

# The Research on Flood and Drought Disasters Reduction of NCDR

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- I. Basic Feature of Taiwan
- II. Introduction of NCDR
- III. Research of Flood and Drought  
Disasters Reduction Division, NCDR
- IV. Future Works

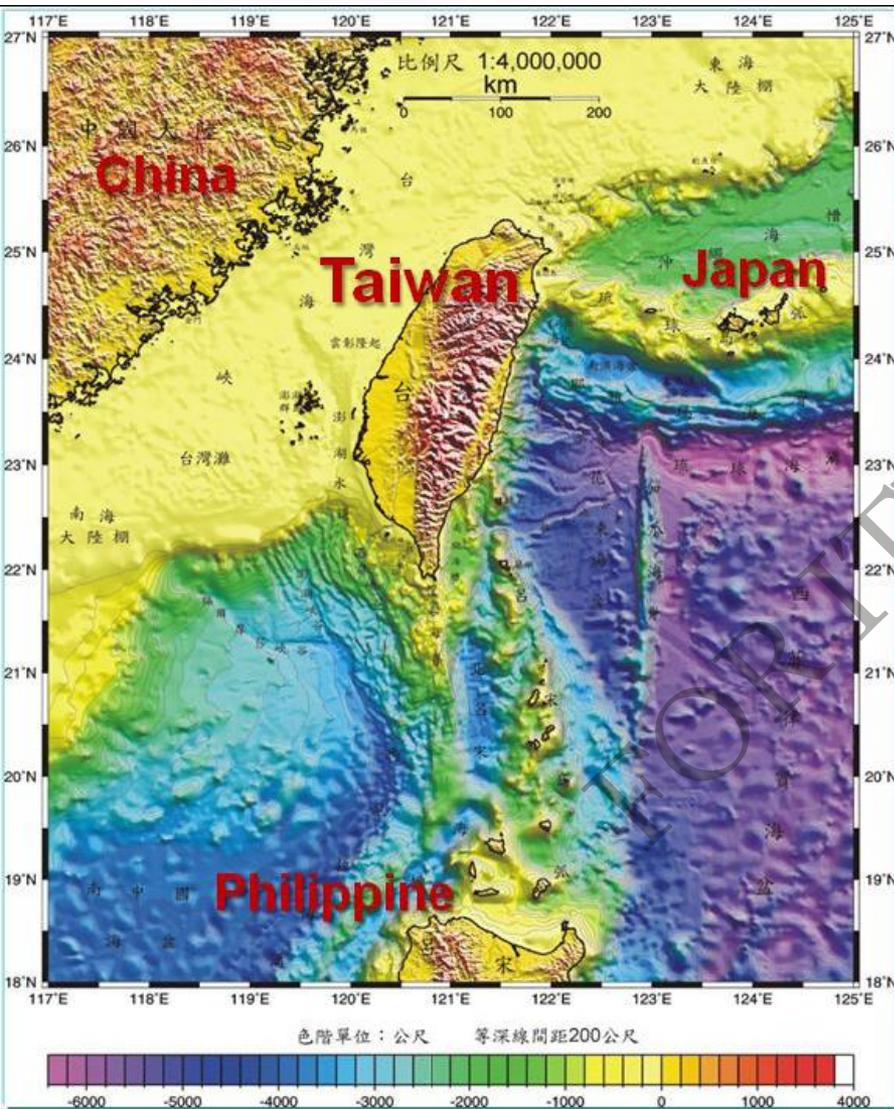


# Basic feature of Taiwan

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# Basic Feature of Taiwan



- **Geographic features**
  - 400 km from north to south
  - 145 km from east to west
  - Area: 36,000 Km<sup>2</sup>, over 70% being slope-land
- **Population (in June, 2006)**
  - 22,900,00 in total, 67.7% living in urban areas
  - Density: 633/ Km<sup>2</sup> , only lower than Bangladesh
- **Tectonic Conjunctions:**
  - Philippine Sea plate
  - Euro-Asia Plate
- **High risk of tropical cyclones**
  - 3.6 typhoons/year

# Natural Disasters in Taiwan



**Earthquake**



**Landslide**



**Typhoon**



**Flood**



**Debris flow**



# Why Taiwan Suffers More than Others

**Countries Most Exposed to Multiple Hazards**  
*Three or more hazards (top 15 based on land area)*

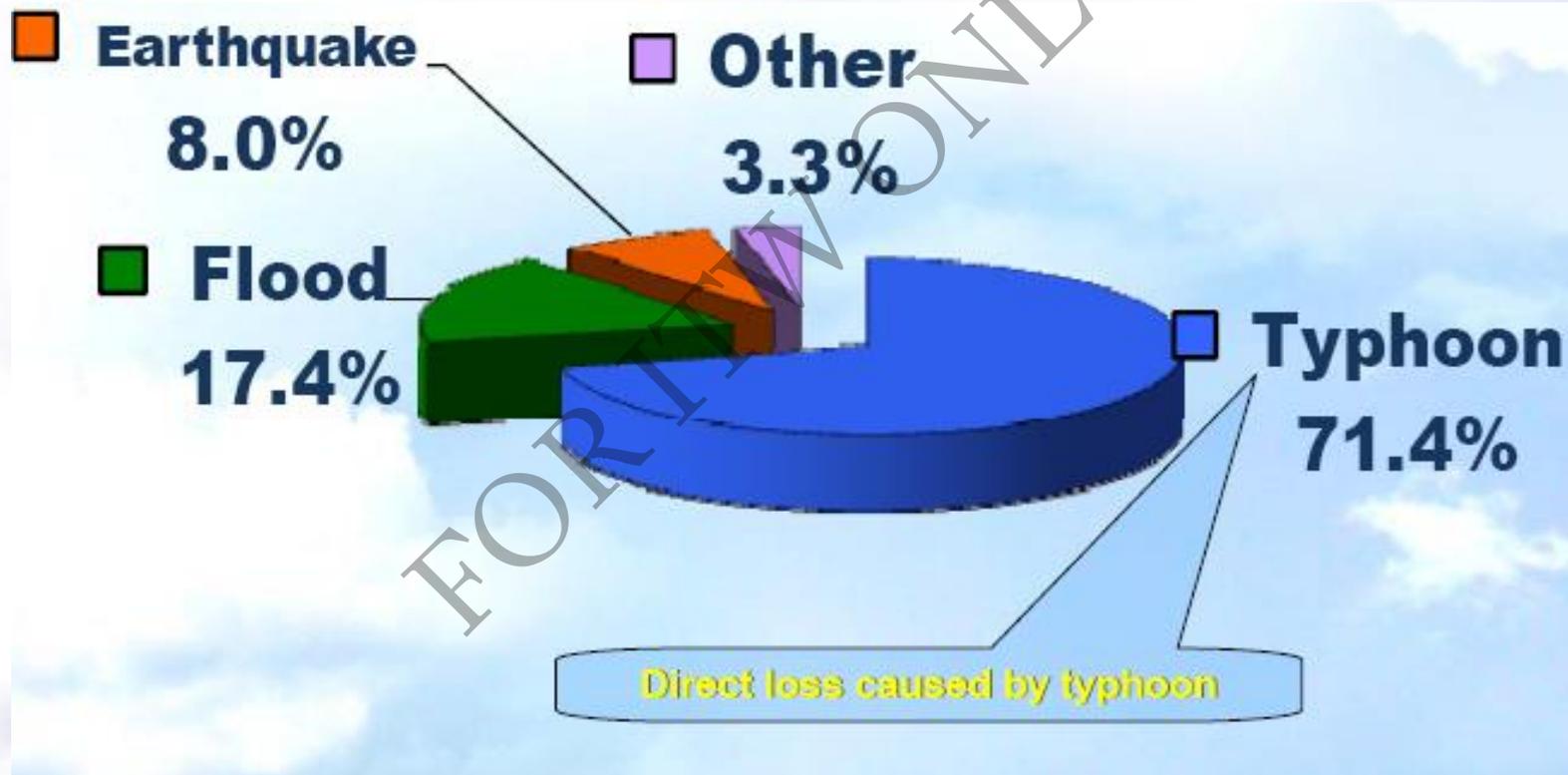
Country	Percent of Total Area Exposed	Percent of Population Exposed	Max. Number of Hazards
Taiwan	73.1	73.1	4
Costa Rica	36.8	41.1	4
Vanuatu	28.8	20.5	3
Philippines	22.3	36.4	5
Guatemala	21.3	40.8	5
Ecuador	13.9	23.9	5
Chile	12.9	54.0	4
Japan	10.5	15.3	4

Source: World Bank, 2005

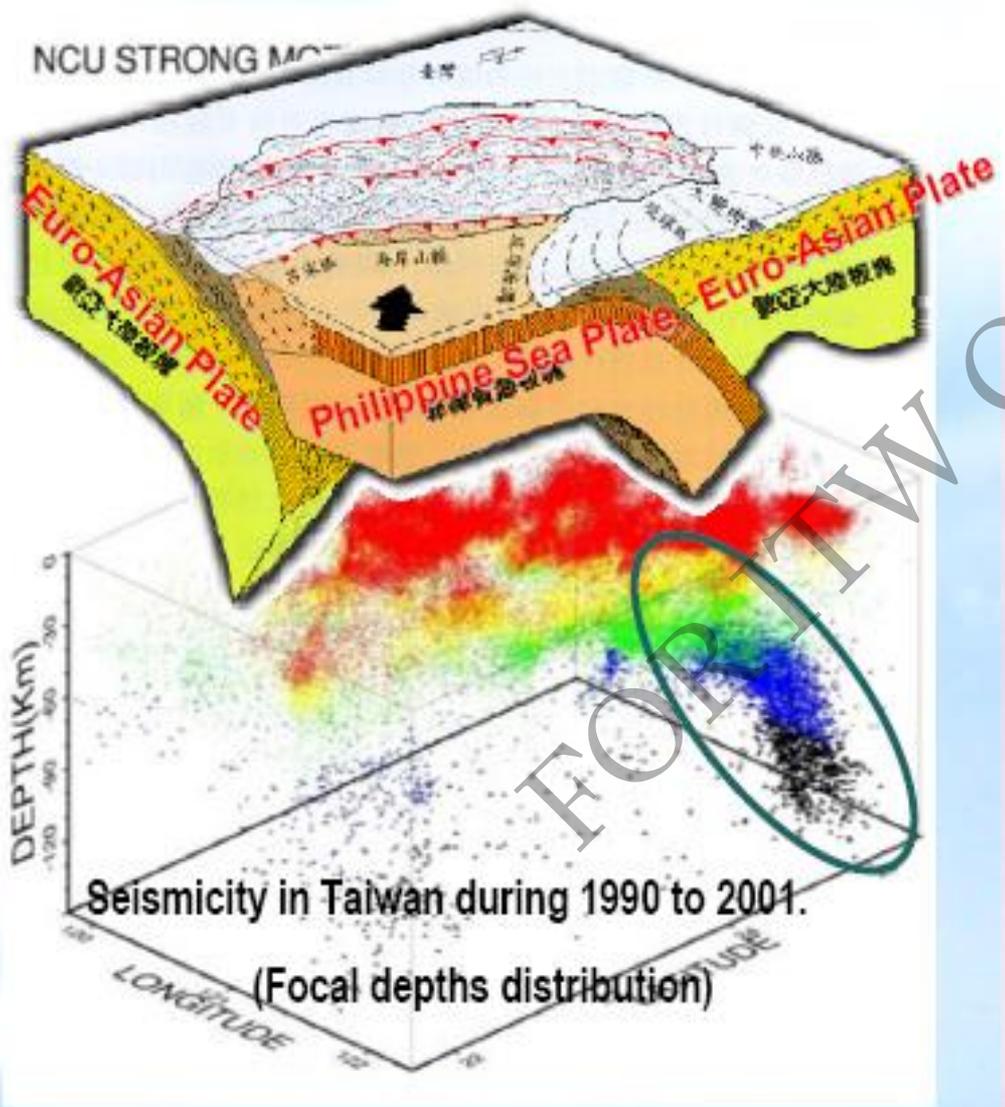
# Loss Analysis of Natural Disasters



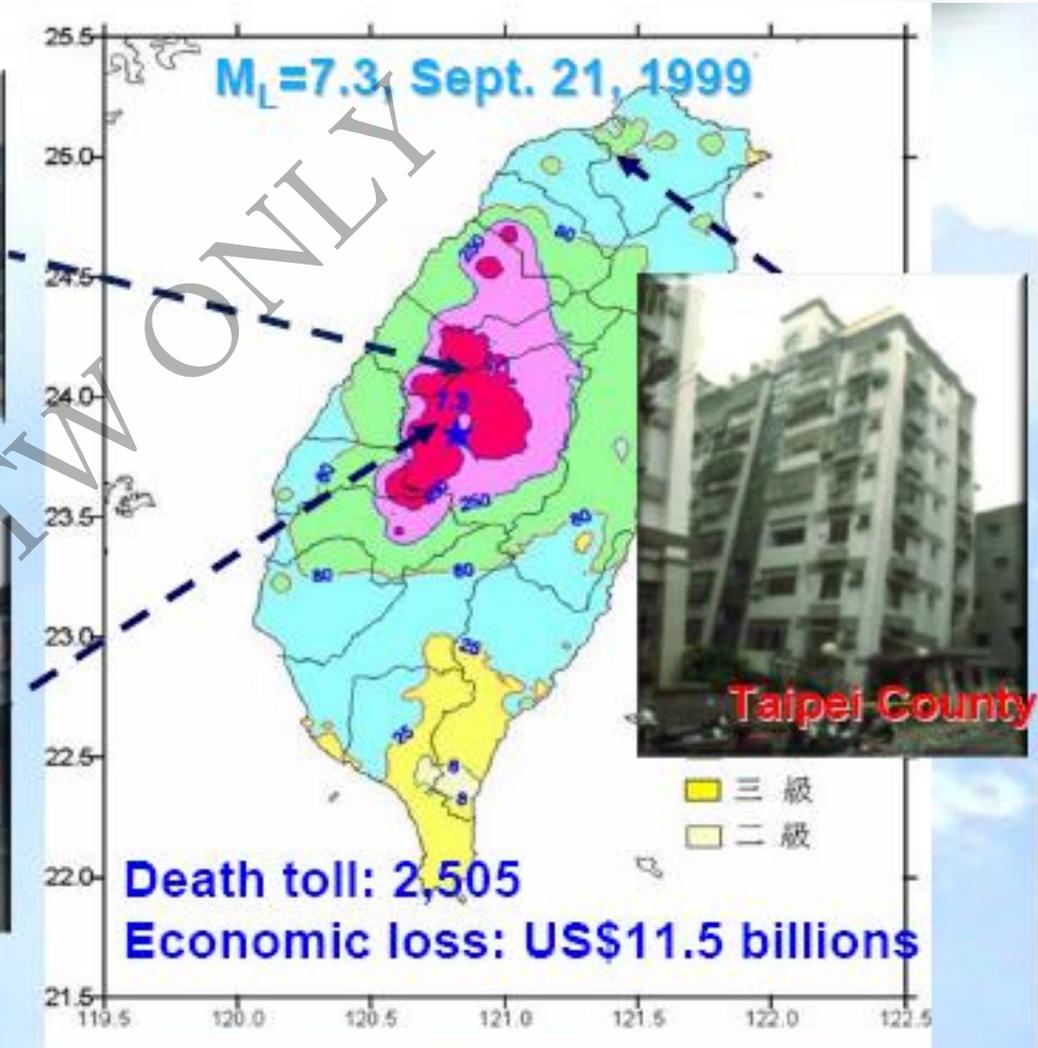
- **Total loss due to natural disasters**



