NCDR

The Household Benefits Assessment of the Flood Reduction Plan in Flood-prone Area: a Case Study in Sinwen, Chiayi, Taiwan

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PSAM9

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Introduction

Total loss due to natural disasters (1958-2001)

Earthquake 8.0%

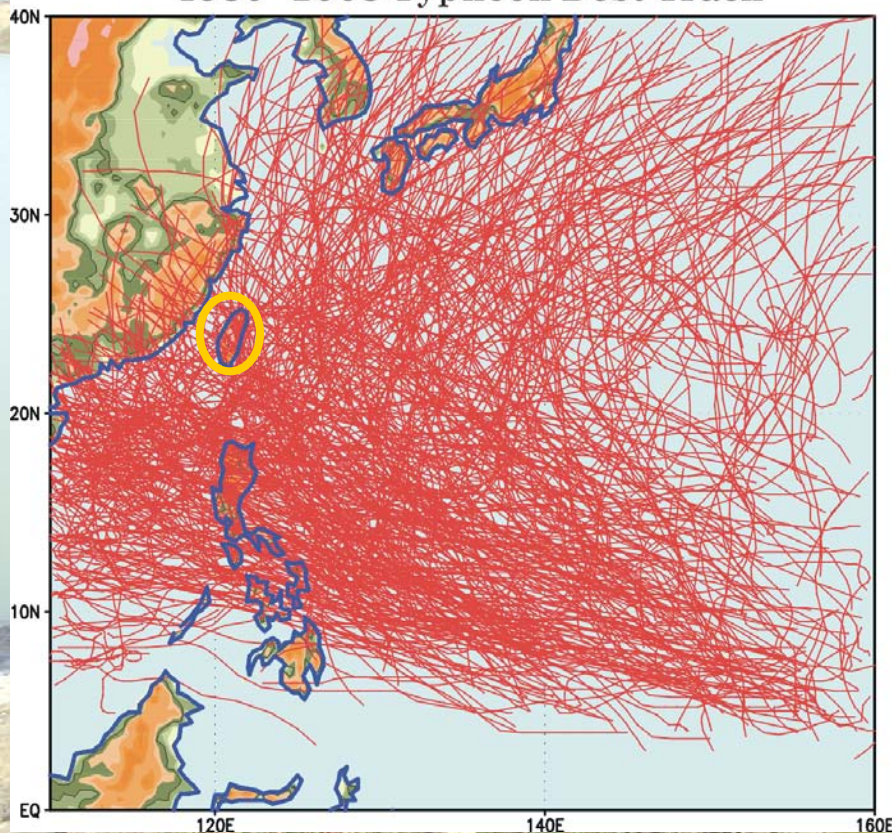**Other 3.3%**

Flood 17.4%

Typhoon 71.4%
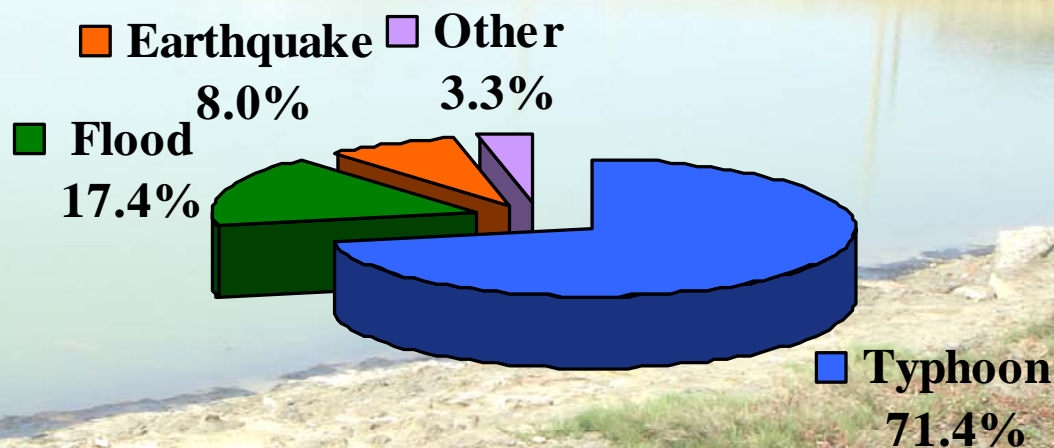
About USD $ 6.1 M per year in Taiwan

72% natural hazard damage is caused by typhoon in Taiwan area

Taiwan was affected by 8 typhoons in 2001

1980~2003 Typhoon Best Track

Typhoon	Death	Injure	Agri. Loss (NT M) (A)	Constr. Loss (NT M) (B)	Total (A+B) (NT M)
Chebi	30	124	737	23.6	760.6
Trami	5	-	73	160.5	233.5
Toraji	214	188	7779	5631	13410
Nari	104	265	4173	1870	6043
Utor	1	6	95	250	345
Total	354	583	12857	7935	20,792

➢ **In 2004, 6 typhoons swept Taiwan**
➢ **In 2005, 4 typhoons hit Taiwan**
➢ **Japan was hit by 10 typhoons in 2004.**

Historical Flood Disaster

Taipei MRT

Typhoon Nari (2001)

Introduction (cont.)

- 'The Flood Reduction Plan in the Flood-prone Area' is ratified by the government on 2006, which aims to ease the impact caused by flood hazard.

