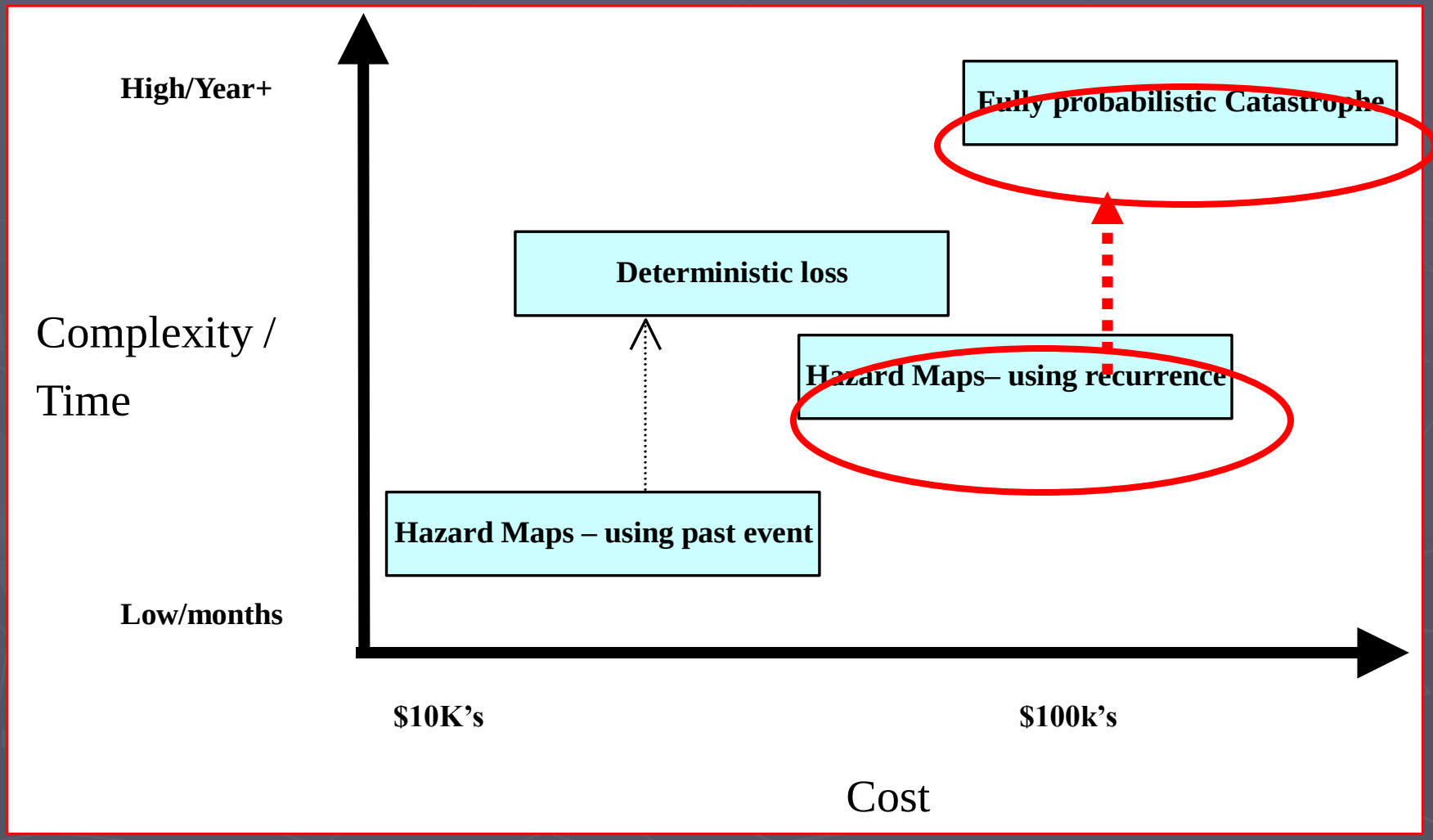
Herb

Xangsane

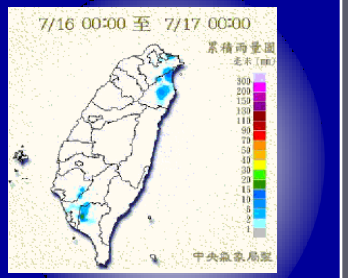
Content Loss

Source	Event	Location	Loss per home (NT$)
Chang et al (2002)	Zeb, Babs	Shih-Jr	$160,000 ~200,000
Wang et al (2002)	Nari	Taipei City	$200,000 ~330,000
Shaw (2003)	Nari	Taipei Area	$250,000