# Seismicity and Active Faults in Taiwan



# 1999 Chi-Chi Earthquake



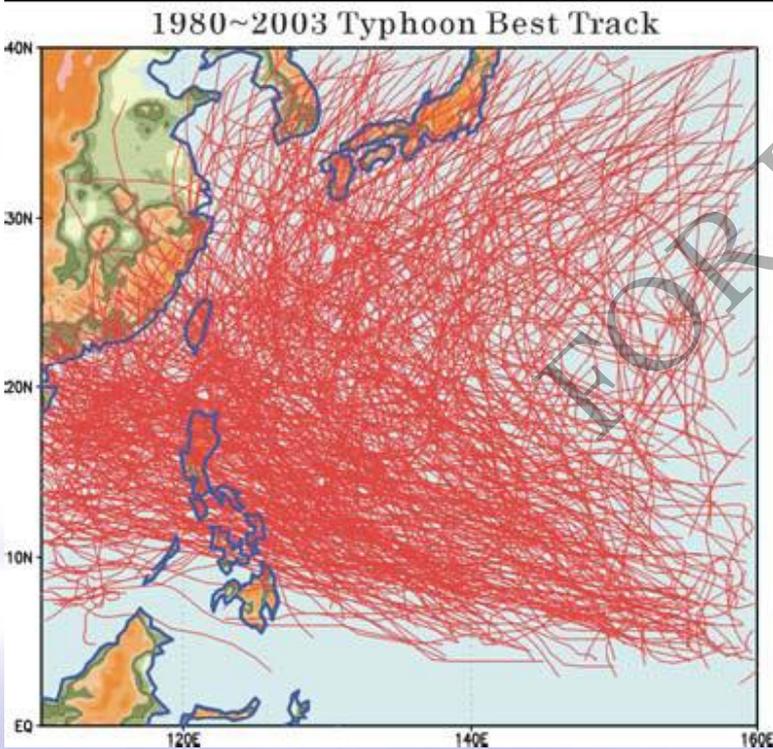
# 1999 Chi-Chi Earthquake





# Losses due to Typhoons in Taiwan

- In average, there are 3.6 typhoons per year
- □ In 2001, 8 typhoons attacked
- □ In 2004, 6 typhoons swept
- □ In 2005, 3 category-4 typhoons
- □ In 2006, 7 typhoons swept
- □ In 2007, 5 typhoons swept



Typhoon	Death	Injure	Agri. Loss (\$US M) (A)	Constr. Loss (\$US M) (B)	Total (\$US M) (A+B)
Chebi	30	124	22.3	0.7	23.0
Trami	5	-	2.2	4.9	7.1
<b>Toraji</b>	<b>214</b>	<b>188</b>	<b>235.7</b>	<b>170.6</b>	<b>406.4</b>
<b>Nari</b>	<b>104</b>	<b>265</b>	<b>126.5</b>	<b>56.7</b>	<b>183.1</b>
Utor	1	6	2.9	7.6	10.5
<b>Total</b>	<b>354</b>	<b>583</b>	<b>389.6</b>	<b>240.5</b>	<b>630.1</b>



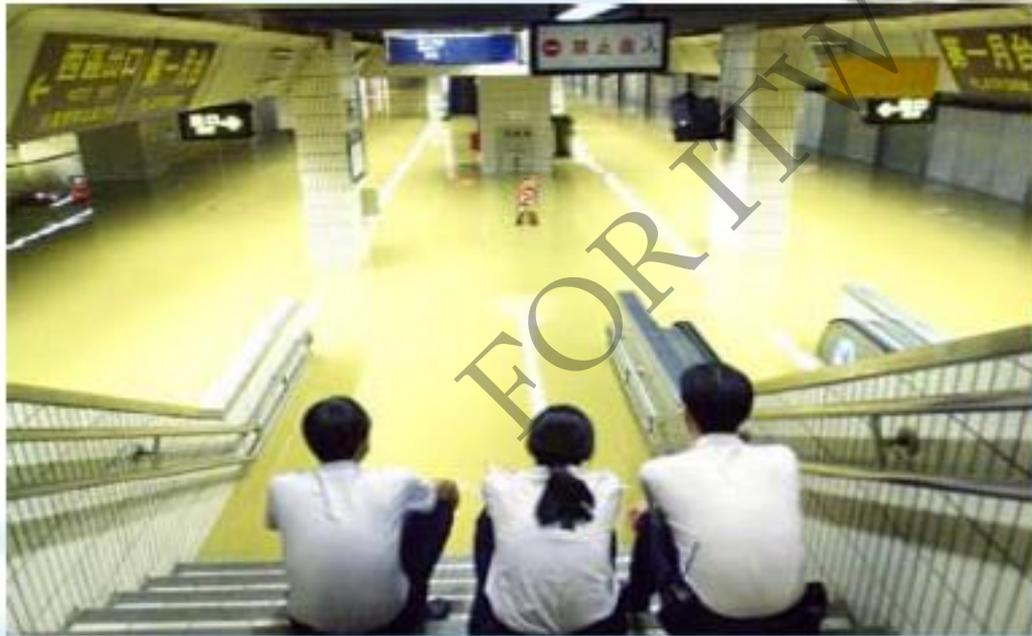
- **Debris flows and urban flooding have become the most**
- **severe hazards in Taiwan area during typhoon season.**



# Historical Flood Disaster



**In Taipei Downtown,  
subway and main streets  
were flooded.**



**Typhoon Nari  
(2001)**

# Debris Flow Disaster



2004, Central Taiwan

敏督利颱風松鶴部落土石流災害

1,080位居民撤離，68棟房屋毀損，1人死亡。



# Debris Flow Disaster





# **Introduction of National Science and Technology Center for Disaster Reduction (NCDR)**

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# What Taiwan Learns in Past Decades



## The four lessons we have

### 1 **Legislation**

*Specific Law will help to conduct all necessary measures, policies and plans for reduction, preparedness, response and recovery.*

### 2 **Teamwork**

*Cooperation and collaboration from inter- and intra- government sectors will be the solid foundation to implement designed plans..*

### 3 **Bottom-up**

*Local government and community need the empowerment from central government and require a well-defined regional plan.*

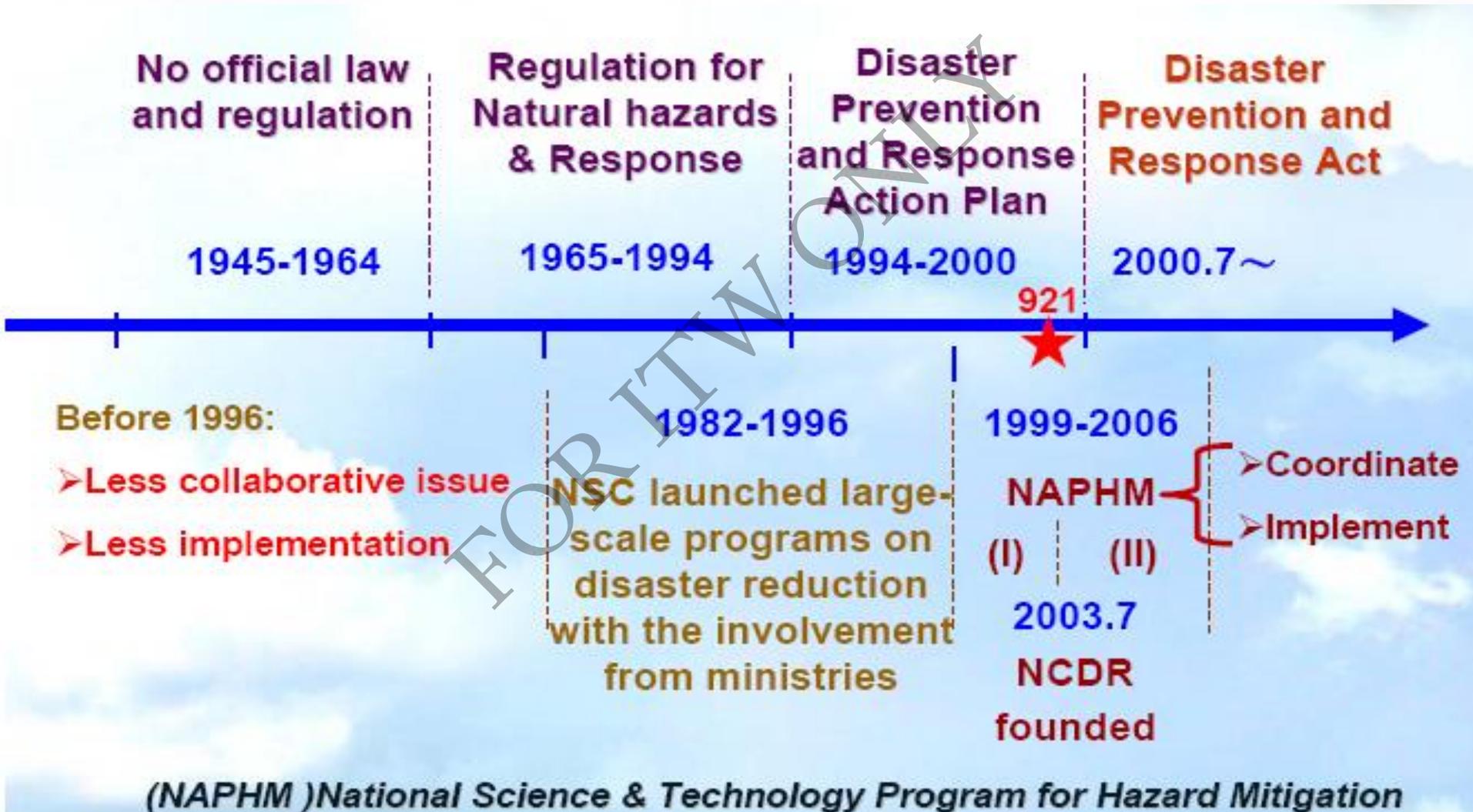
### 4 **Technology**

*Academic supports and research results with practical concerns and fulfilled implementation will provide the best reference of policy making.*

# Infrastructure against Disaster



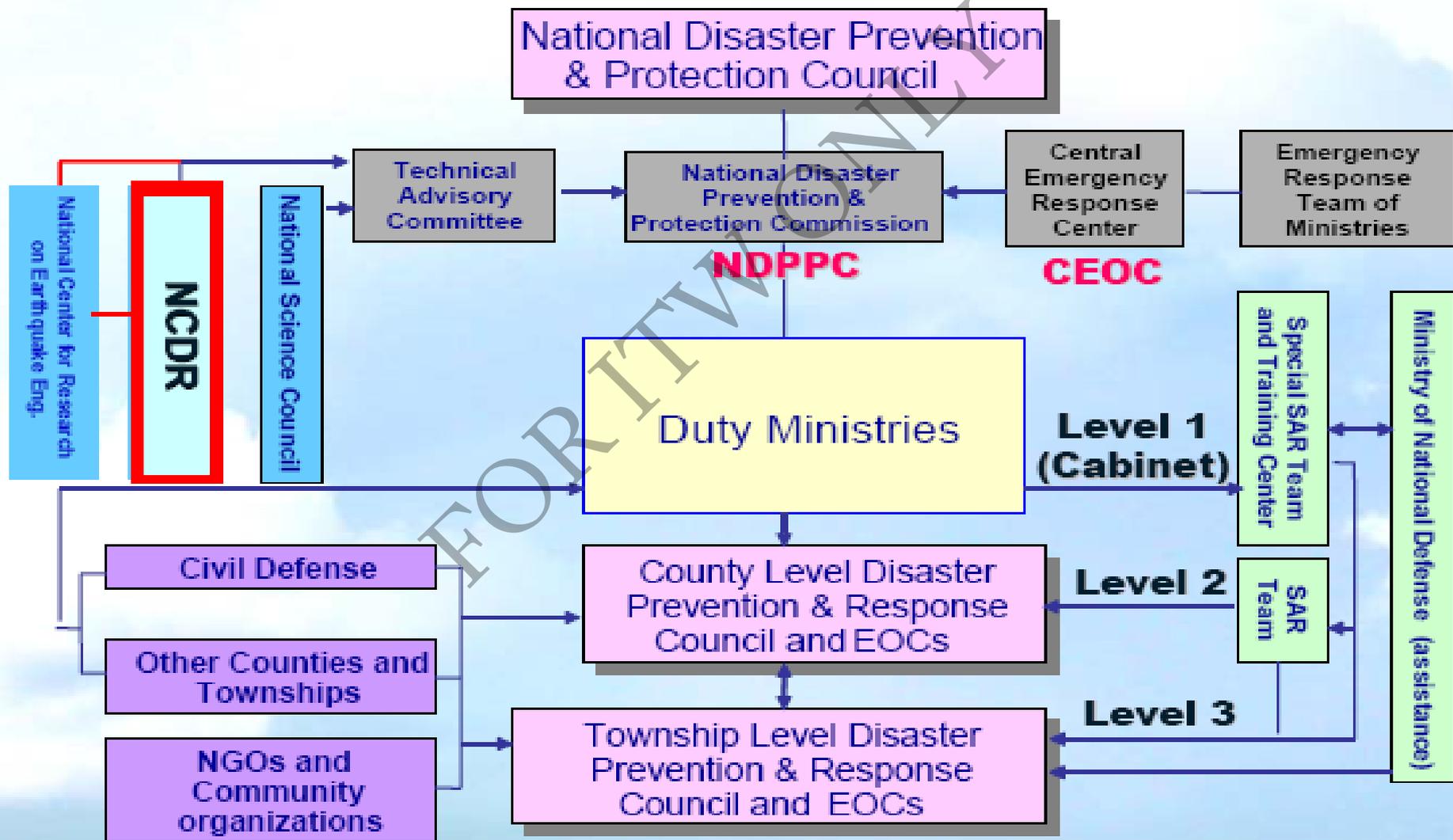
# History of System Development and Technology Innovation





# Framework of Current Disaster Management Organizations in Taiwan

According "Disaster Prevention and Response Act", enforced in 2000



# Headquarters for Emergency Response & Disaster Response



## Union Development Building

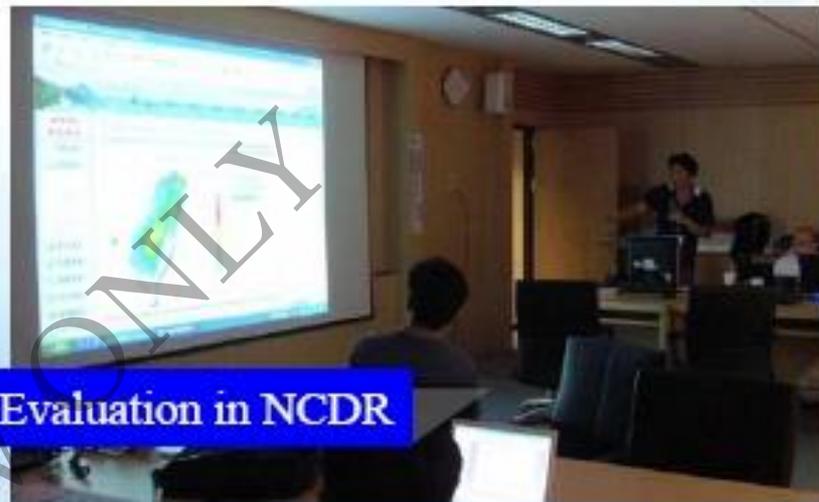
- Communication Center (17F)
- Conference Room (15-16F)
- Architecture and Building Research Institute (12-13F)
- Aviation Safety Council (11F)
- Airborne Service Corps (10F)
- NCDR (9F)**
- Nation Fire Agency (6-8F)
- Disaster Prevention and Protection Commission (5F)
- Emergency Operation Center (3-4F)