- This paper try to the data of household survey to build up an model of household flood loss which is suitable for cases in flood-prone areas around Taiwan.

Literature review

- Flood damage is traditionally categorized in terms of direct or indirect damage, and tangible or intangible damage.

  Such as Breaden (1973), Grigg and Heiweg (1975), and Grigg et al. (1976).

Literature Review- flood loss model

- Models with the flood loss and the flood characteristics
  - Damage curve- the loss and the flood depth or peak vol.
    - Damage curve for a region
      - Using regional and historical 'aggregate loss' and max. depth
      - Ex. Grigg (1975)
    - Damage curve for a kind of building or structure
      - Using the loss data of a kind of building or a sample building
      - Ex. Penning-Rowsell and Chatterton (1977), Chang and Su (2001)
    - Damage curve for a kind of land use
      - Using the loss data of a kind of land use
      - Ex. Grigg et al. (1975), Tsai et al. (1994, 1995)
    - A set of damage curves (for a type of dwelling in a land use)
      - Ex. Su et al. (2005), Kang et al. (2005)

Literature review- Loss Assessment

（Shaw, et al., 2005）

Damage Loss **=**

Lost value of service flows from the date of the flood until the date of the decision to restore the damaged capital

+ Min

1. *Lost value of service flows from the date of the decision to restore the damaged capital until an indefinite future.*

2. *The cost of restoration plus the lost value of services during the period of restoration*

3. *The cost of replacement plus the lost value of services during the period of replacement*

An example for Car loss after flood disaster

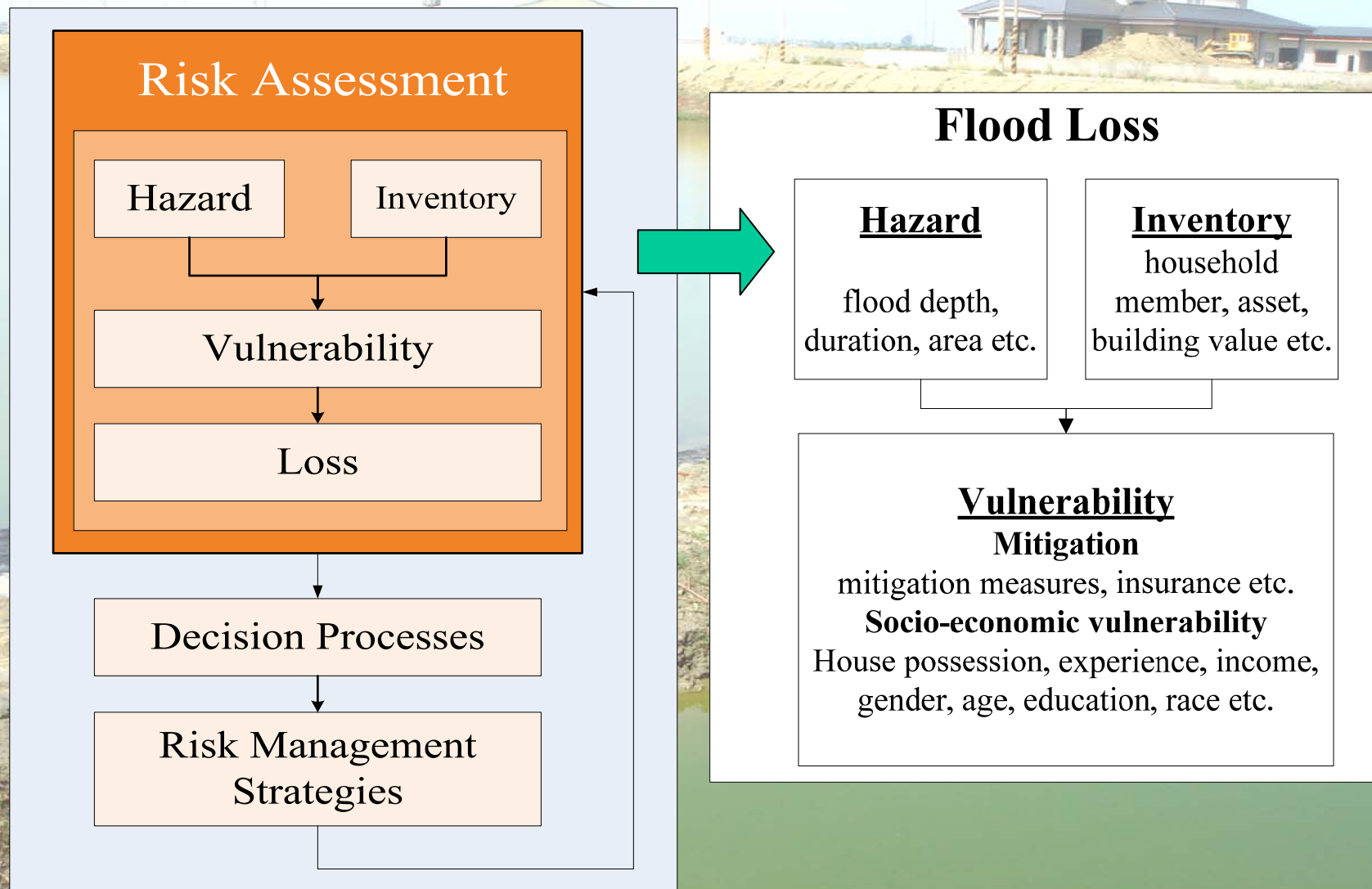| Content \ Method	Economics Method	Engineering Method
(1) The loss of car value	**V**	**V**
(2) The loss of restoration or replacement	**V**	**?**
(plus) The loss of car services during the car broke	**V**	**?**
Total Loss	**(1)+(2)+(3)**	**(1)**