Flood Risk Assessment- Model types



Structure of Fully Prob. Model



Define Rainfall Evens

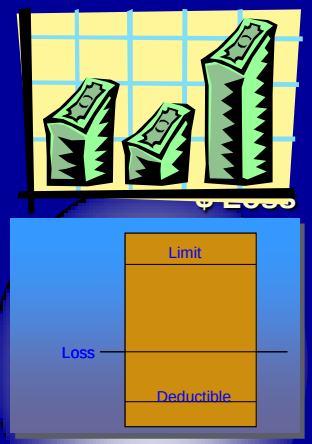
Stochastic Events module

Calculate inundation depth and extent

Hazard Module

Calculate Damage

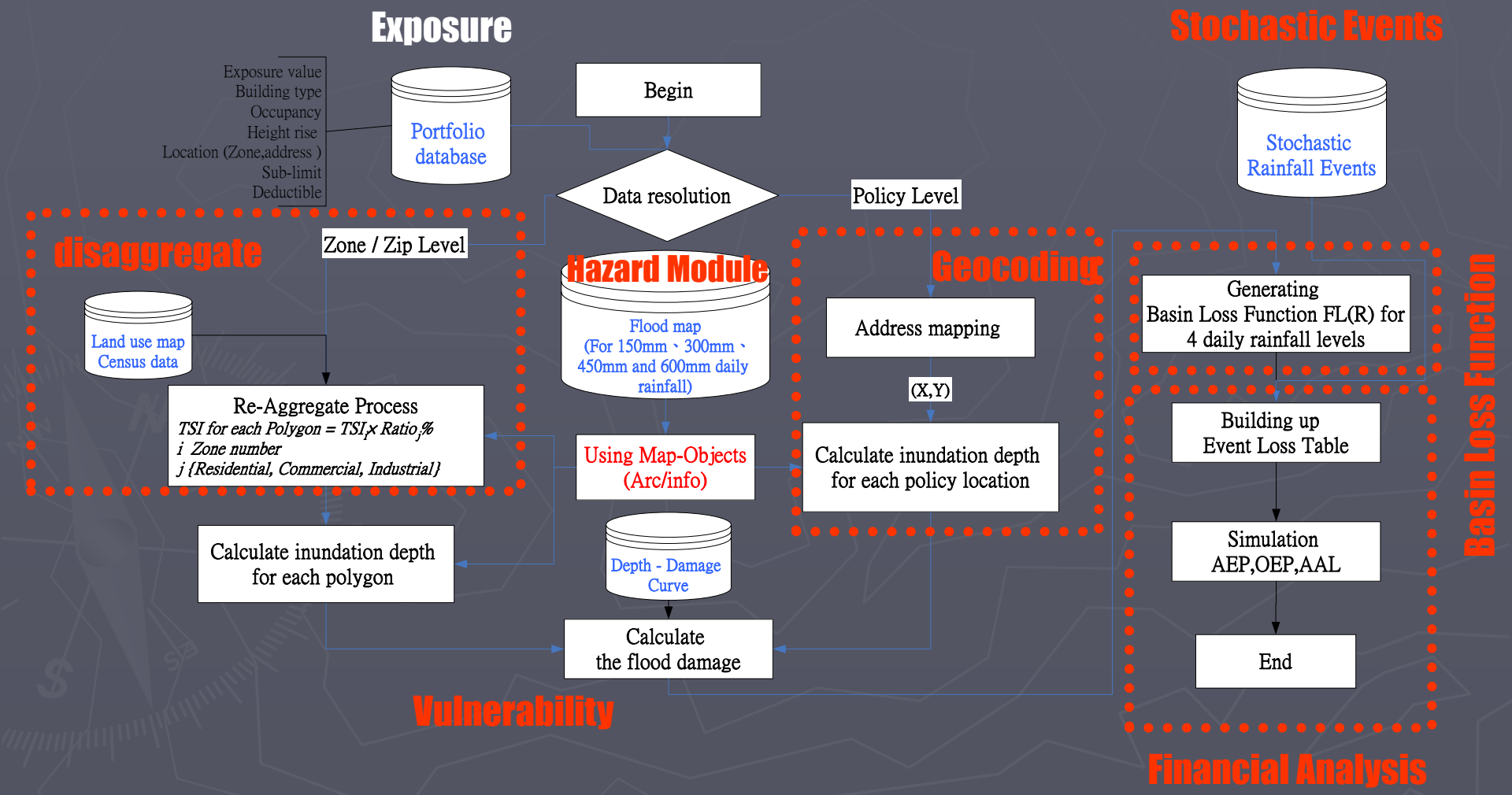
Vulnerability Module



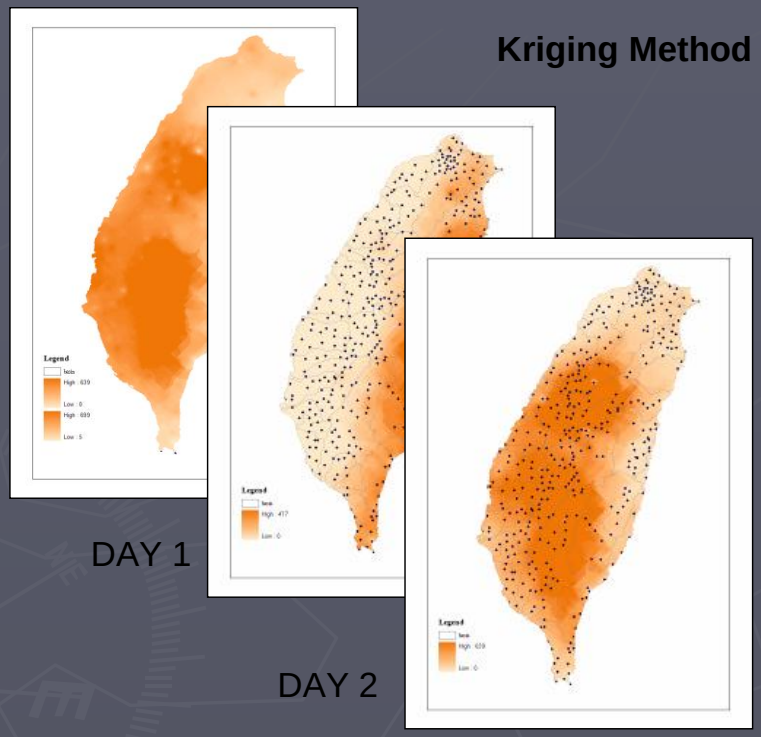
Calculate financial loss

Financial Loss Module

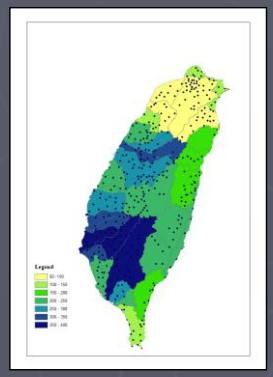
Flowchart


Exposure
Exposure value
Building type
Occupancy
Height rise
Location (Zone,address)
Sub-limit
Deductible
Portfolio database
Begin
Data resolution
Policy Level
Stochastic Events
Stochastic Rainfall Events
disaggregate
Zone / Zip Level
Land use map
Census data
Re-Aggregate Process
TSI for each Polygon = TSIi× Ratioj%
i Zone number
j {Residential, Commercial, Industrial}
Calculate inundation depth for each polygon
Hazard Module
Flood map
(For 150mm、300mm、450mm and 600mm daily rainfall)
Using Map-Objects (Arc/info)
Depth - Damage Curve
Calculate the flood damage
Vulnerability
Geocoding
Address mapping
(X,Y)
Calculate inundation depth for each policy location
Generating Basin Loss Function FL(R) for 4 daily rainfall levels
Building up Event Loss Table
Simulation AEP,OEP,AAL
End
Financial Analysis
Basin Loss Function

Event-Based Database



Kriging Method

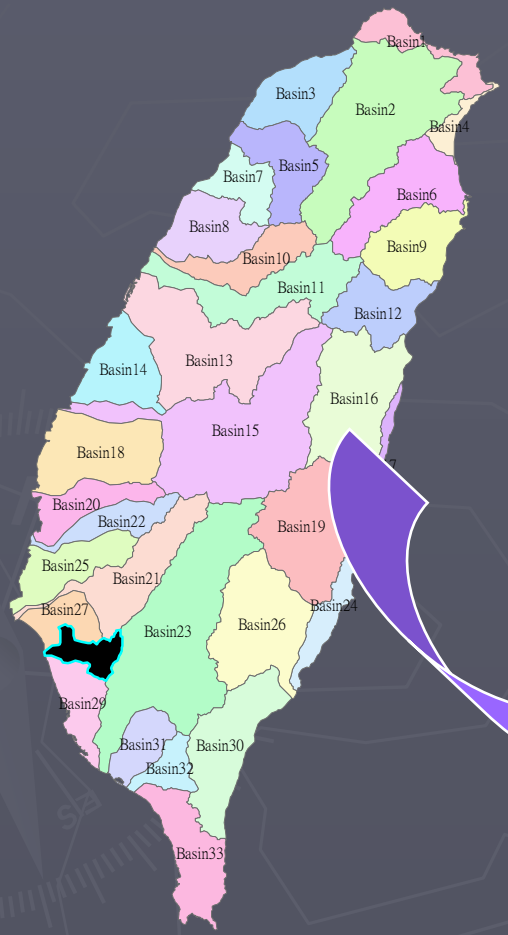


Event Basin Maximum Daily Rainfall table

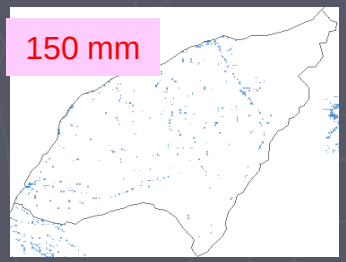
ID	Rate	Basin 1 (mm)	....	Basin 33 (mm)
1	0.01	145	...	678
2	0.02	245	...	54
...	....	....	...	...
322	0.03	33	.....	232

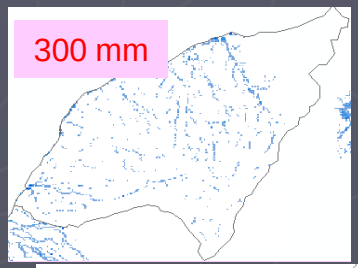
Rainfall data (1961~2006)
224 Typhoons & 98 Rainstorms = 322 Major rainfall events