# Analysis & Evaluation Division of CEOC



Discussion of Analysis & Evaluation in NCDOR



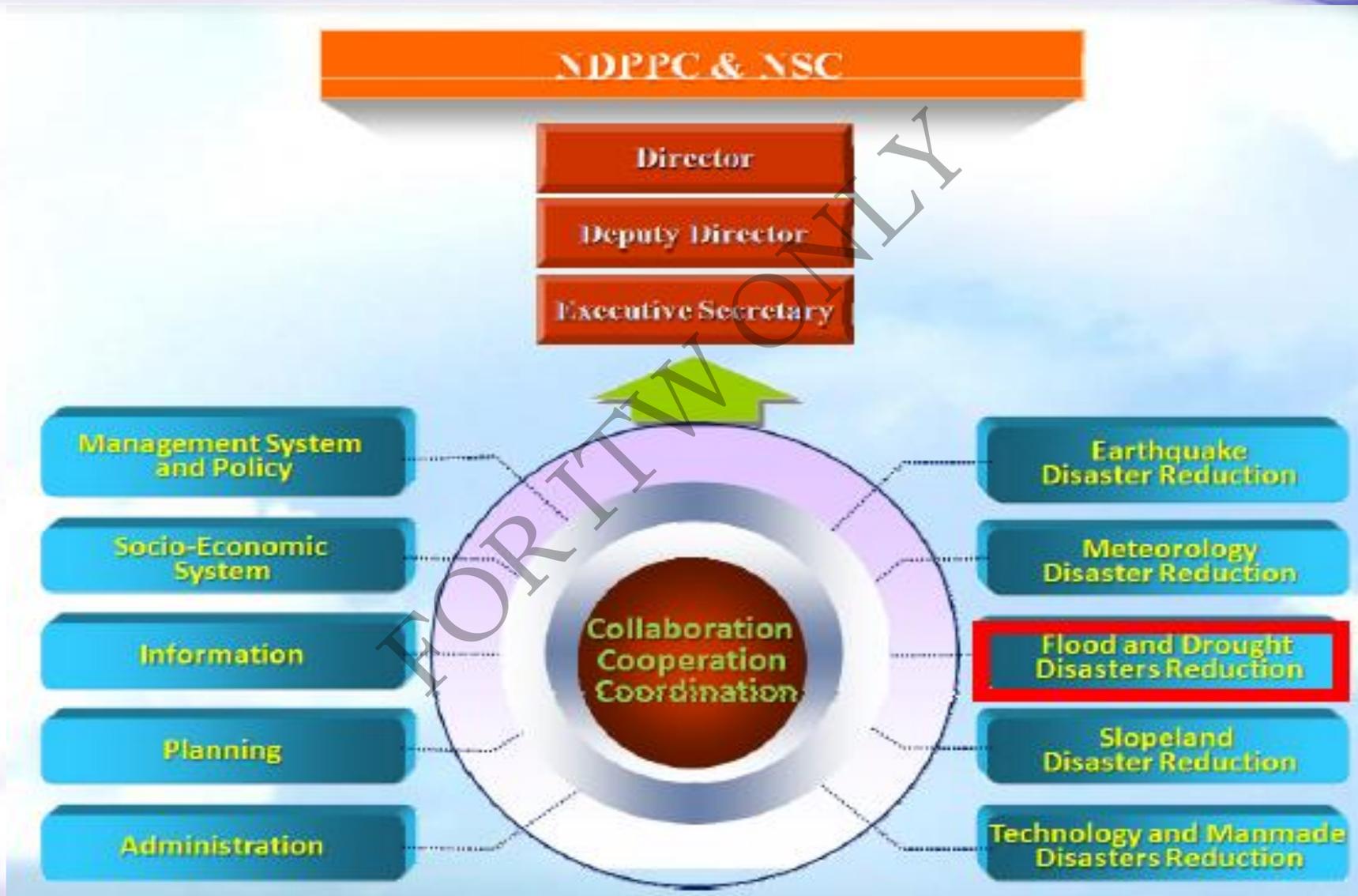
Discussion of Analysis & Evaluation in CEOC



# Report of Analysis & Evaluation at CEOC



# Organization of NCDR





# **Research of Flood and Drought Disasters Reduction Division**

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# Flood and Drought Disasters Reduction Division

- **Research and development**

- ◆ Devote to science research in flood and drought disasters
- ◆ Develop the hazard mitigating technologies

- **Technical support**

- ◆ Assist to the planning and operation of the agencies for flood and drought disasters prevention and rescue
- ◆ Decision making supports to the emergency and water management authorities during disasters

- **Practical application**

- ◆ Establish the practicable procedures for flood and drought disasters reduction
- ◆ Staff training for other agencies and public education in flood and drought disasters prevention technologies

# The inundation potential maps of Taiwan

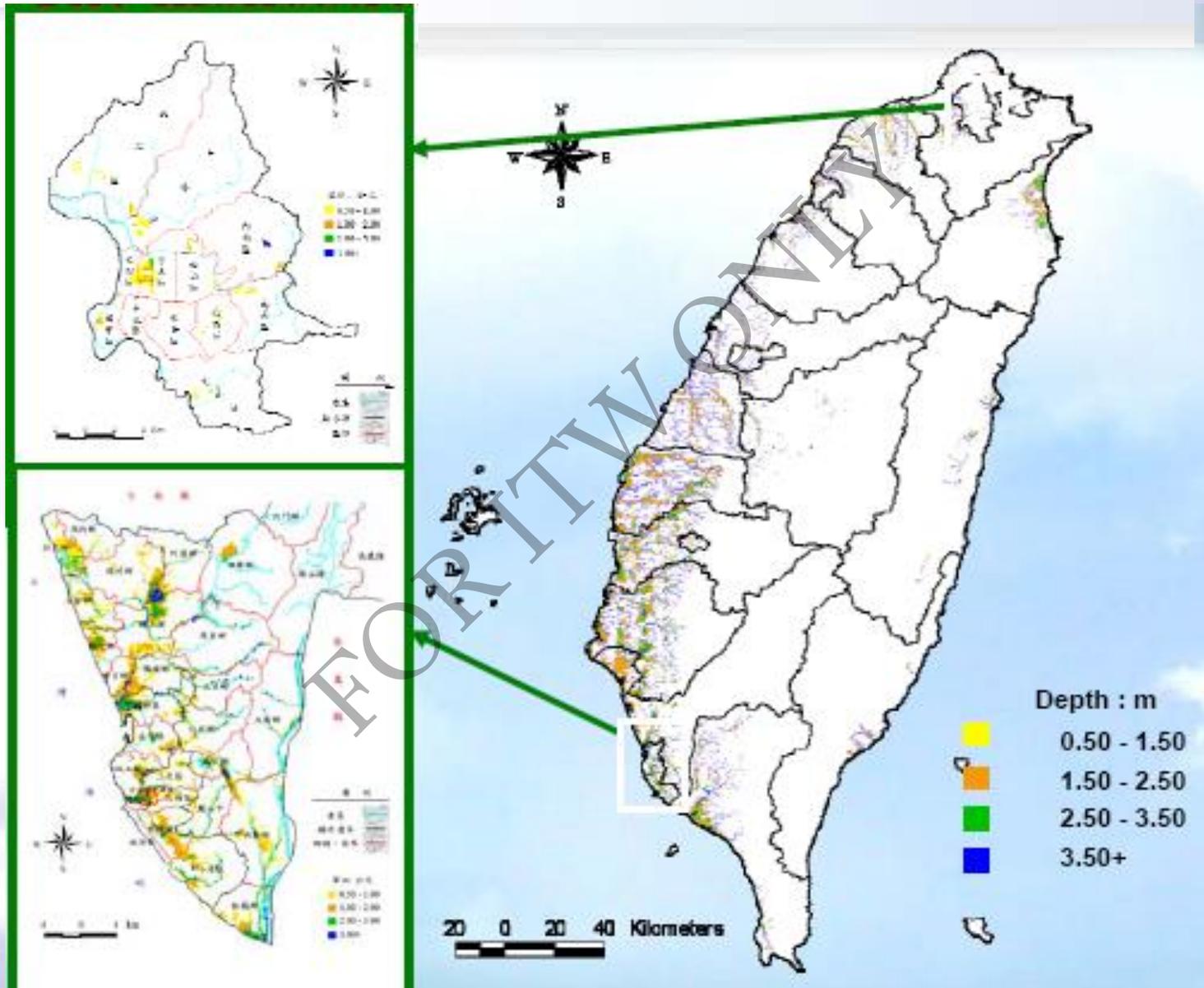


- **The flood-and-drought mitigation research group published the island-wide inundation potential maps in 2001.**

## **Applications of the inundation potential maps:**

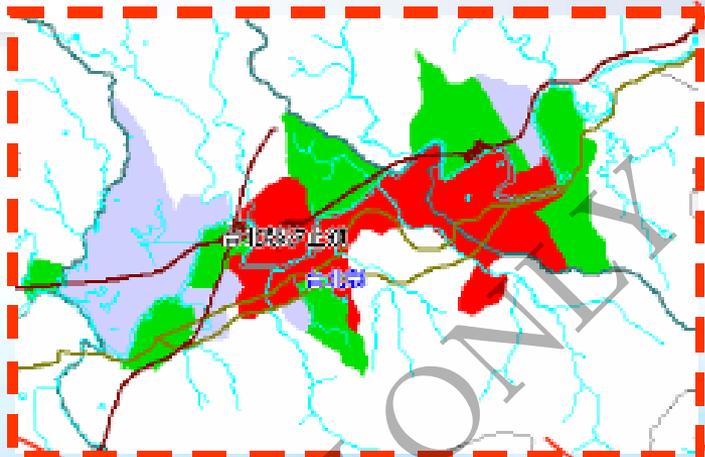
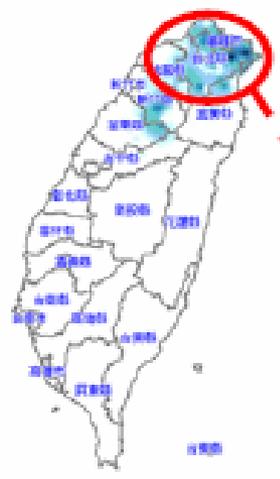
- – For floodplain managements
  - • Evaluation for the land resources
  - • Avoid the inappropriate land uses
- – For flood mitigations
  - • Establish the flood prevention strategy
  - • Set the flood response measures
- – Incorporation with social-economic information
  - • Analyze the loss and damage of flood hazard
  - • Determine the flood insurance premium rates

# Inundation potential maps of Taiwan



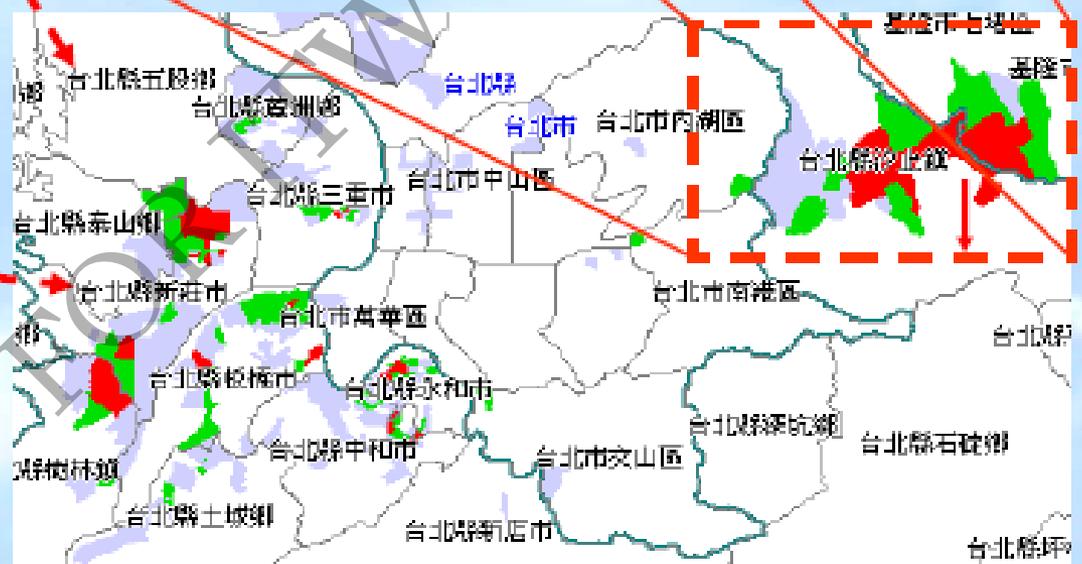


# Estimation of Inundation and Warning



- River
- County boundary
- Township boundary
- Highway
- Major road

Real-time Rainfall Records  
+

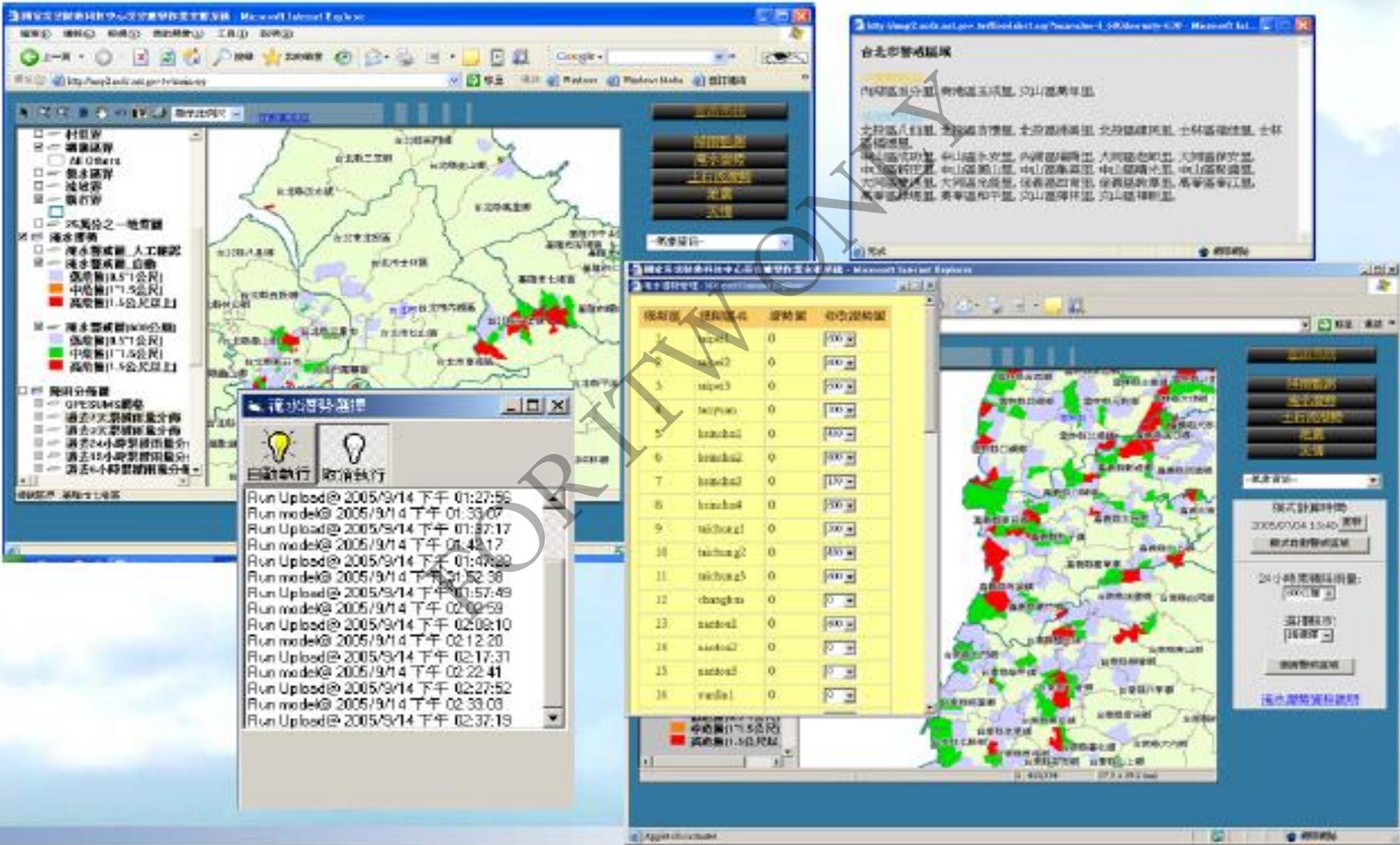


Flood Potential

- Highest (avg. depth > 1.5 m)
- Higher (avg. depth 1.0m - 1.5m)
- High (avg. depth 0.5m - 1.0 m)

Rainfall Forecasting

# The User Interface for the Forecast of Inundation Potential Areas



The interface displays a map of Taipei with inundation potential areas highlighted in red and green. A legend on the left indicates different levels of inundation: 高水警 (17.5公尺以上) in red, 中水警 (17.5公尺) in green, and 低水警 (17.5公尺以下) in blue. A central table lists various districts and their corresponding inundation levels.