Flood loss model for households

The survey data of flood loss

- **<u>Survey</u>**
  Typhoon --MINDULLE（2004/07/01）
  Typhoon --AERE（2004/08/25）
  911 Flood （2004/09/11）

- **Survey area**：**Five counties**
  (Taipei, Keelung, Taichung, Chiayi and Yulin)
- **Survey method**：**367 samples**
                    (sample error is 5.1%)

Framework of risk assessment
(Grossi et al. 2005, Cutter et al. 2003)

Risk Assessment

| Hazard | Inventory |

↓

Vulnerability

↓

Loss

→

Decision Processes

↓

Risk Management Strategies

Flood Loss

Hazard

flood depth, duration, area etc.

Inventory
household member, asset, building value etc.

Vulnerability
Mitigation
mitigation measures, insurance etc.
Socio-economic vulnerability
House possession, experience, income, gender, age, education, race etc.

The Content of Loss Estimation

Capital	Item	Loss Content		
Human Capital	**Human Capital Loss**	The cost for absence form work		
		The cost of disease caused by disaster	**Medical expenses**	
			The cost for absence form work	
Man-made Capital	**House Loss**	The cost of structure recovery		
		The cost for taking refuge		
		The cost of clean and decoration	**Absence from work**	
			Pay for clean	
	Appliances Loss	The cost for fixing or losing furniture or electric equipment.		
	Transportation	The cost for fixing or losing car or motorbike.		
	Public Facility	The cost of fixing public facility		
Natural Capital	**Land Loss**	The value of land		

Total Loss = Human capital Loss+ House Loss+ Appliances Loss
+ Transportation Loss+ Public Facility Loss+ Land loss

The result of model coefficient estimations

Variables	Coefficient	T-statistics	P Value
Constant	-1.418	-0.582	(0.561)
Log (flood depth (cm))	1.966	8.300	(0.000)***
Log (regional flood duration (hour))	0.493	3.512	(0.001)***
Log (house member)	0.756	2.875	(0.004)**
House possession dummy	-1.515	-2.969	(0.003)**
Log (flood experience)	0.346	1.782	(0.076)
Log (average household income)	0.166	0.708	(0.480)
F value		(16.758)***	

* Significance at 95% level   ** Significance at 99% level   *** Significance at 99.9% level

Verification of flood loss model

Data	Average loss/ household	Inaccuracy
Flood survey on 2004	27,407 NTD	11.22%
Model Result	30,483 NTD	

Data	Average loss/ household	Inaccuracy
Flood survey on 2005	32,110 NTD	10.24%
Model Result	28,821 NTD	