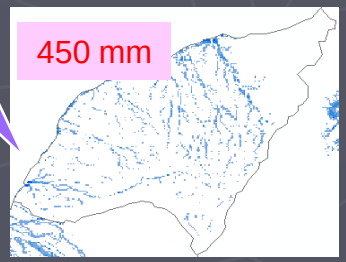
Flood Hazard Maps

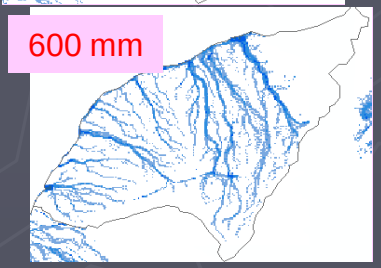


- 33 River Basins
- 4 Rainfall levels

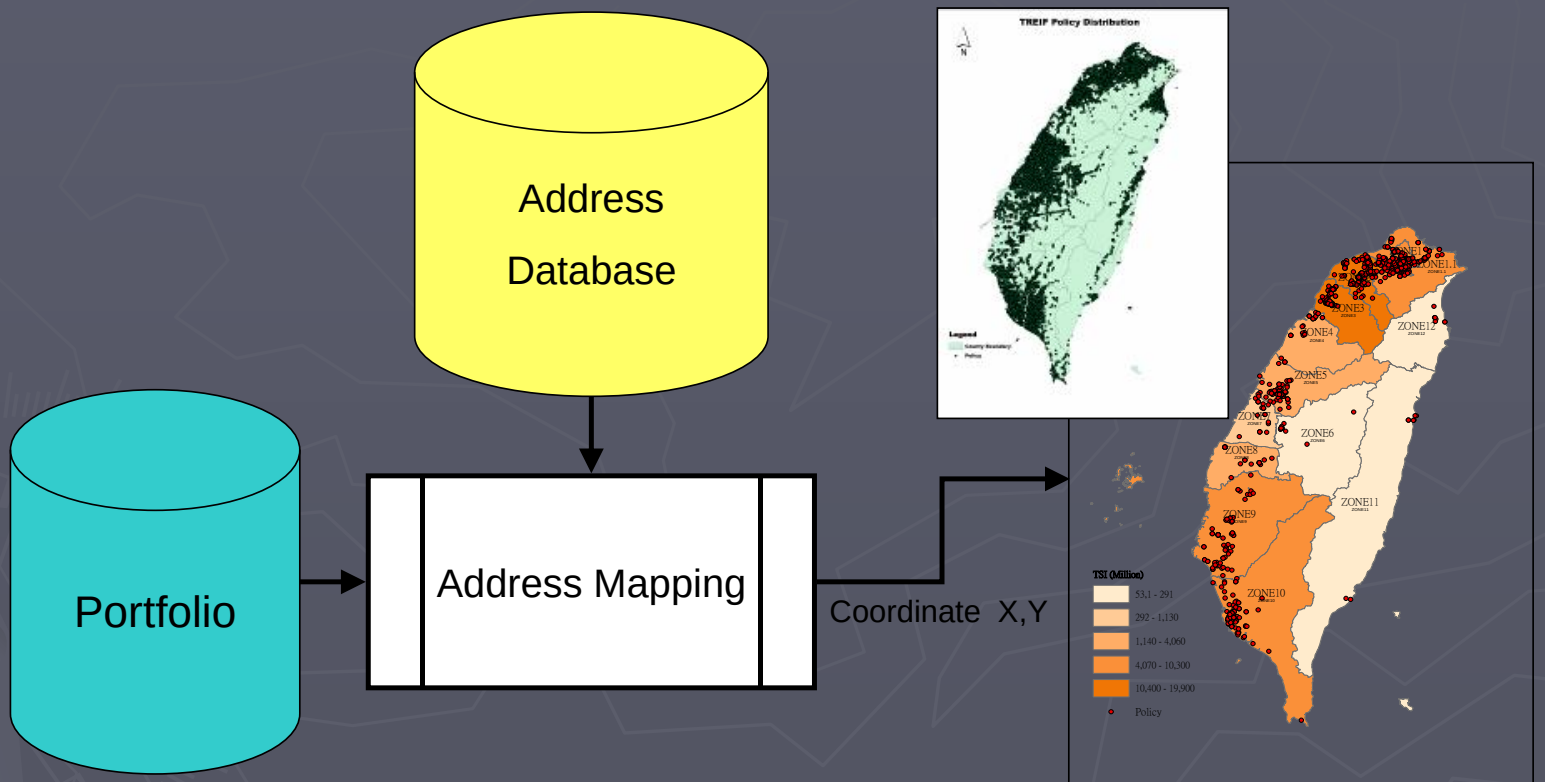




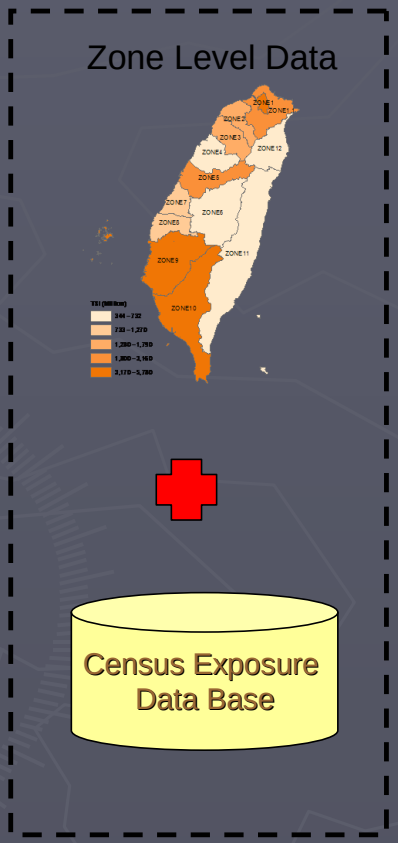


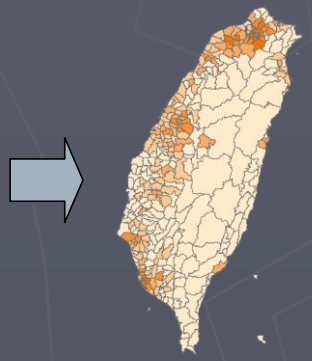


Geo-coding Technology

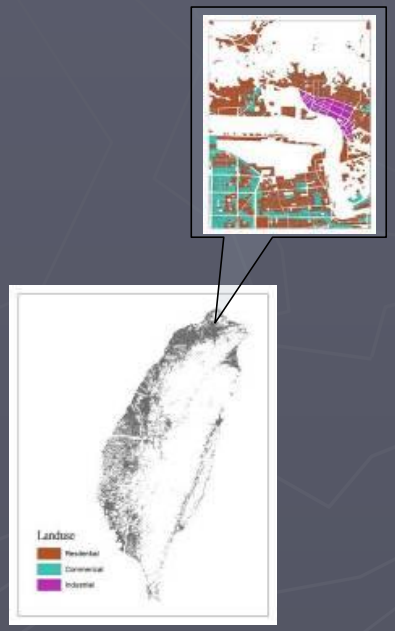


Re-distribution of Exposure





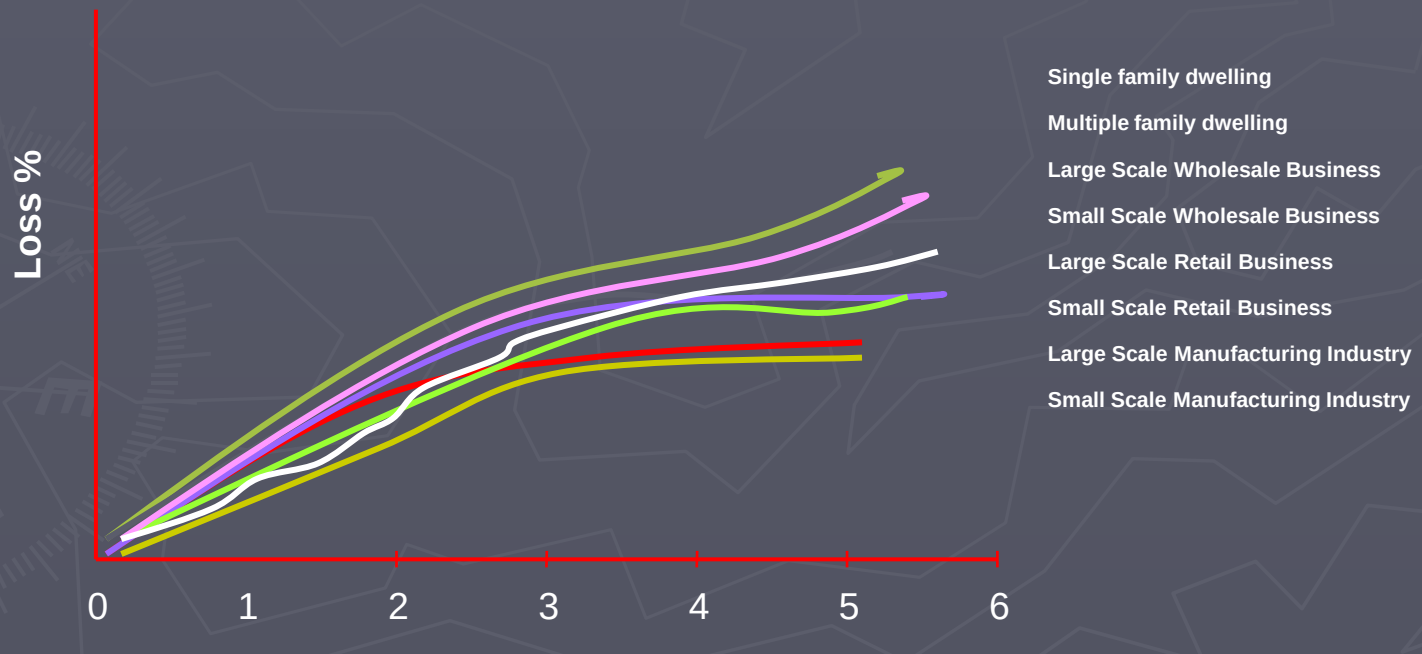
Zip Code Level Data



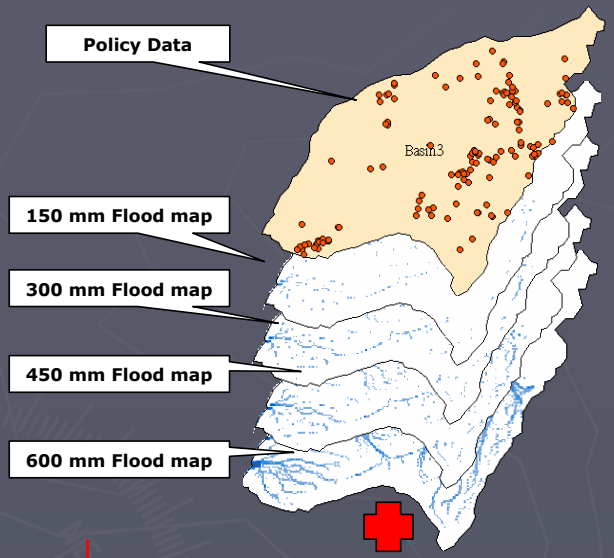
Land Use Map

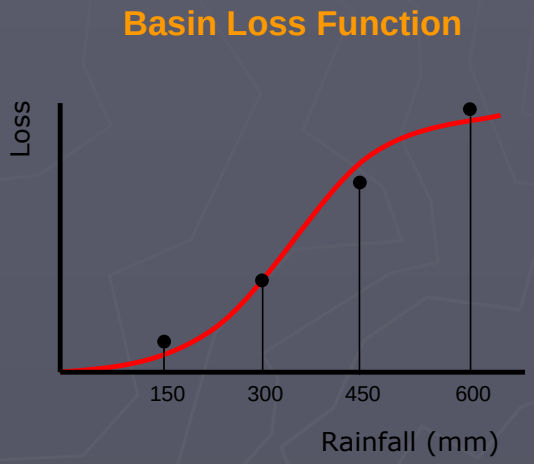
Vulnerability Curve

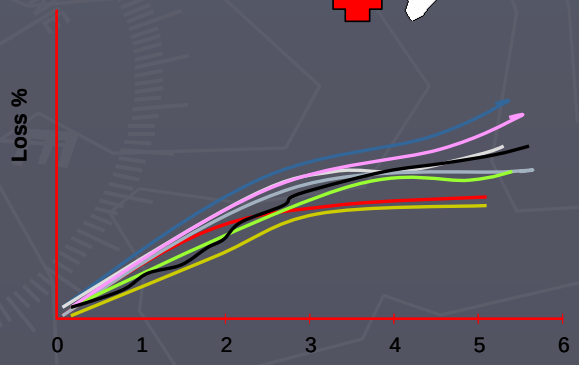
- Insurance data
- Household survey



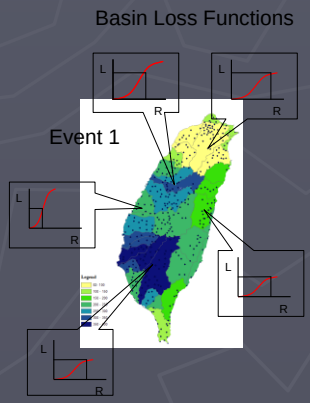
Basin Loss Function



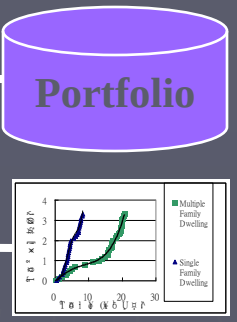