行政区	inundation level	inundation level
1. taipei1	0	100
2. taipei2	0	100
3. taipei3	0	100
4. taipei4	0	100
5. taipei5	0	100
6. taipei6	0	100
7. taipei7	0	100
8. taipei8	0	100
9. taipei9	0	100
10. taipei10	0	100
11. taipei11	0	100
12. taipei12	0	100
13. taipei13	0	100
14. taipei14	0	100
15. taipei15	0	100
16. taipei16	0	100
17. taipei17	0	100
18. taipei18	0	100
19. taipei19	0	100
20. taipei20	0	100
21. taipei21	0	100
22. taipei22	0	100
23. taipei23	0	100
24. taipei24	0	100
25. taipei25	0	100
26. taipei26	0	100

A log window in the foreground shows the following entries:

```

Run Upload@ 2005/9/14 下午 01:27:56
Run model@ 2005/9/14 下午 01:33:07
Run Upload@ 2005/9/14 下午 01:37:17
Run model@ 2005/9/14 下午 01:43:17
Run Upload@ 2005/9/14 下午 01:47:29
Run model@ 2005/9/14 下午 01:53:38
Run Upload@ 2005/9/14 下午 01:57:49
Run model@ 2005/9/14 下午 02:02:59
Run Upload@ 2005/9/14 下午 02:08:10
Run model@ 2005/9/14 下午 02:12:20
Run Upload@ 2005/9/14 下午 02:17:31
Run model@ 2005/9/14 下午 02:22:41
Run Upload@ 2005/9/14 下午 02:27:52
Run model@ 2005/9/14 下午 02:33:03
Run Upload@ 2005/9/14 下午 02:37:19
    
```

The interface also includes a sidebar with various map layers and a right-hand panel with buttons for 'Run', 'Stop', and 'Refresh'.



The inundation potential database can be used to propose the local disaster prevention & response basic plan for local governments.

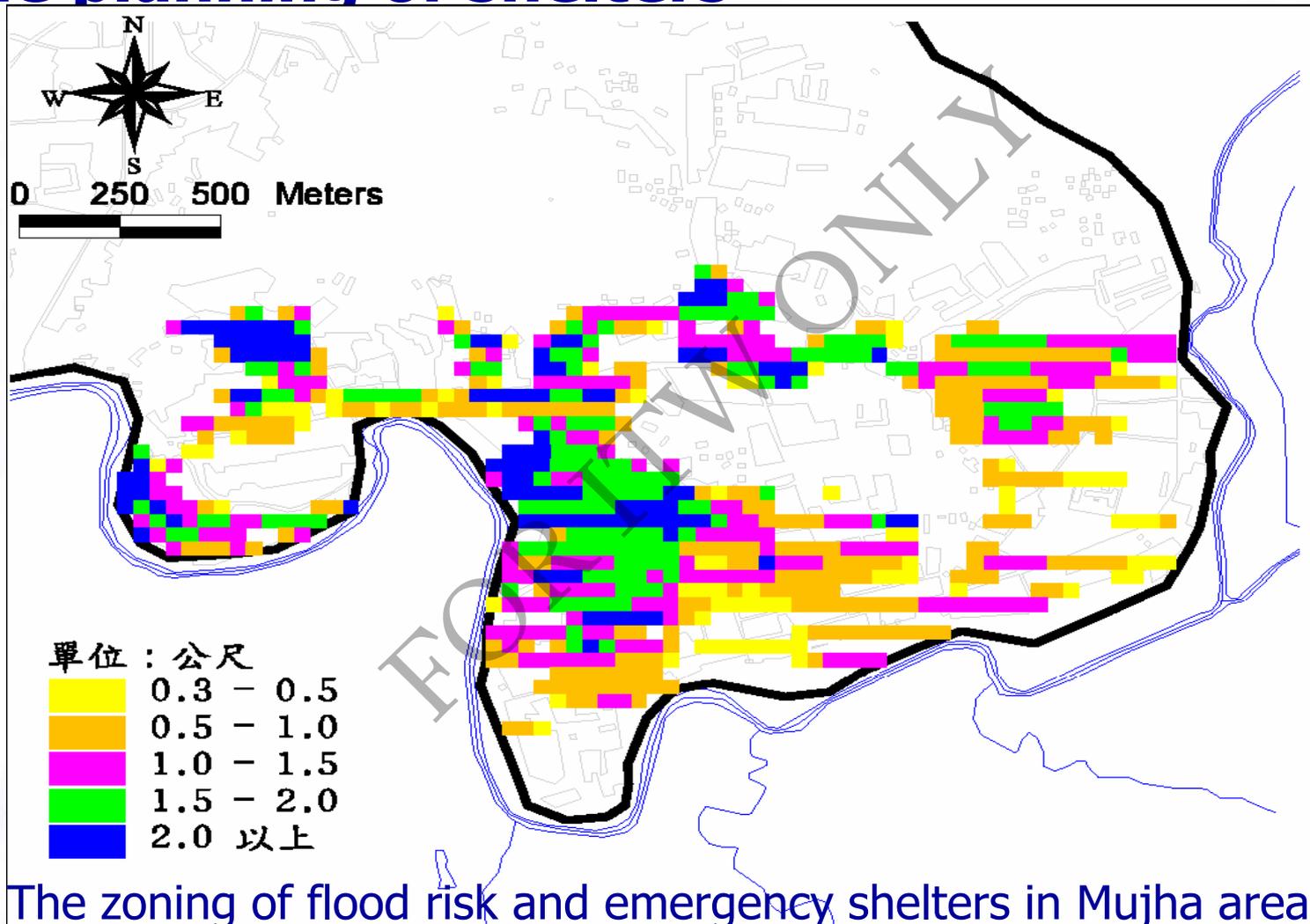
Applications are following:

- Design the defense scope of flood disaster for county,
- Allocation of rescue resources,
- Planning of shelters and evacuating routes,
- Improvement of the drainage system for high risk inundation areas,
- Land resources evaluated and identified by the IPMs to avoid inappropriate land use,
- Planning inundation warning system.



- Integrated historical flood events and inundation potential data to design the maximum defense scope of flood disaster.
- Example in Taipei
  - Typhoon Nari event
  - 600 mm/day inundation potential data

# The planning of shelters

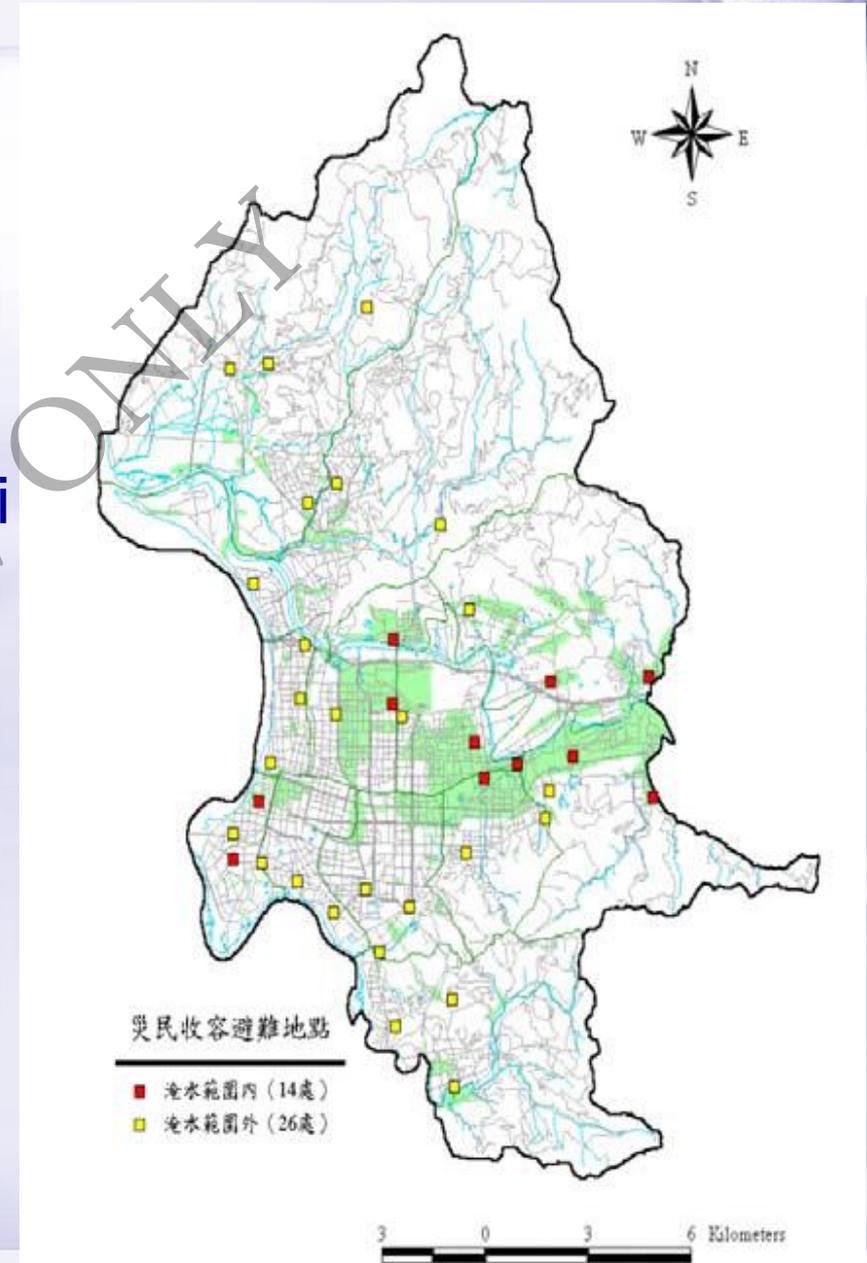


- The zoning of flood risk and emergency shelters in Mujha area, Taipei

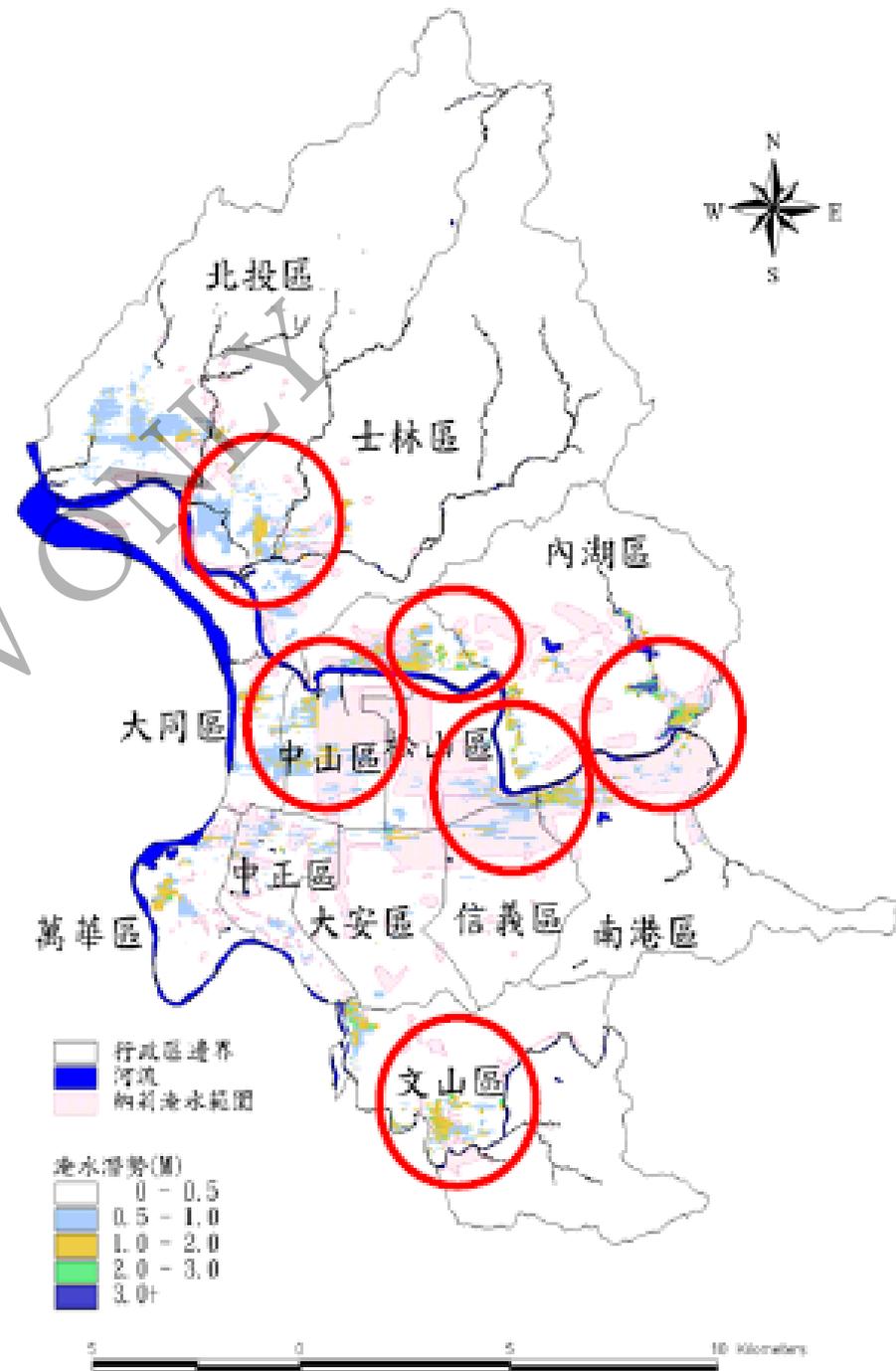
## Check the suitability of shelters

Use the design maximum defense scope map of flood disaster to check the suitability of shelters that have been planned before the Typhoon Nari event.