Model accuracy nearly 90 %

Case Study - Sinwen, Chiayi

Lon-Gon river

Ba-Chun river
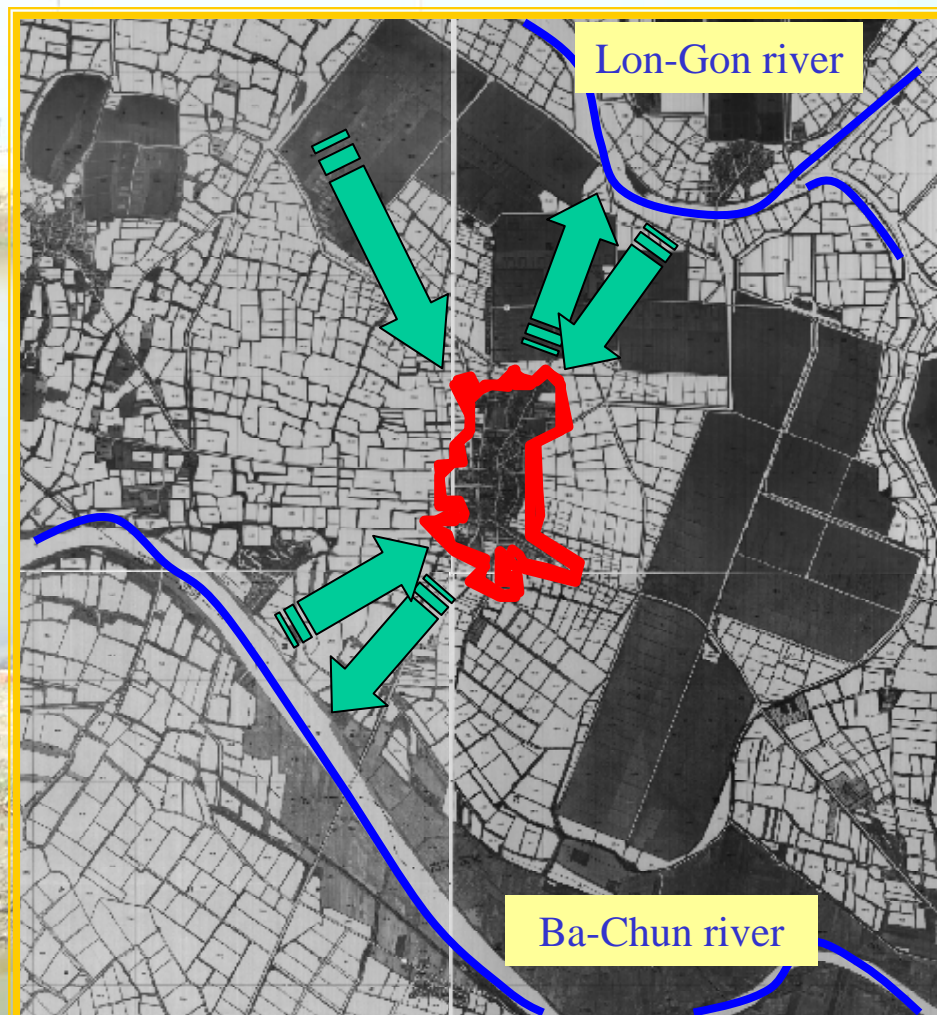