According to the given portfolio, 33 basin loss functions will be derived.

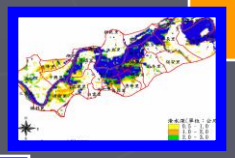


Event Loss Table



Stochastic Event Module

Hazard Module



Vulnerability Module

Event database

Rainfall distribution

Insurance scheme

ID	Annual Mean Rate	Loss$
#0001	0.010	6.5 億
#0002	0.002	….
#0003	….	….
….	….	….
….	….	….

Agg Exc Prob (AEP) Curve

ID	Annual Mean Rate	Loss$
#0001	0.010	6.5 億
#0002	0.002	….
#0003	….	….
….	….	….
….	….	….

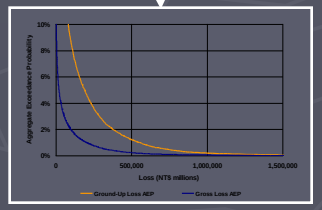
How severe?

Severity Distribution (Loss distribution)

$\lambda = \sum_i \lambda_i$

Poisson Model

Aggregate loss Simulation (Monte Carlo Simulation)

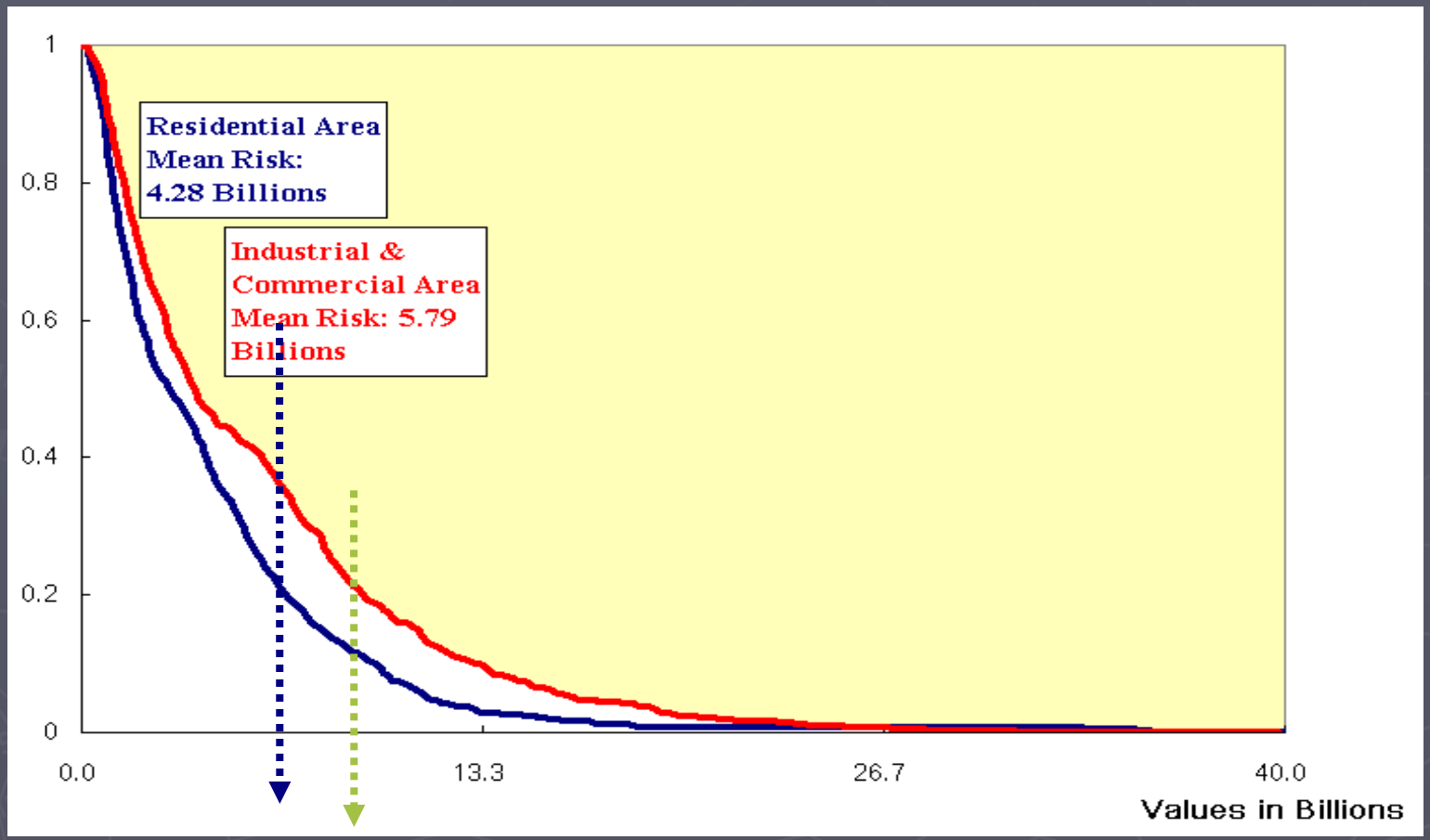


How many times?