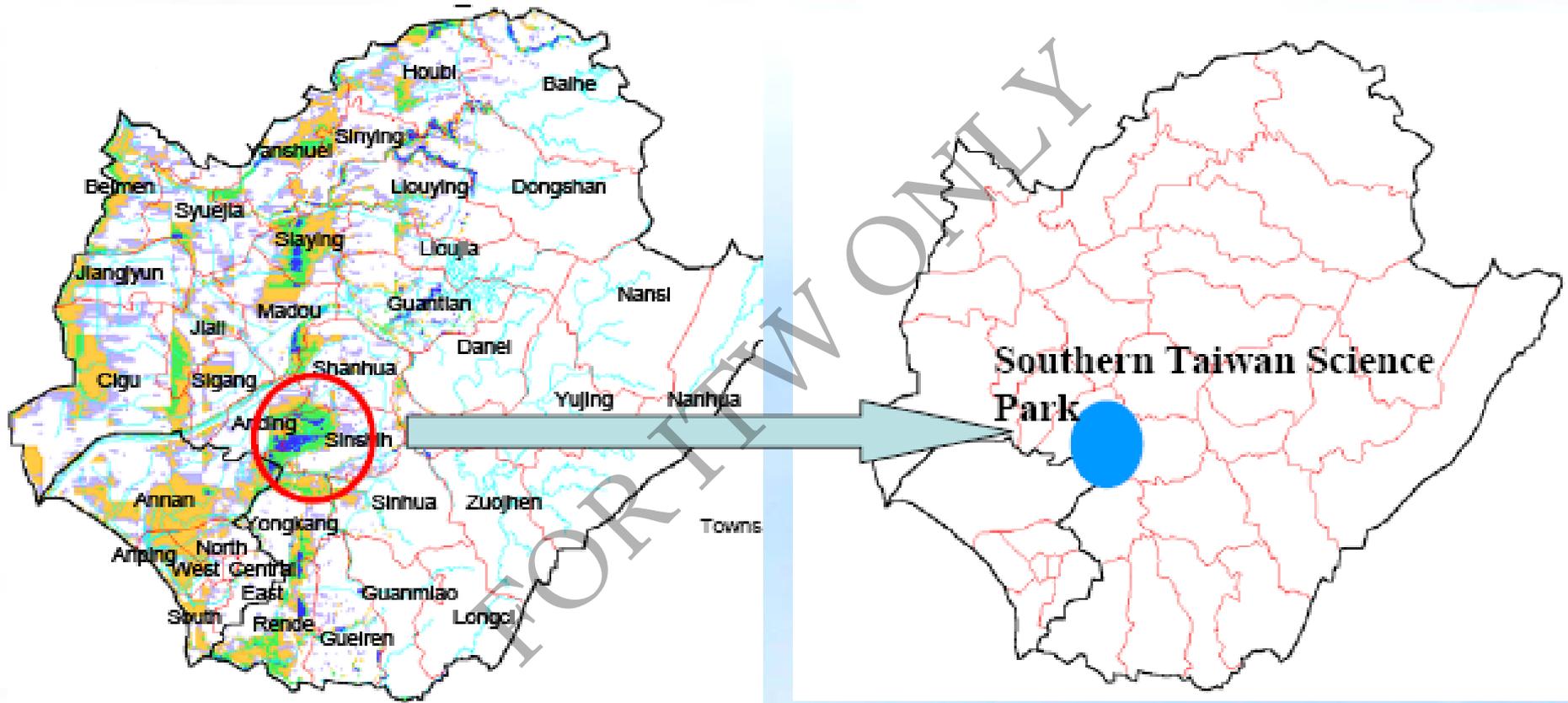
- inside the inundation areas (14 points)
- outside the inundation areas (26 points)



For these high risk inundation areas, high priority should be given to improve the drainage system.



# An incorrect example

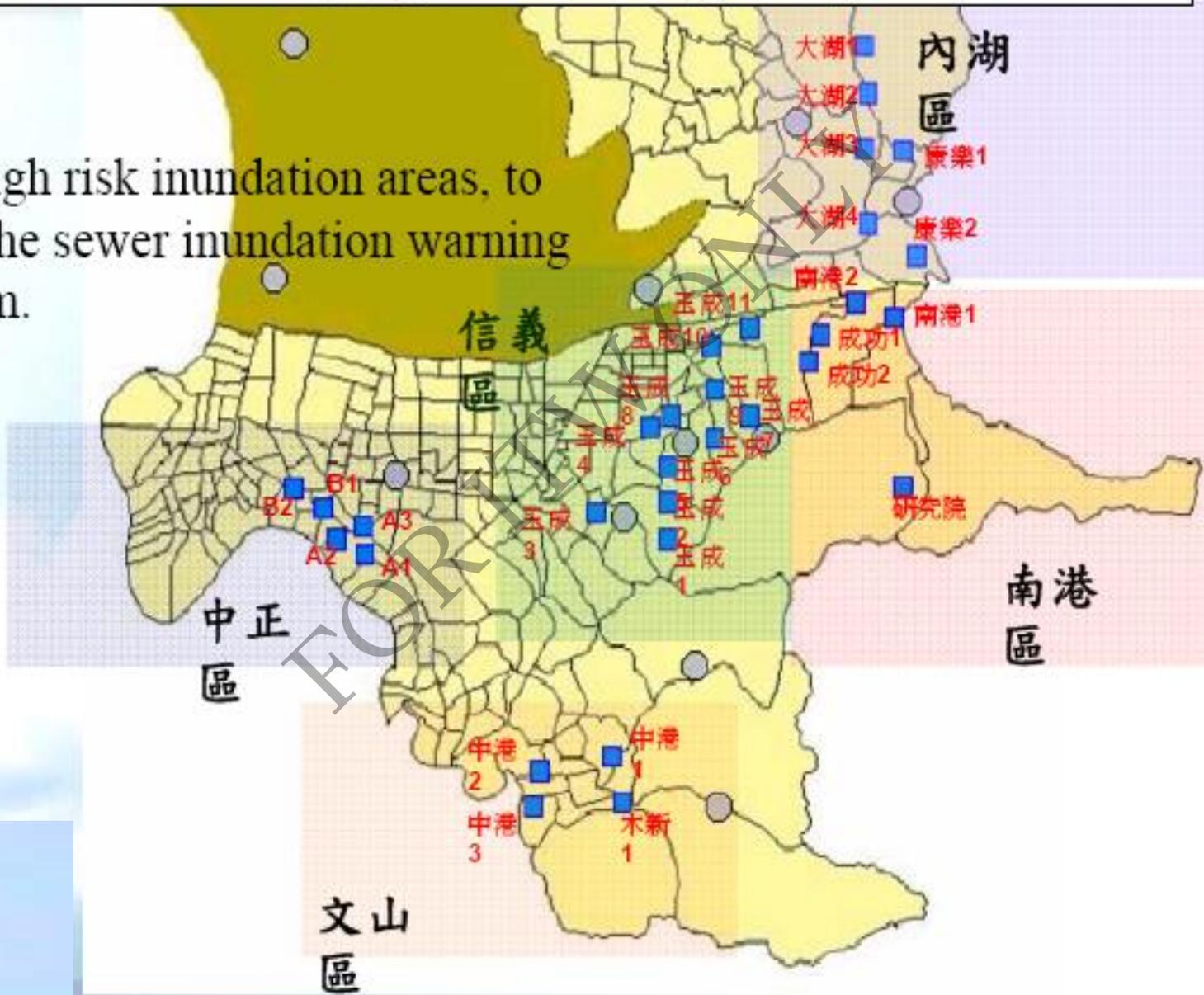


- Because the location of high-tech Science Park did not refer to the inundation potential analysis information at the beginning, so now the government must spend much more money to improve the flood-protect system.



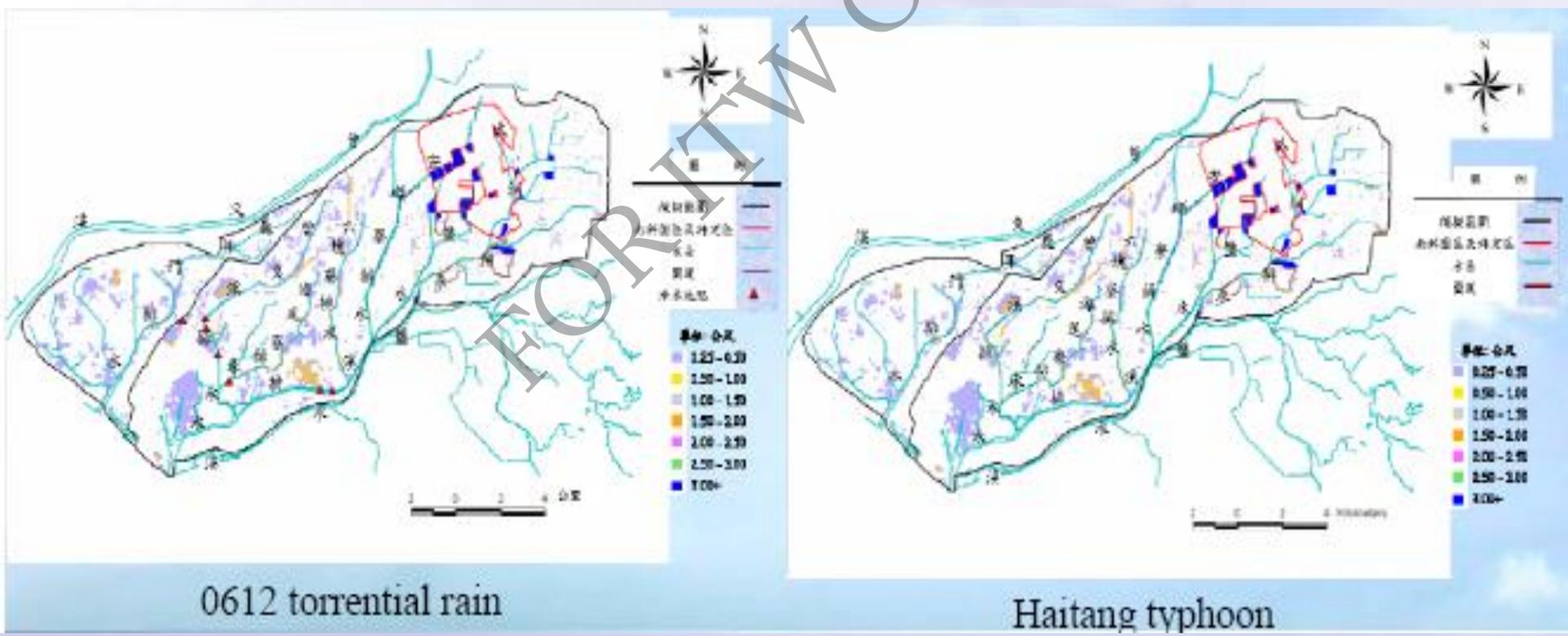
# The distributed map of monitors stations network for sewer warning system in Taipei city.

For high risk inundation areas, to plan the sewer inundation warning system.



# Flood Hazard Scenario Simulations

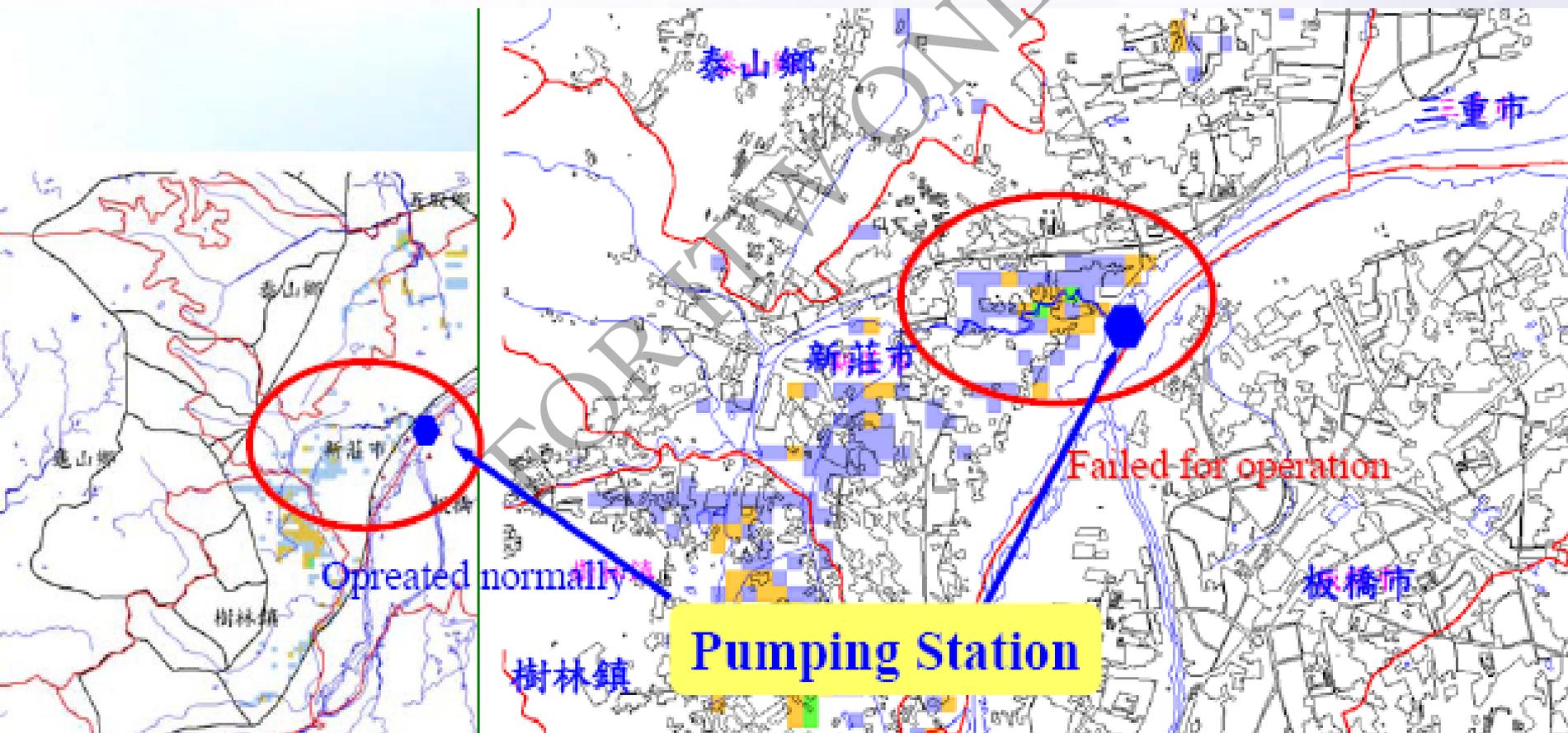
- Flood and Drought Disasters Reduction Division of NCDR did the flood hazard scenario simulations of 0612 torrential rain and Haitang typhoon in Yen-Shui Creek Basin by using the updated DEM.