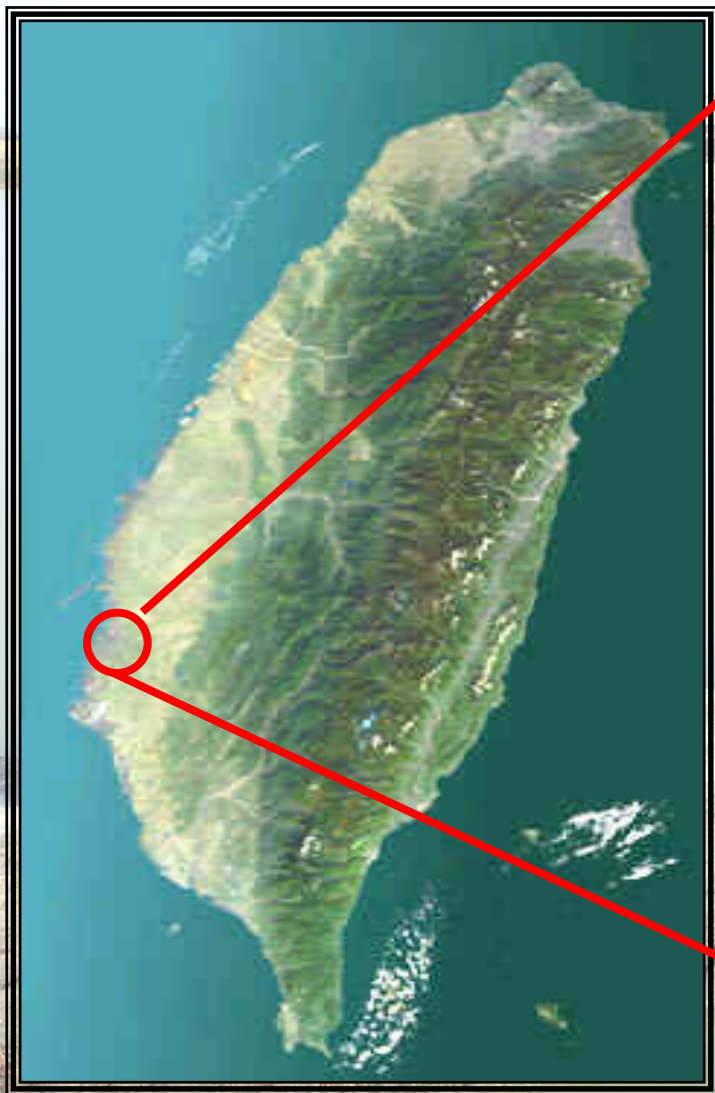
Hazard analysis
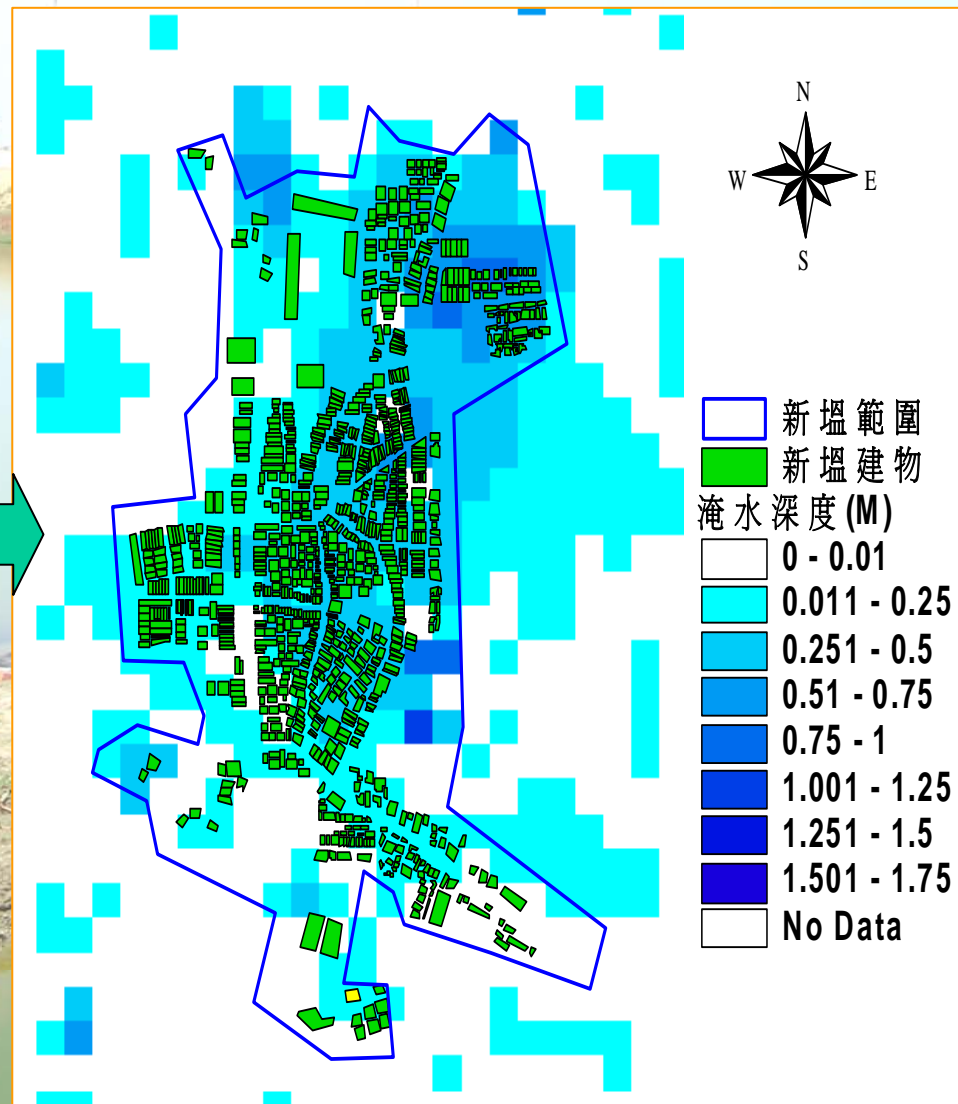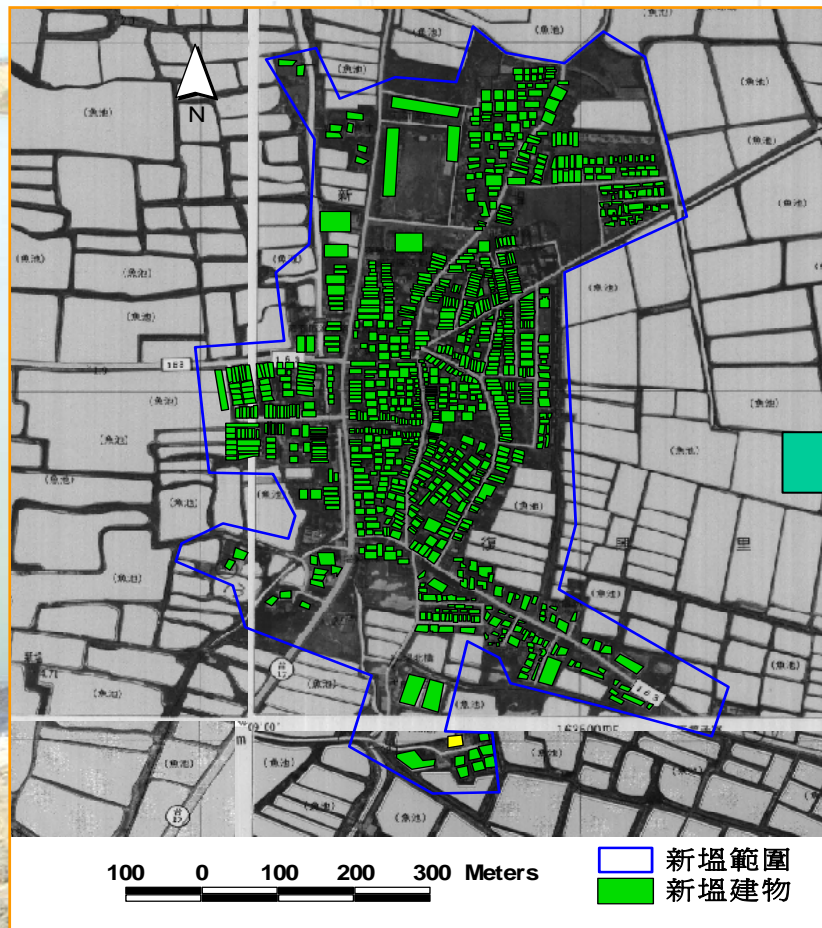
10 years return period