(Monte Carlo Simulation)

Monte Carlo Simulation

-Aggregate Exceedance Probability Curve

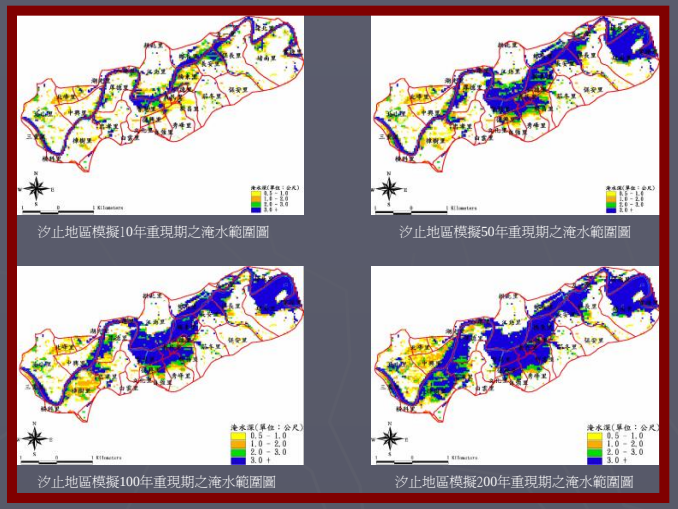


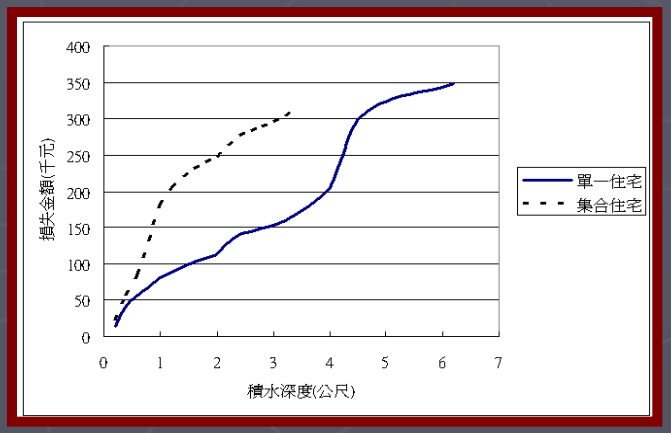
Case Study- Northern Region

Flood hazard maps by 4 rainfall levels

Mapping flood with building type using spatial, socio-economic data and GIS

Flood losses by return periods



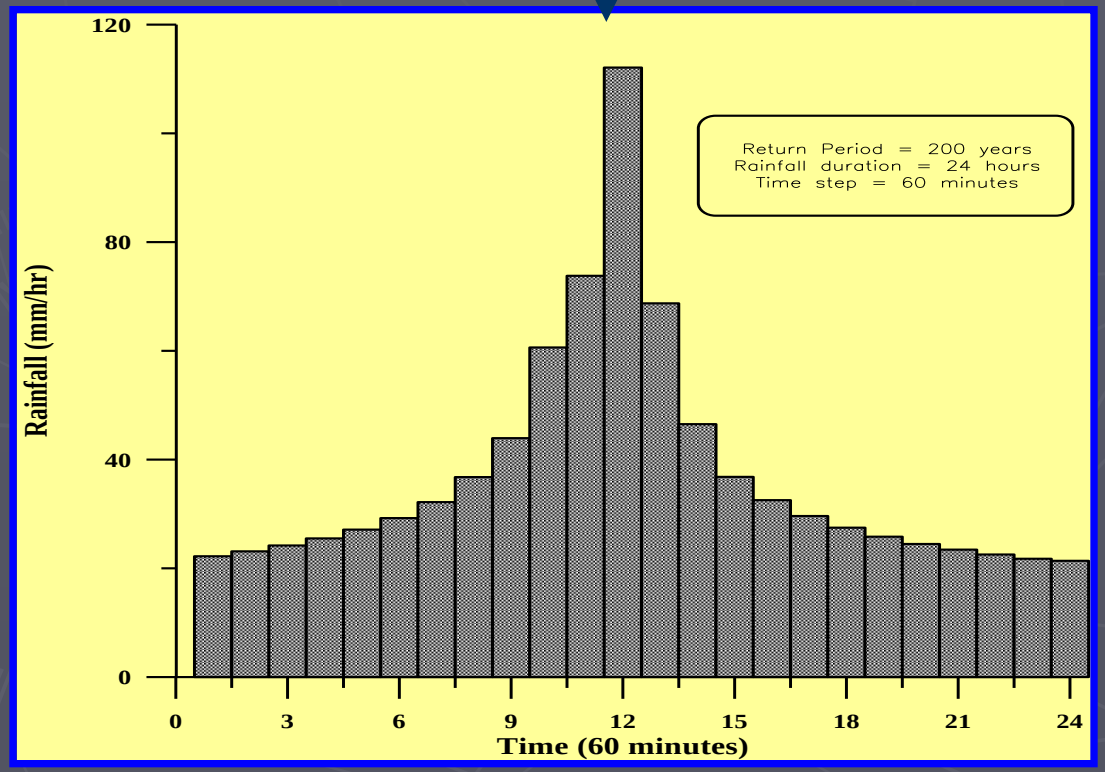


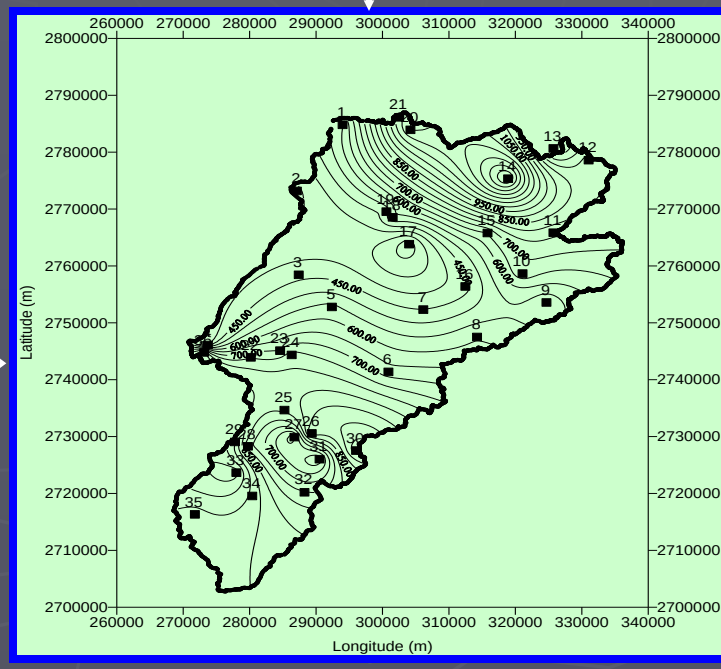
Simulation of Inundation Maps

- **24 maps of 6 watersheds are simulated by distributed watershed model linked to a GIS capability**
- **A 1-D dynamic channel-flow routing and 2-D diffusive overland-flow routing are adopted at alluvial plain to simulate the flow conditions of the main channel and its adjacent floodplain.**
- **The two routing are linked by a free weir formula.**
- **The model are simulated by 4 designed rainfall patterns**