# Flood scenario simulations

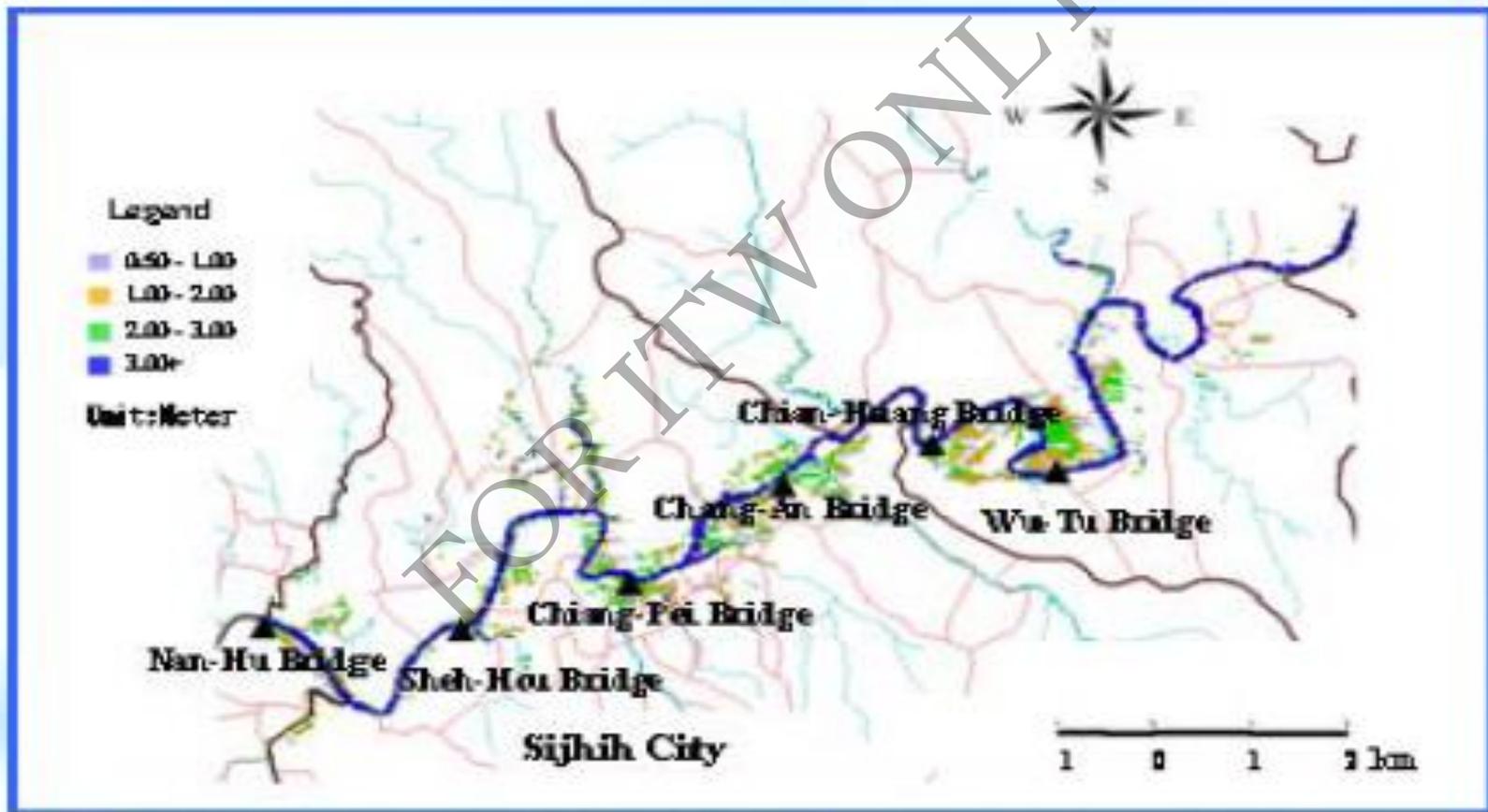


- The results of scenario simulations were used for determining the flood prevention strategies and the emergency response procedures.



# Flood-mitigation projects of Keelung River

- The study evaluates the effect of flood mitigation projects proposed by the Keelung River Regulation Committee on alleviating flooding hazards for both preliminary stage and long-term plan of engineering regulations.

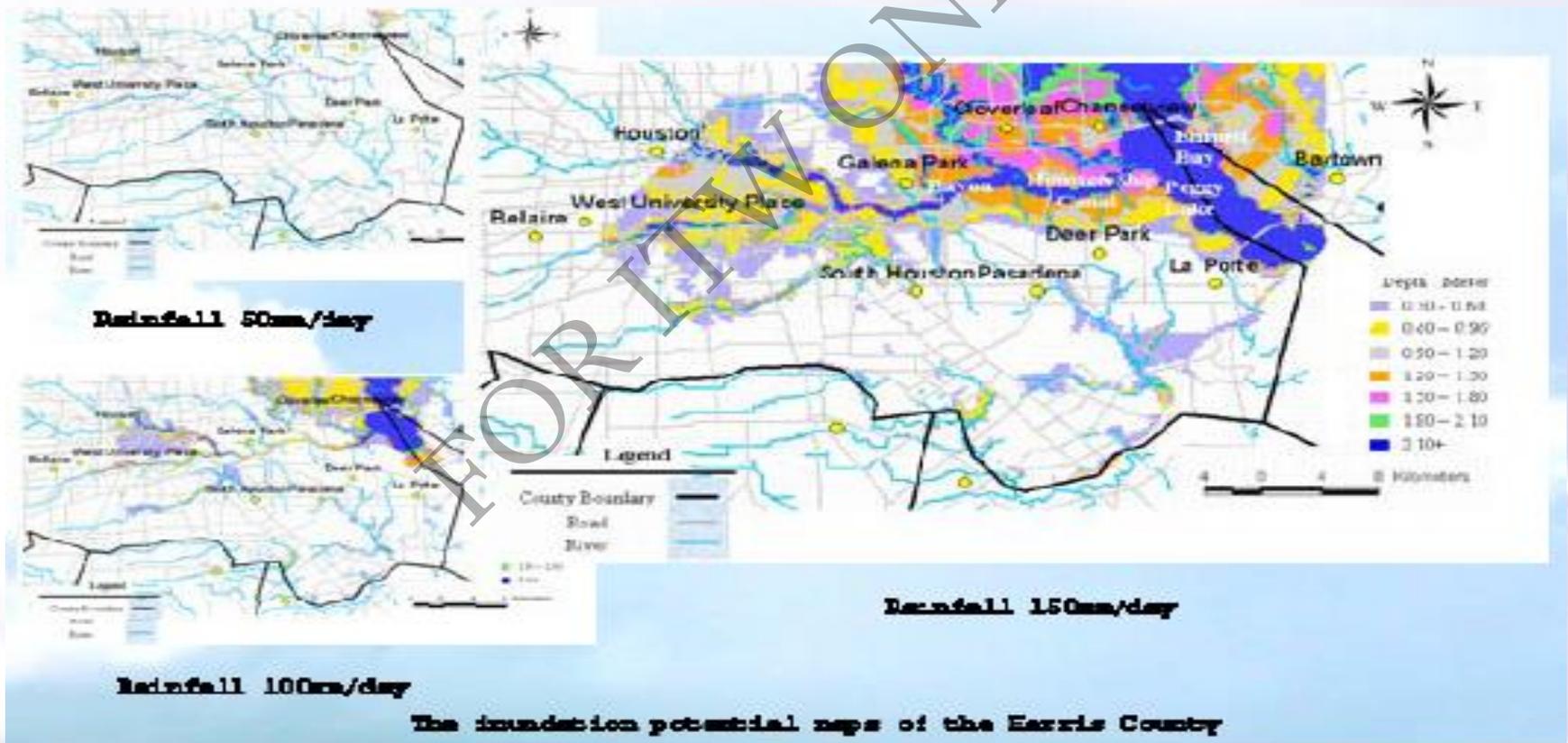


Inundation depth/range with revise flood division structure measures.  
(maximum division capacity of 1310m<sup>3</sup>/s)

# International collaboration

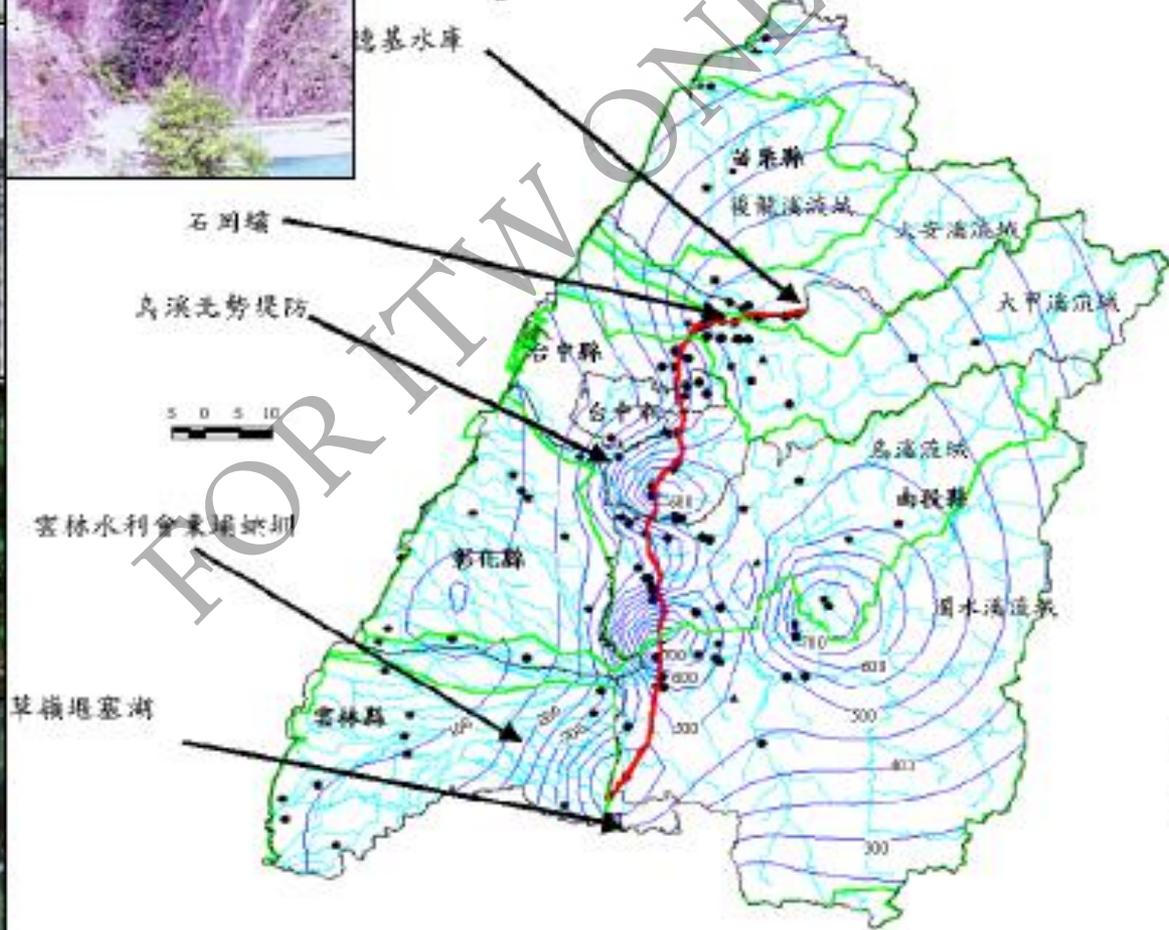
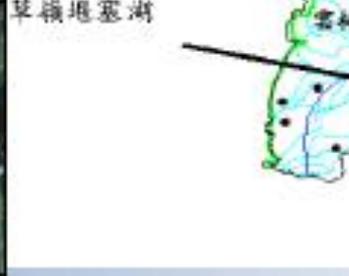
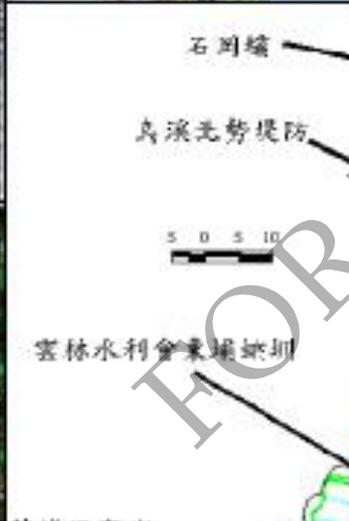


- The collaboration enhanced the functions of inundation model and accomplished the Graphic User Interface (GUI) of the inundation model.



# Field investigation of Chi-Chi earthquake

The field-survey group was teamed up right after the earthquake to investigate the damage of hydraulic facilities caused by the Chi-chi earthquake