Flood simulation

工程整治前
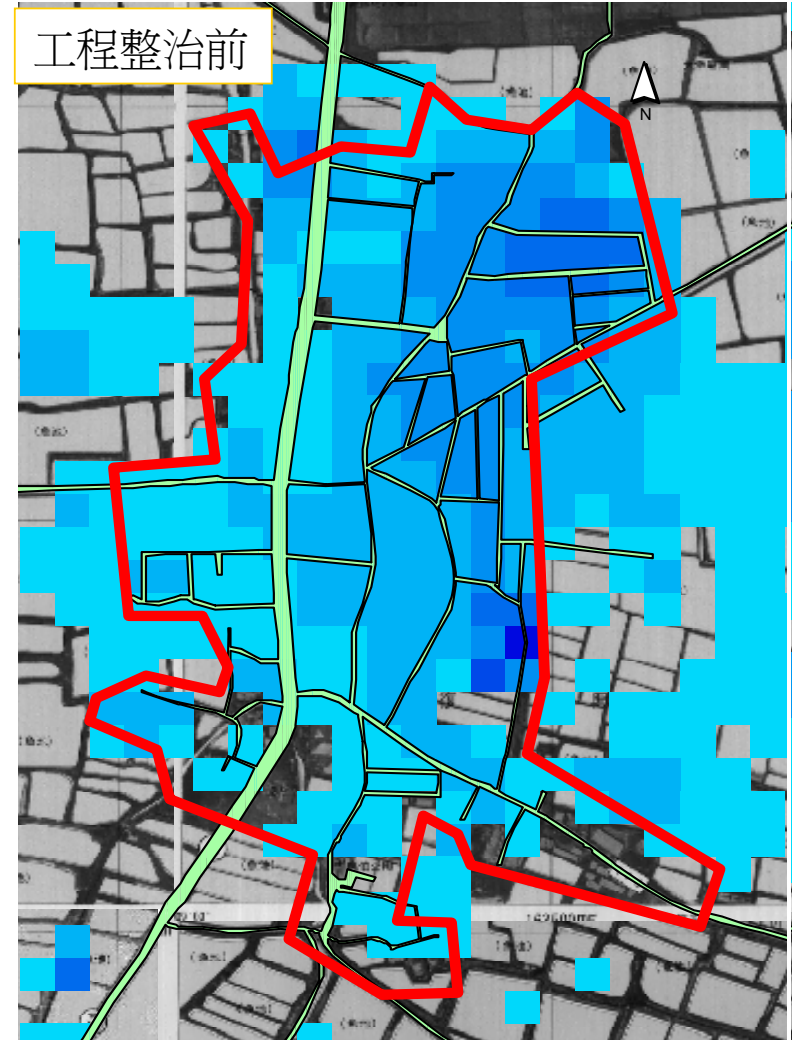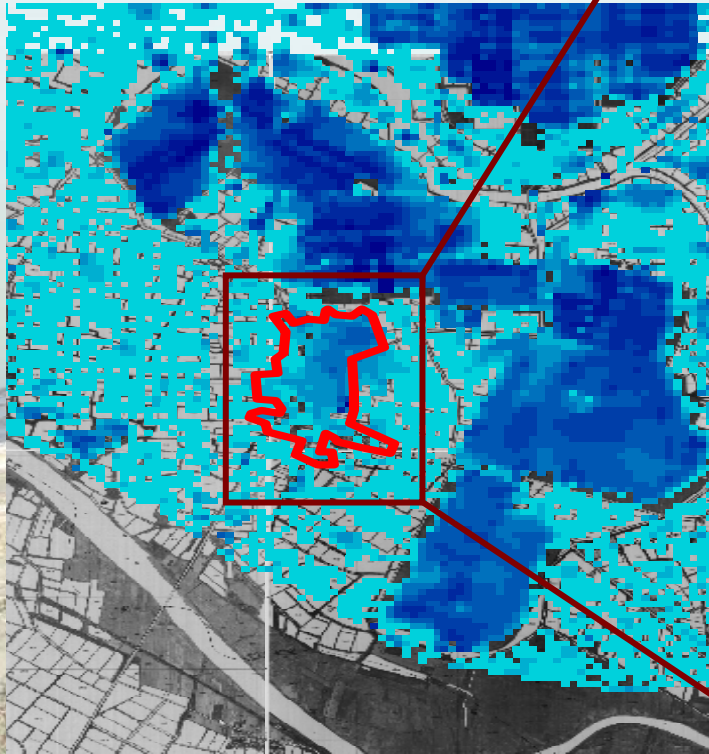
Source：Water Resource Agency

Inventory

Household distribution map

Scale	
100 0 100 200 300 Meters	

新塭範圍
新塭建物

新塭範圍
新塭建物
淹水深度(M)
- 0 - 0.01
- 0.011 - 0.25
- 0.251 - 0.5
- 0.51 - 0.75
- 0.75 - 1
- 1.001 - 1.25
- 1.251 - 1.5
- 1.501 - 1.75
- No Data