Designed Rainfall Pattern

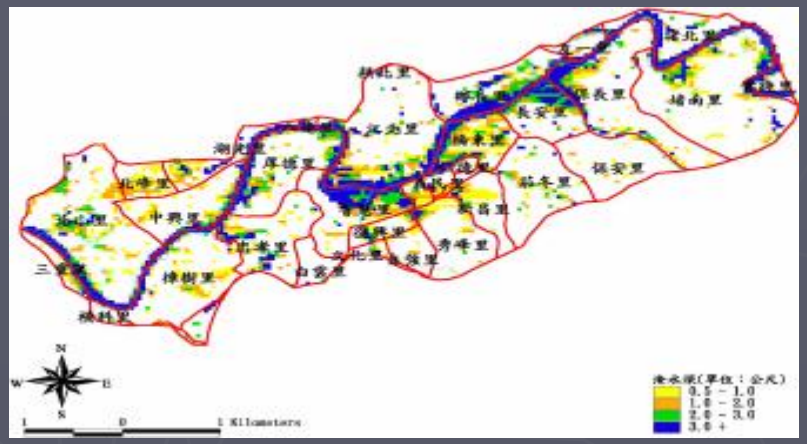
Intensity-duration-frequency relationship



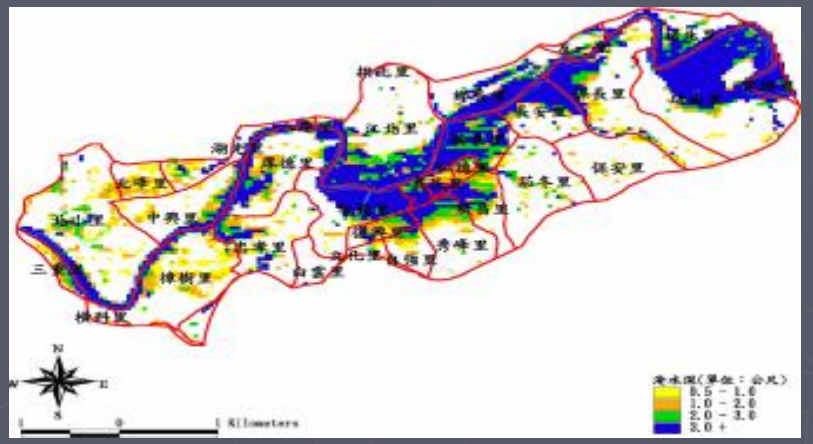


200-yr return period and 24-hr duration in Tan-Sui watershed

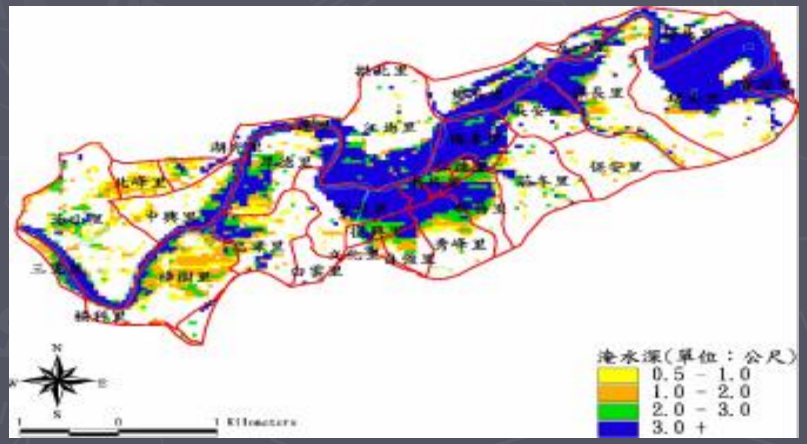
Simulation of Inundation Maps



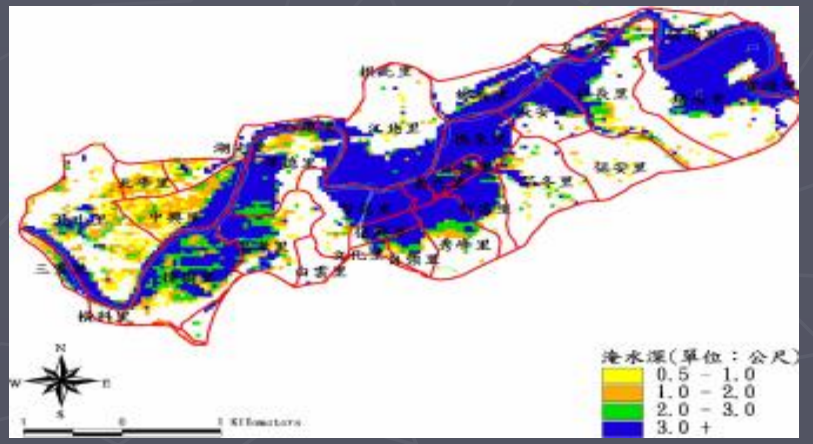
汐止地區模擬10年重現期之淹水範圍圖



汐止地區模擬50年重現期之淹水範圍圖



汐止地區模擬100年重現期之淹水範圍圖



汐止地區模擬200年重現期之淹水範圍圖

Correlation Matrix of Precipitation in Northern Taiwan

Correlation Matrix	北海岸	淡水河流域	桃園沿海	頭城沿海	頭前溪流域	蘭陽溪流域
北海岸	**1.00**	0.82	0.63	0.88	0.55	0.91
淡水河流域	0.82	**1.00**	0.75	0.74	0.75	0.82
桃園沿海	0.63	0.75	**1.00**	0.51	0.72	0.54
頭城沿海	0.88	0.74	0.51	**1.00**	0.49	0.87
頭前溪流域	0.55	0.75	0.72	0.49	**1.00**	0.55
蘭陽溪流域	0.91	0.82	0.54	0.87	0.55	**1.00**

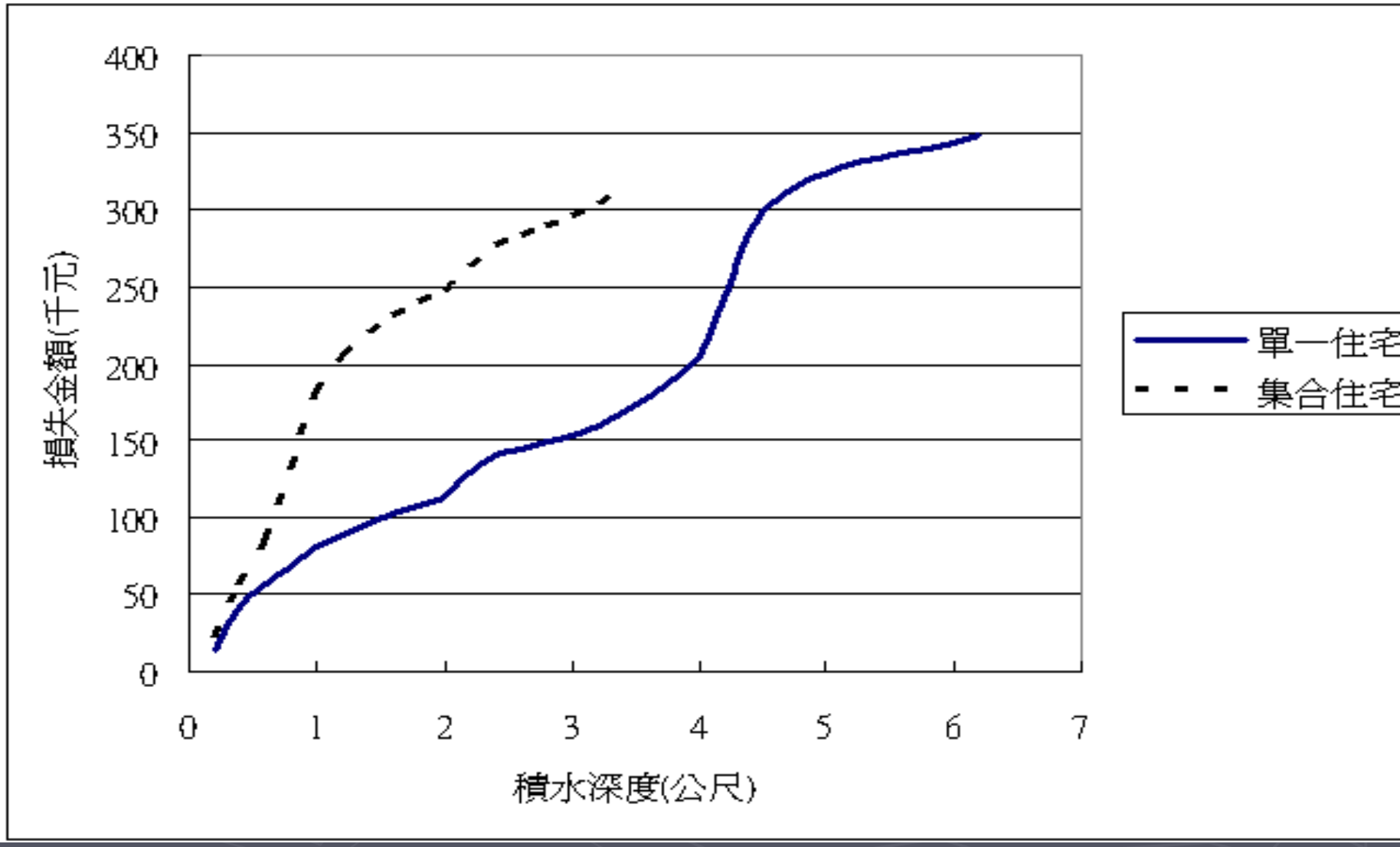
Cell-based exposure mapping
-- Census and land use database