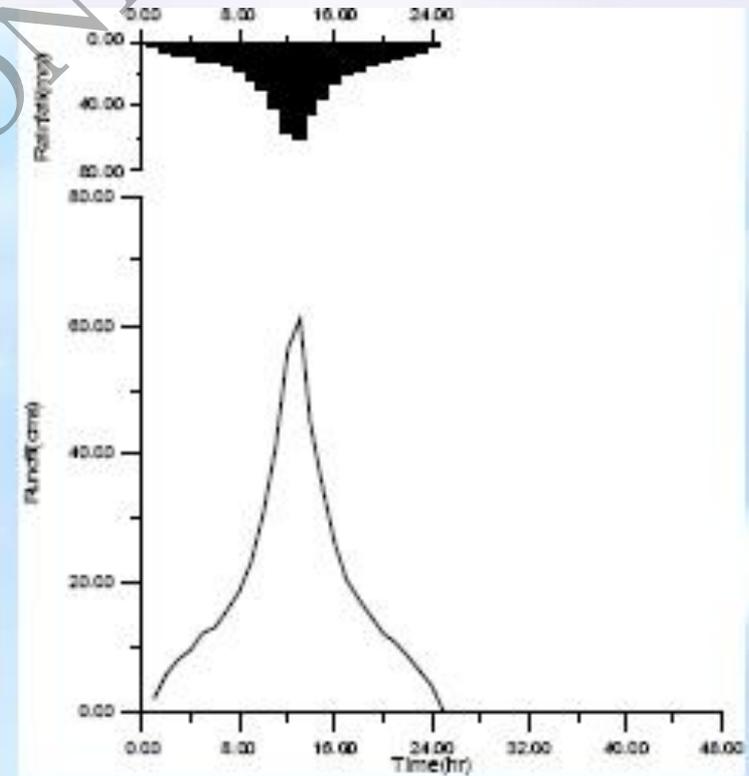


圖例

- 斷層
- 縣市邊界
- 流域邊界
- PGA值(gal)
- 河海堤
- 水庫及壩河堤
- 崩山阻塞河道
- 農田水利設施
- 市界

# Reinforcing the Hydrologic Monitoring System for Landslide Lake

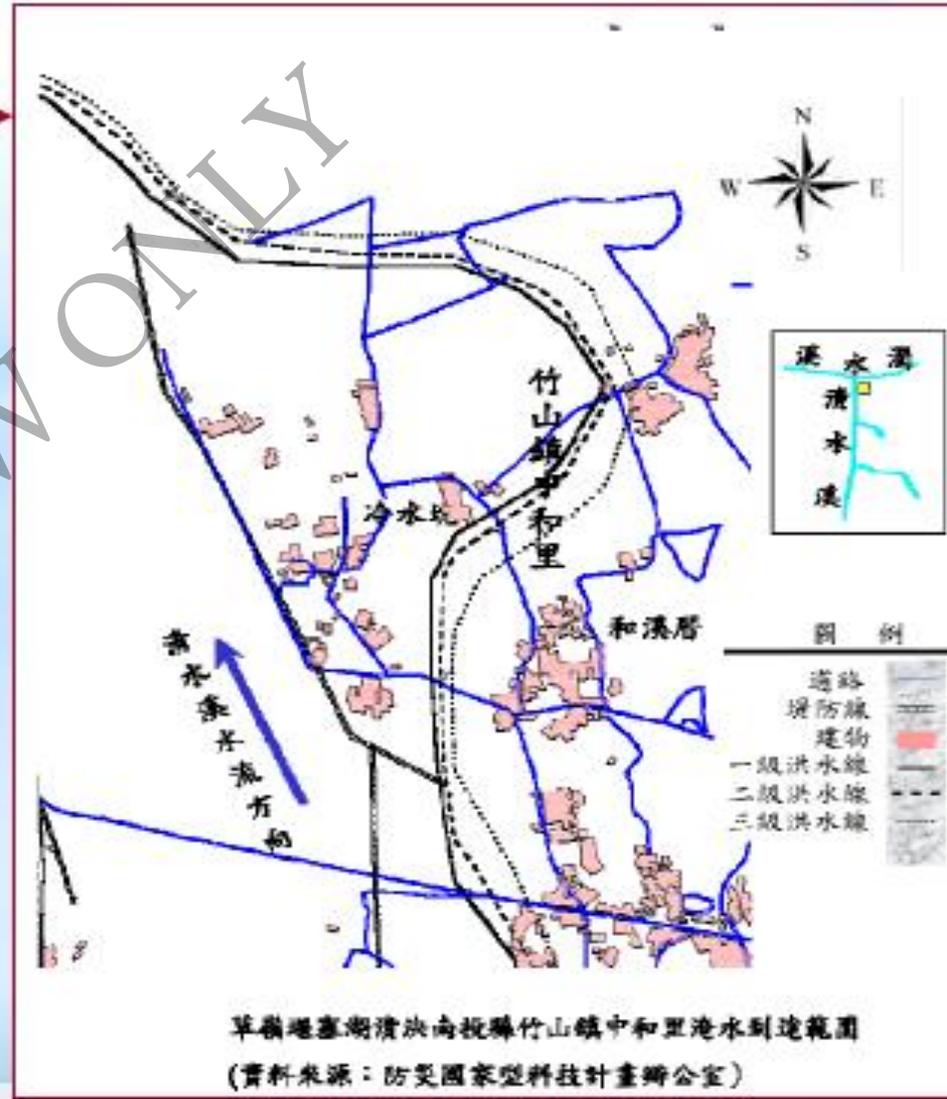
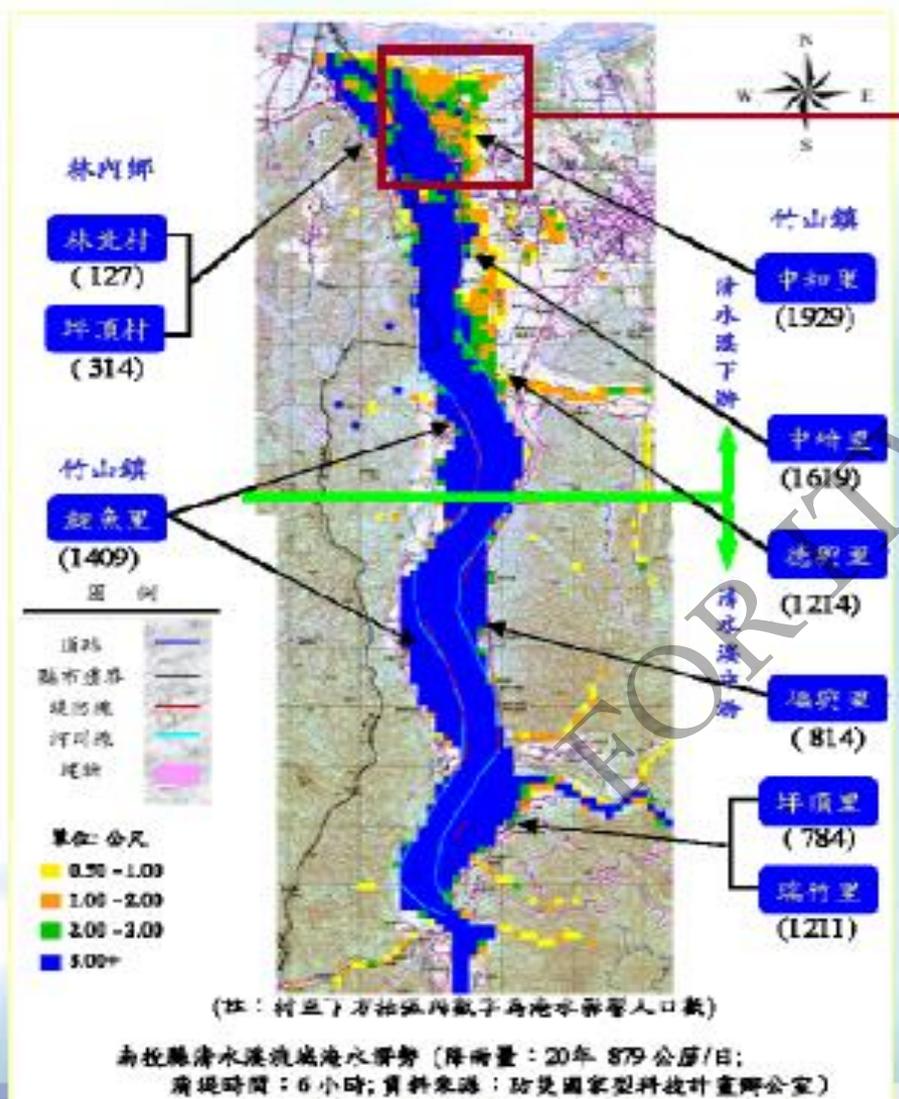
- Evaluated and strengthened the hydrologic monitor networks.
- Established the rainfall-runoff forecast system for Tsao-Ling landslide lake watershed.





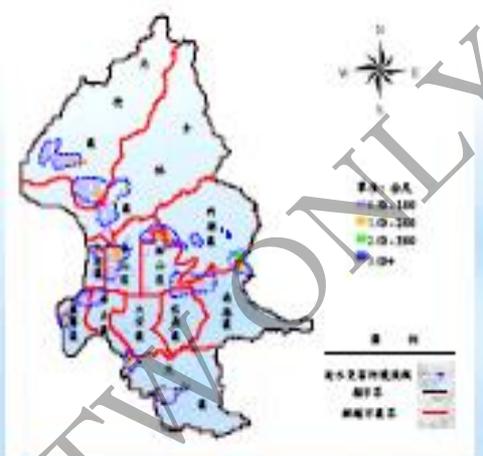
❖ Flood potential analysis for the downstream area of the landslided lake caused by the Chi-chi earthquake

❖ The plan of the emergency response measures for flood disaster

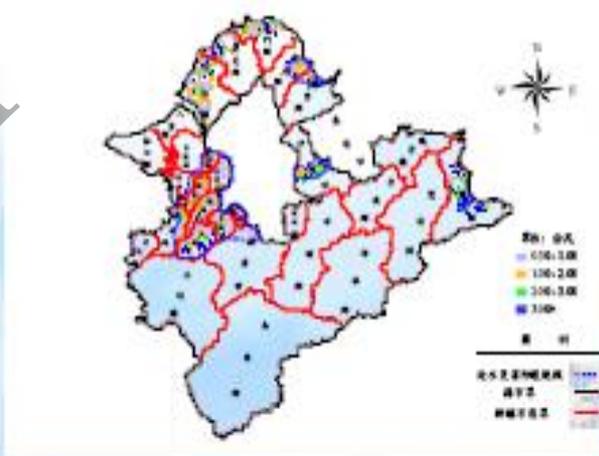


# Design Defense Scope of Inundation Disaster

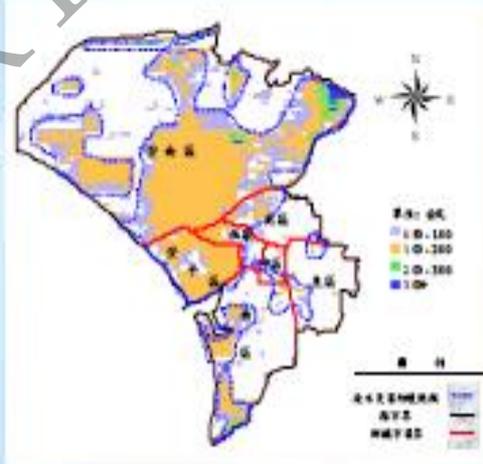
- The main purpose of design defense scope of inundation disaster is to help the cooperation teams of NCDR to carry out the defense scope of inundation disaster for local governments.



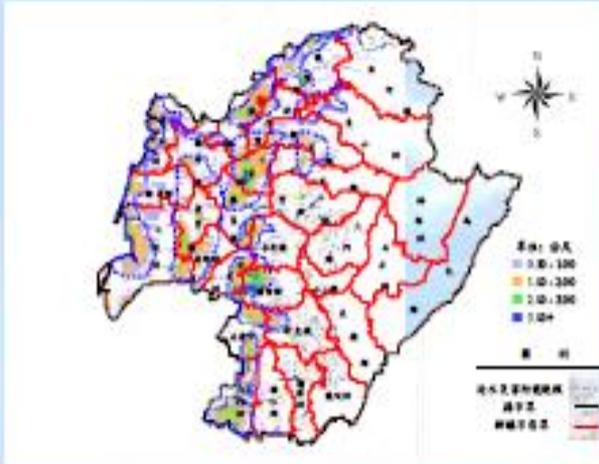
(a) 基隆市 200年重現期淹水災害防護規模



(b) 台北縣 200年重現期淹水災害防護規模



(c) 基隆市 100年重現期淹水災害防護規模

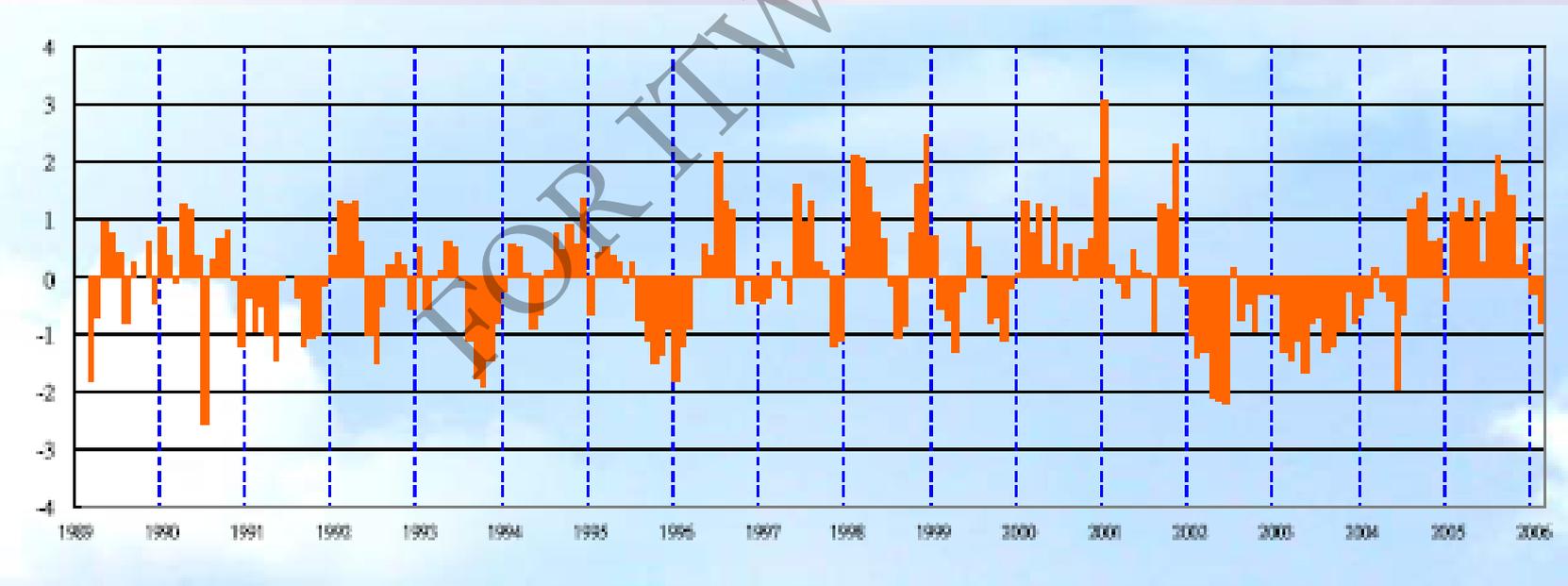


(d) 台南縣 100年重現期淹水災害防護規模



# Research of Drought Mitigation

- The research of drought mitigation is a new work of the Flood and Drought Disasters Reduction Division. The main object is to collect related references, analyze the cause of drought in Taiwan and provide response policies for the decision maker.





# Real time rainfall information system

- The real time rainfall information system was built and used for emergency operations.

即時降雨資訊查詢系統

最近 1 日降雨排名前 100 大雨量站  
(2008-06-11 23:00 至 2008-06-12 23:00)

排名	雨量站	降雨量 (mm)	縣市	縣鎮市區	流域
1	洪盆坑	147	花蓮縣	壽豐鄉	花蓮溪流域
2	水坑	145	花蓮縣	吉安鄉	花蓮溪流域
3	月眉山	120	花蓮縣	壽豐鄉	花蓮溪流域
4	花溪	114	花蓮縣	花蓮市	花蓮溪流域
5	吉豐	105.5	花蓮縣	吉安鄉	花蓮溪流域
6	日山	96.5	花蓮縣	萬榮鄉	花蓮溪流域
7	龍龜潭	96.5	花蓮縣	壽豐鄉	花蓮溪流域
8	中興	91.5	花蓮縣	壽豐鄉	花蓮溪流域
9	雙溪	83.5	花蓮縣	壽豐鄉	花蓮溪流域
10	關東	80.5	台東縣	關東鄉	
11	軒城	79	花蓮縣	軒城鄉	花蓮溪流域
12	東河	79	台東縣	東河鄉	海岸山脈東側河系流域
13	大壠閣	71.5	花蓮縣	花蓮市	花蓮溪流域
14	太史	67	花蓮縣	萬榮鄉	花蓮溪流域
15	加本	58.5	台東縣	太麻里鄉	海岸山脈河系流域
16	大風	54.5	花蓮縣	萬榮鄉	花蓮溪流域
17	山障閣 (關東中)	46	雲林縣	古坑鄉	北港溪流域
18	高崙鄉	43	花蓮縣	秀林鄉	太魯閣河系流域
19	羅武	43	宜蘭縣	羅東鎮	蘭陽溪流域
20	野湖	41	花蓮縣	豐濱鄉	海岸山脈流域
21	大東里	40.5	台東縣	大東里鄉	海岸山脈河系流域
22	風林	36.5	花蓮縣	鳳林鎮	花蓮溪流域