Vulnerability

Risk Assessment

無工程　　有工程

Risk Assessment

- Hazard
- Inventory
- Vulnerability
- Loss

Decision Processes

Risk Management Strategies

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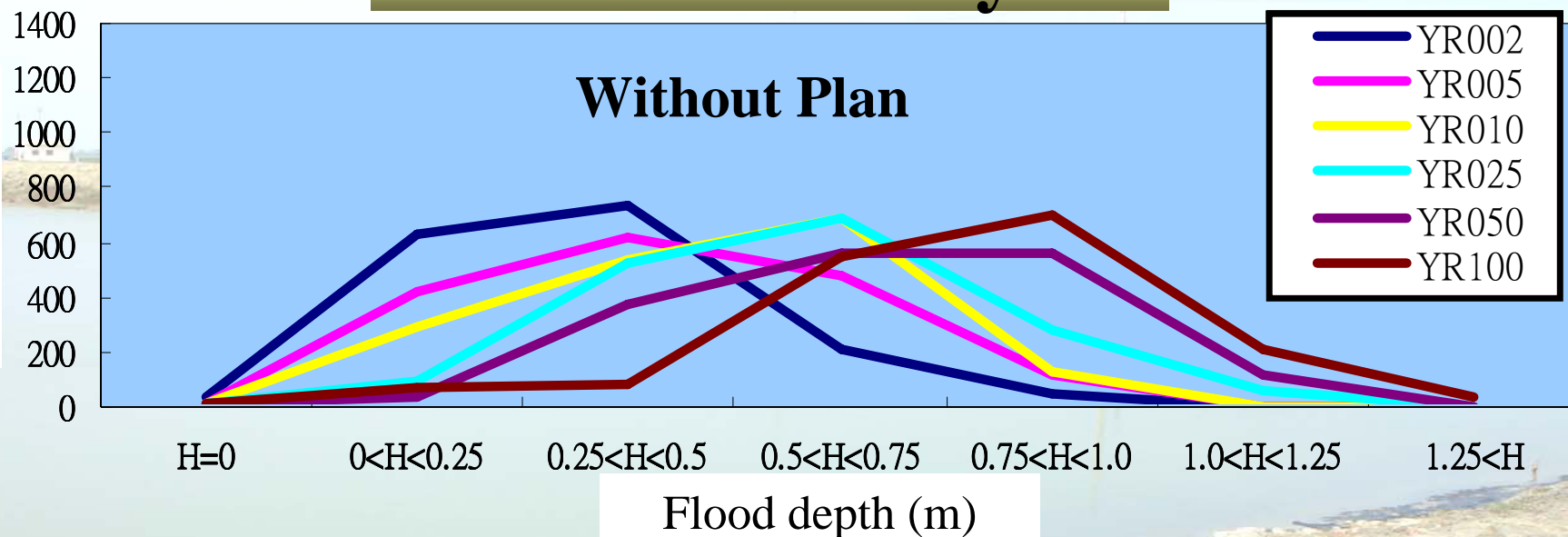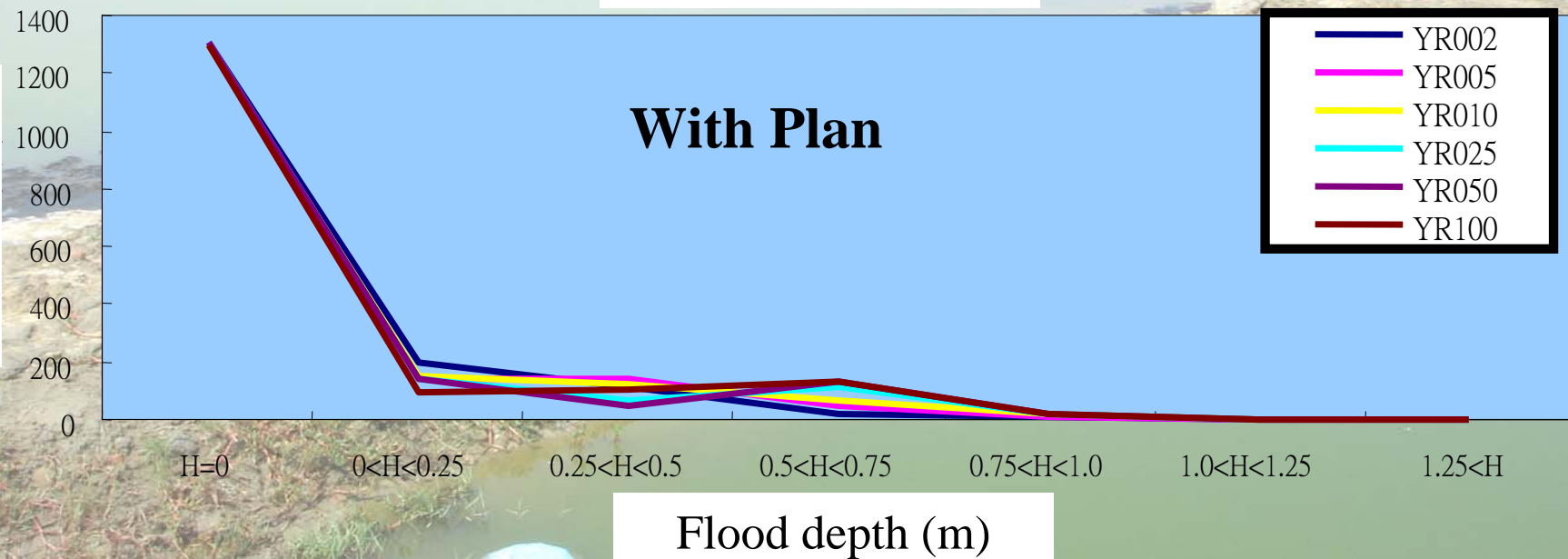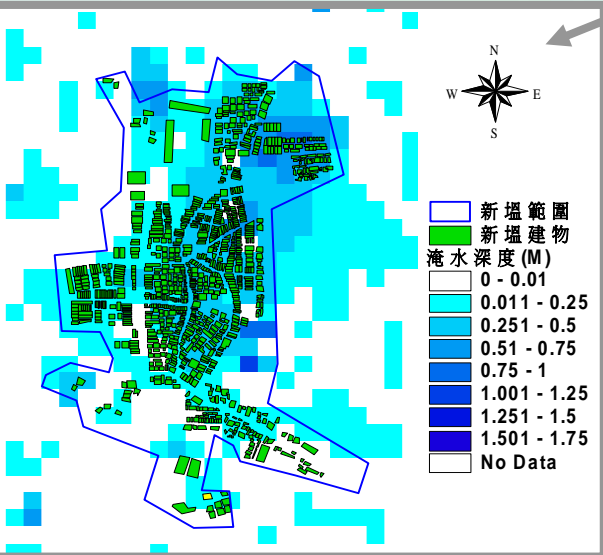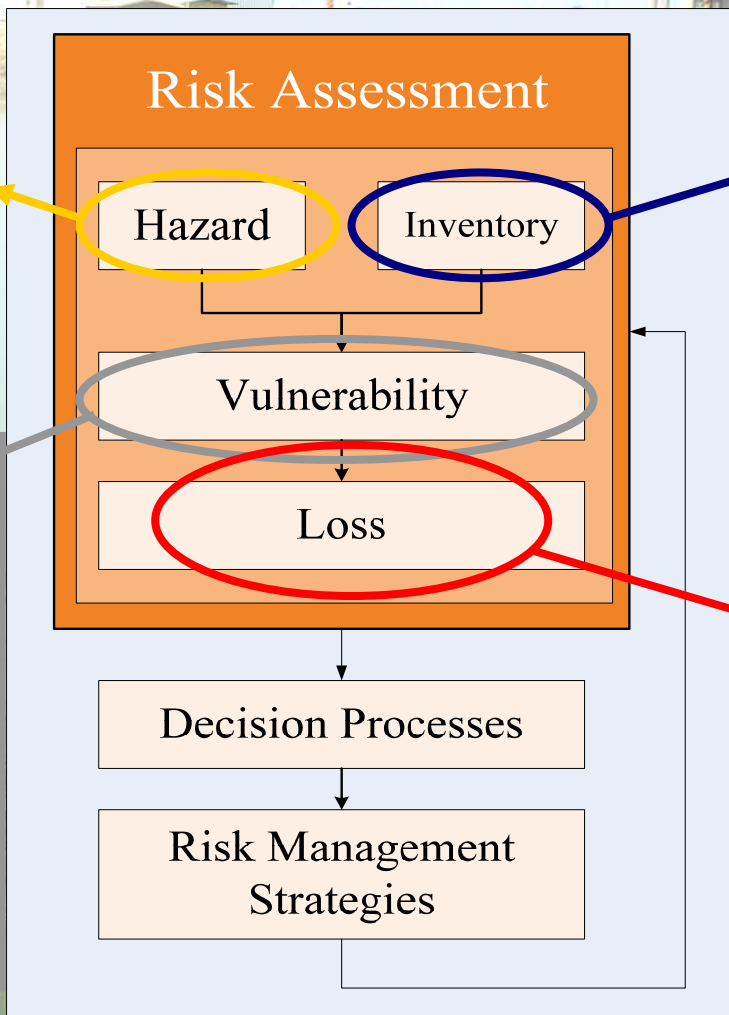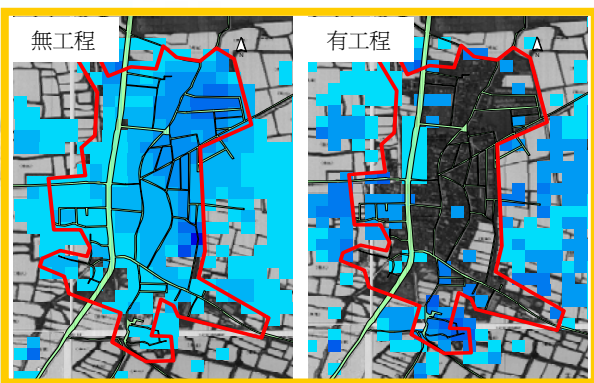
對數家戶損失=