Assess flood exposures-

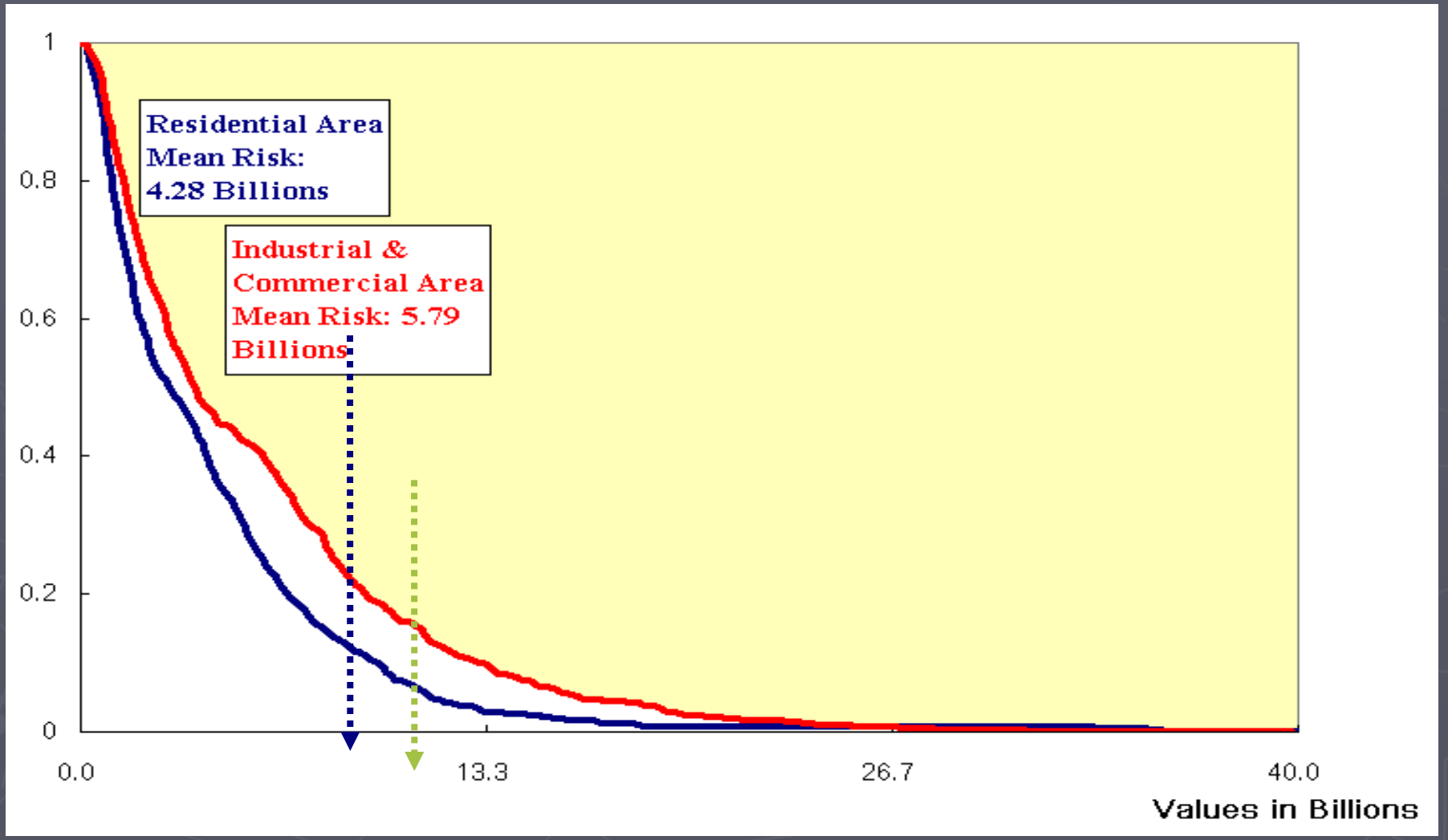
No of residential house flooded

Rain(mm)	600mm	450mm	300mm	150mm	Total Residential Building
Basin 2 (North Coast)	4,547	3,933	3,167	2,040	42,345
Basin 3 (Tao Yuan)	67,763	24,500	13,242	4,233	352,849
Basin 1 (Tan-Sui)	117,391	85,480	53,985	23,616	579,371
Basin 5 (Tou-Chan)	7,587	5,713	4,097	1,560	79,487
Basin 4 (Tao Chen)	5,890	4,573	2,525	444	17,942
Basin 6 (Lan Young)	27,772	21,665	10,838	1,380	76,931

Flood depth-loss curve



Aggregate EP Curve by Category



Annual Aggregate Flood Losses in Northern Region by Category (in NT$ billion)

AAL

PML

	99% Risk	95% Risk	Mean Risk	5% Risk	1% Risk
Residential Area	0	0.51	4.28	11.6	18.5
Industrial & Commercial Area	0	0.65	5.79	16.3	25.5

Insurance scheme-Wind

- **Wind exposure is low in Taiwan**
  - ❖Reinforced concrete construction provide great protection from wind
  - ❖Dominant eastern landfall of storms reduce the wind speed on the western side

- Options:

- ➢Included in the basic fire policy
- ➢Deductible and coverage limit

Insurance scheme--Flood

- Major Criteria
  - Compensation
  - Affordable (willingness to pay)
  - Government/private balance
  - Mitigation measure
  - Politically acceptable
  - Fair and equitable
  - Financially sound
  - Easy to administer
  - Easy to understand

Willingness to pay

- Survey on Kee-lung River residents
  - 35% participation rate
  - Average WTP-- NT$1,000 per year
- New survey (nationwide)
  - Average WTP– NT$1,500 per year

Available options

1. Government flood insurance program
2. Multi-peril endorsement to fire policy
3. Government relief program
4. Hybrid of insurance and state fund
5. Private insurance

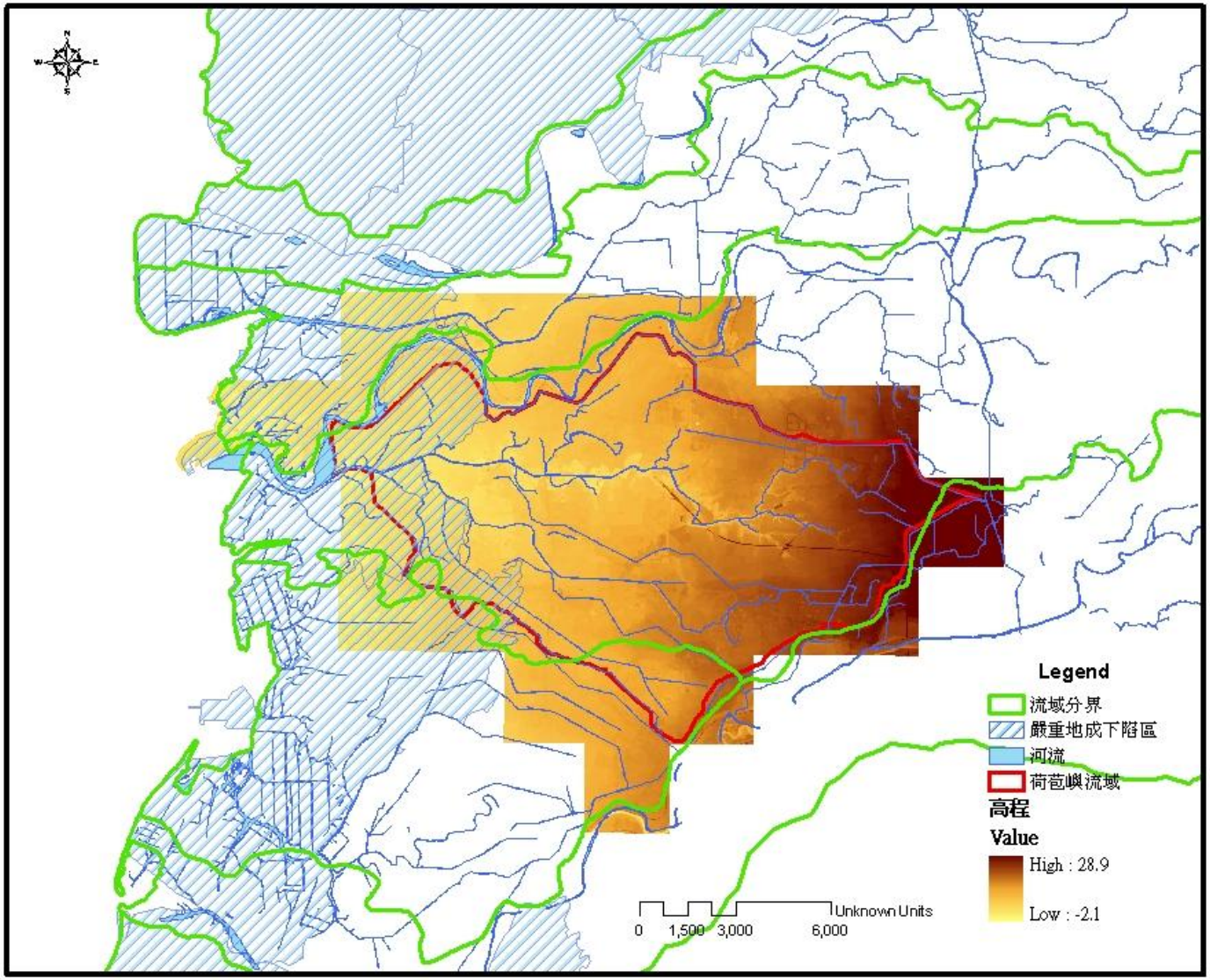
Suggestions

- Integrate climate/hydrology/socio-econ database
- Improve/validate flood hazard maps
- Collect risk mitigation/ flood exposure data
- Upgrade/calibrate risk assessment model
- Design of multi-peril assessment model

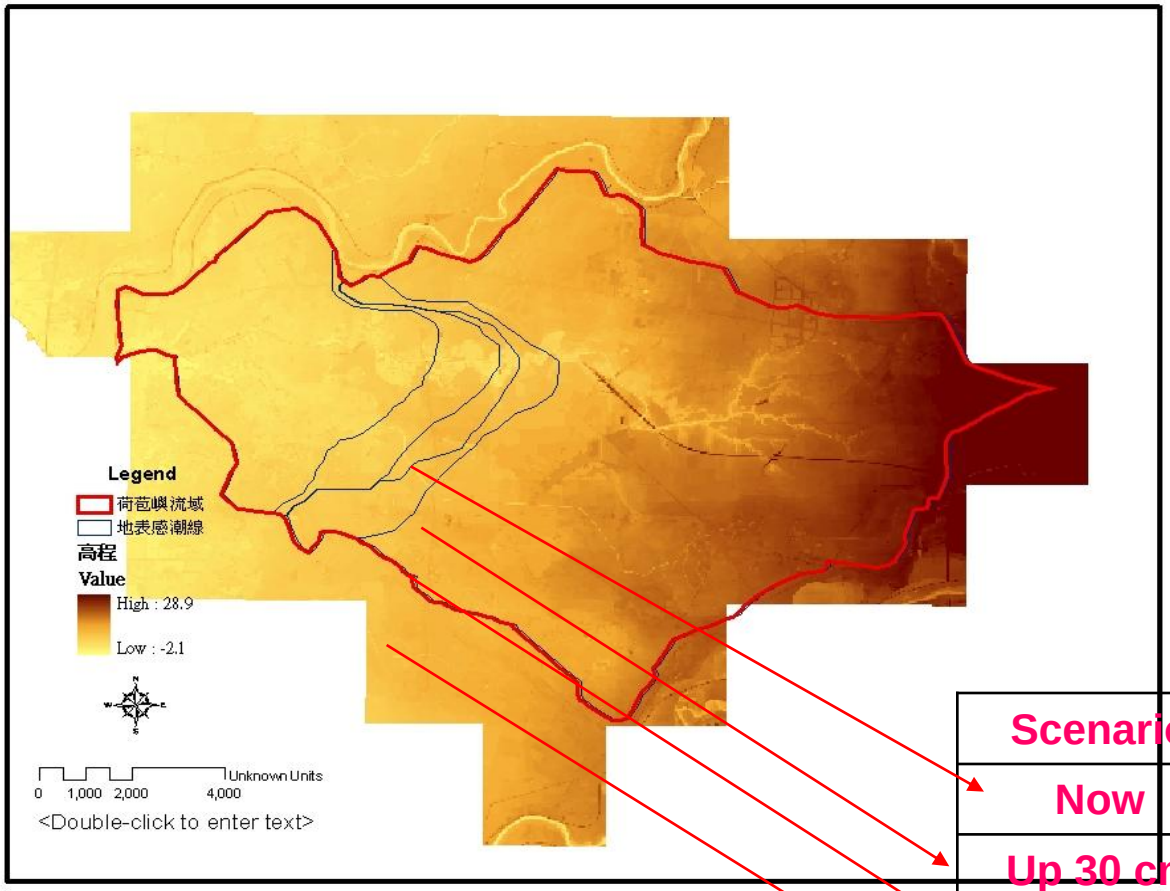
On–going research

- Policy Options & Case Study in Coastal Area
  - ✓ Flood mitigation projects
  - ✓ Land Use and development Regulation
  - ✓ Compulsory flood insurance program
  - ✓ Government relief program
  - ✓ Private insurance
- Uncertainty in Risk Assessment
  - ➢ Spatial correlation
  - ➢ Over-time variations
  - ➢ Local participation
  - ➢ risk perception


94194007
94194008
94194009
三江國小
東榮國中
94194017
東榮街
東石國小
東石鄉
94194018
港墘國小圍潭分校
港墘國小
海通路
94194019
港墘國小洲子分校
嘉義縣
知德工商
竹村國小成後分校
94194027
94194028
94194029
竹村國小
網寮國小
布袋鎮
布袋漁港
通濟國中


Legend
流域分界
嚴重地成下陷區
河流
荷苞嶼流域
高程
Value
High : 28.9
Low : -2.1
0 1,500 3,000 6,000
Unknown Units

Simulate Sea level Rise



Scenario	Area	Increment
Now	19.41%	---
Up 30 cm	24.19%	4.77%
Up 50 cm	25.89%	6.47%
Up 100 cm	30.87%	11.45%

THANK YOU

Comment Welcome