- 1.418

+ 1.966 (對數 淹水高度)

- 1.515 (房屋為自有)

+ 0.346(對數 淹水次數)

+ 0.756 (對數 家庭人口數)

+ 0.166 (對數 家戶每人所得)

+ 0.493 (對數 區域淹水時間)

The flood loss of household

Return period	Loss without the plan A (dollars)	Loss with the plan B (dollars)	Benefit A-B (dollars)
2 years	12,115,750	1,859,054	10,256,696
5 years	20,775,736	2,803,818	17,971,917
10 years	25,332,873	3,418,418	21,914,455
25 years	36,625,441	4,138,915	32,486,527
50 years	48,429,457	4,266,747	44,162,710
100 years	61,307,861	4,578,949	56,728,912

Expected benefit of the plan

Return period	Benefit of the plan (dollars)	Probability	Expected benefit (NT dollars)
2 years	10,256,696	0.5	5,128,348
5 years	17,971,917	0.3	5,391,575
10 years	21,914,455	0.1	2,191,446
25 years	32,486,527	0.06	1,949,192
50 years	44,162,710	0.02	883,254
100 years	56,728,912	0.02	1,134,578
Annual expected benefit of the plan			16,678,393

About USD $ 0.5 M

CONCLUSION

- This paper according to the loss definition of welfare economics to built a regression model for loss assessment. And the verification confirms that the model can be use in the flood-prone area in Taiwan.

- Since the household is the basic unit of mitigation behaviors and the most vulnerable group. This paper provides a detailed method of assessing household benefits.

CONCLUSION

- If the plan benefits from other sectors, such as industry and agriculture, are assessed with similar method used in this paper, they can be added with household benefits and a complete plan benefit is shown.

Thank you

for your attention

NCDR Website
http://www.ncdr.nat.gov.tw/english/index2.htm