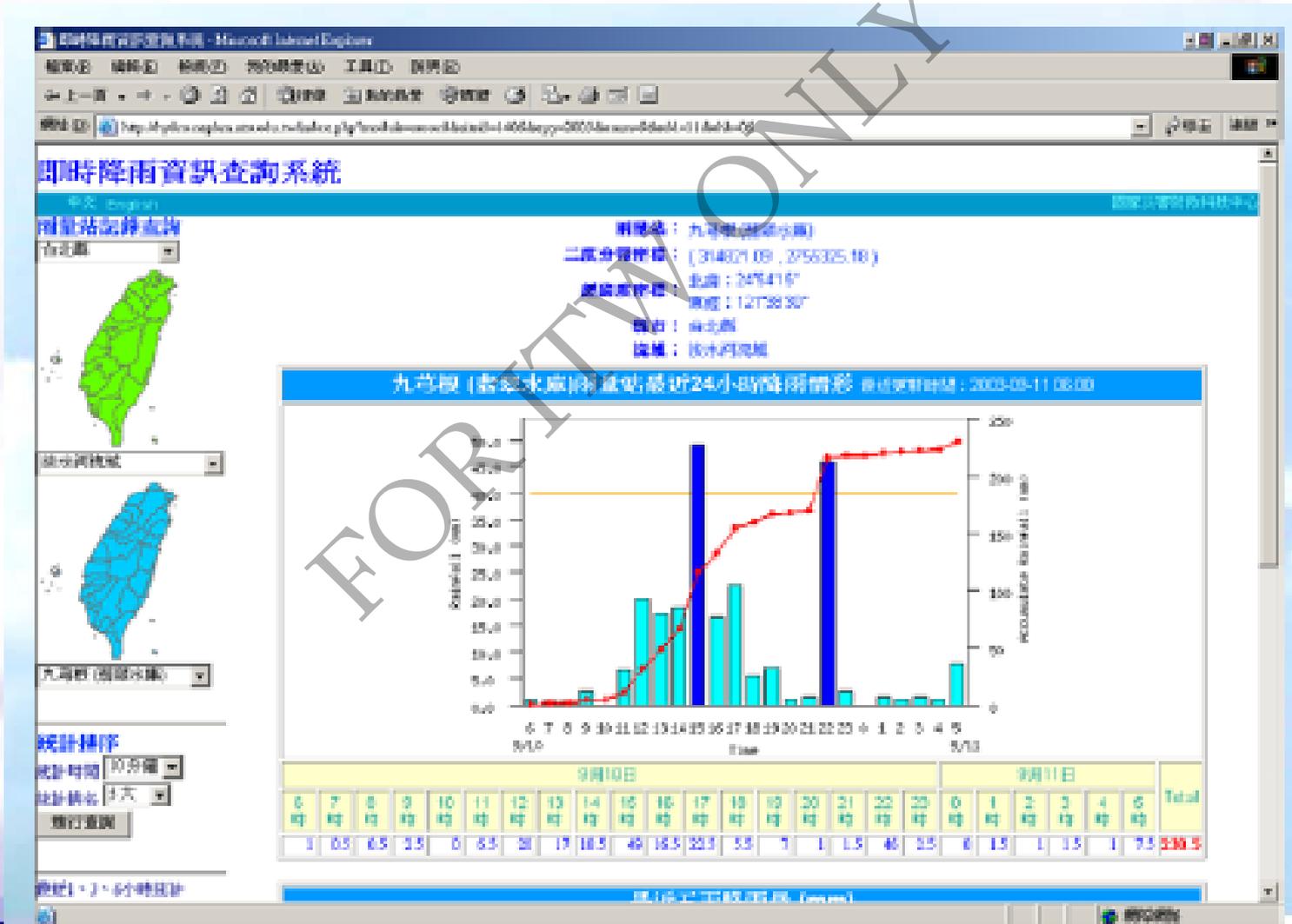
統計排序  
統計時間: 1日  
統計雨量: 300次  
進行查詢

頁數: 1 / 3 - 小屏統計



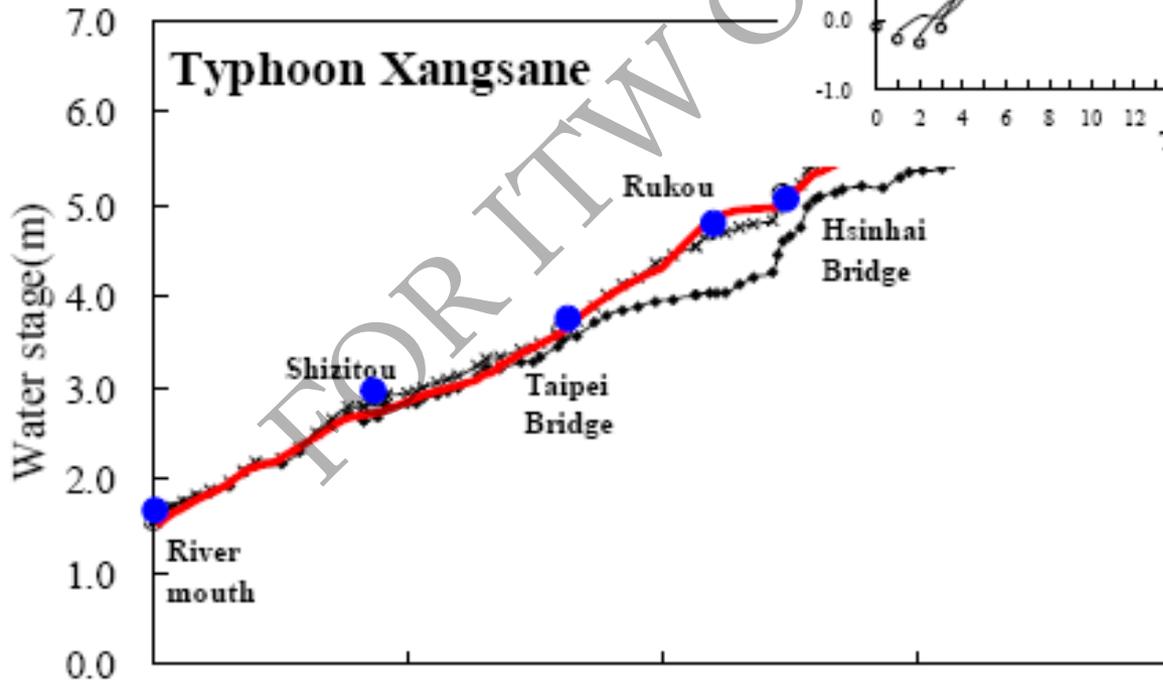
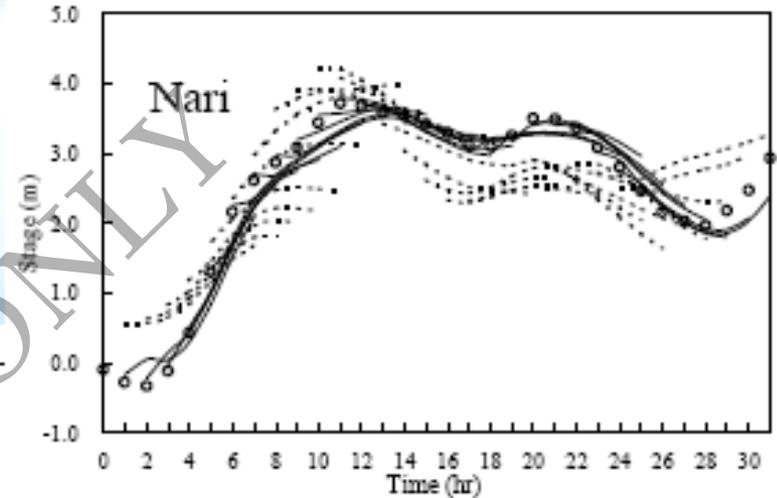
# Real time rainfall information system

- The system collects the national wide precipitation records and provides value-added information.



# River stage forecasting model

The dynamic routing model with real-time roughness updating and stage correction technique can provide a useful tool for flood forecasting.

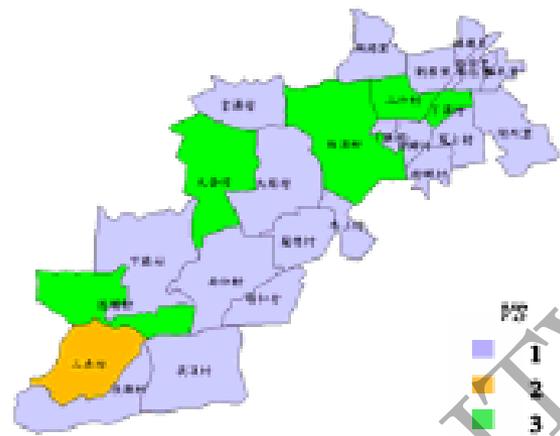


○ Observed    — Roughness updating    - - - - Real-time stage correction

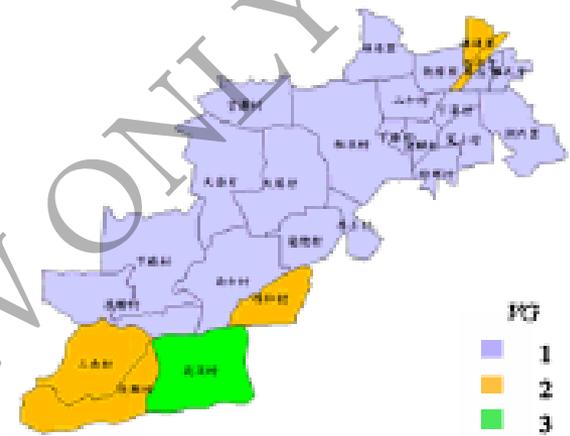
# Inundation impact index for disaster risk assessment



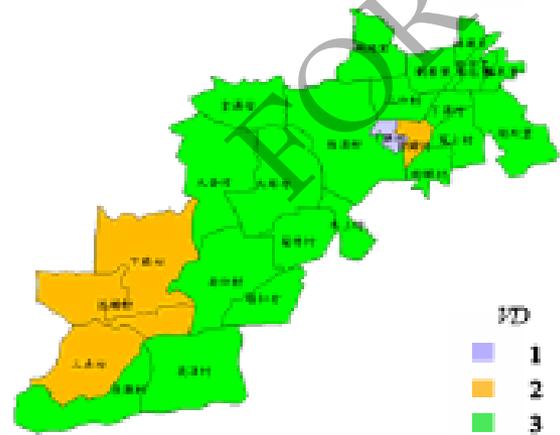
- The purpose of this study is to develop a methodology through the application of inundation impact index, which can be used to estimate the severity and the probability of inundation disaster.



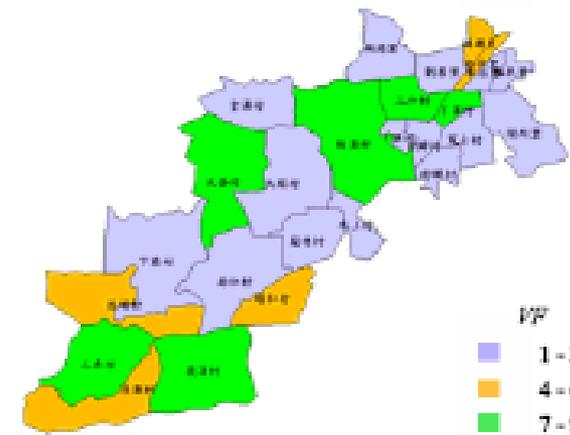
歷史淹水脆弱度指標



地勢地形脆弱度指標



防洪設施脆弱度指標



淹水脆弱度指標

南靖排水

# Development of E-investigation technique

## ■ 執行進度

- 勘災作業機制之研擬
- 電子勘災技術研發
  - 提供全部縣市勘災點查詢模式
  - 強化系統畫面美編
- 複合性資料庫建置
  - 全台易致災區域分析
  - 近5年重大颱風事件災害資料
  - 展示查詢系統之開發
- 國內外重大天然災害綜合評估





# Improvement of Inundation Warning Technology

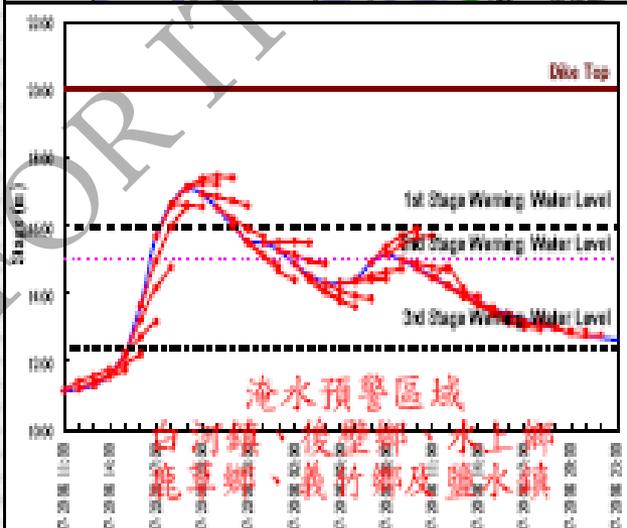
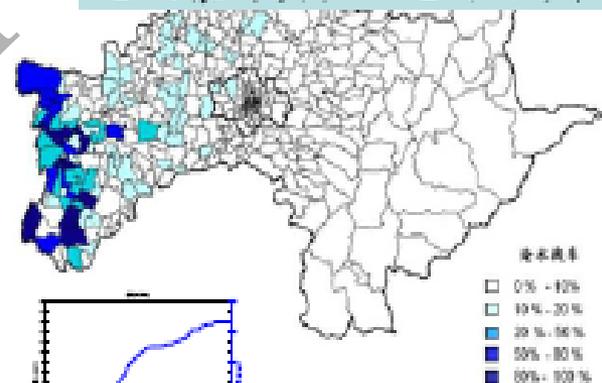
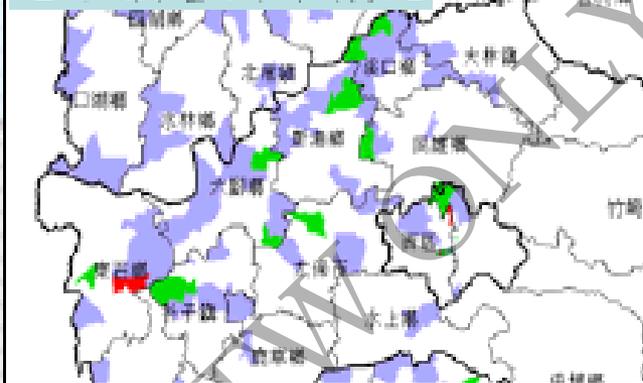


網址(D) <http://map2.ncdr.nat.gov.tw/REPORT/frame.aspx>

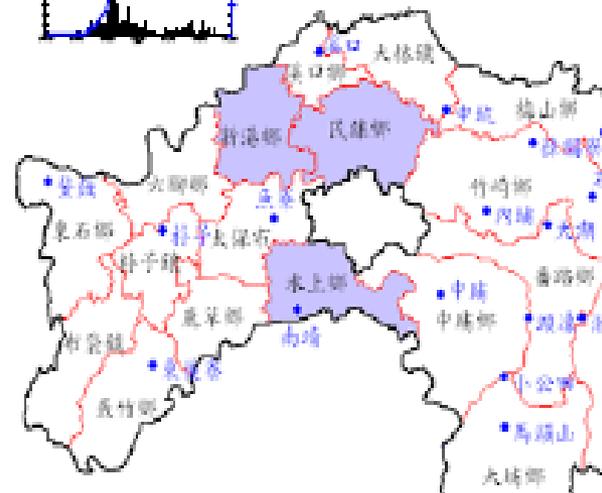
中央災害應變中心

淹水預警圖庫擴充

颱風嘉義村里淹水機率



八掌溪橋水位\_淹水預警



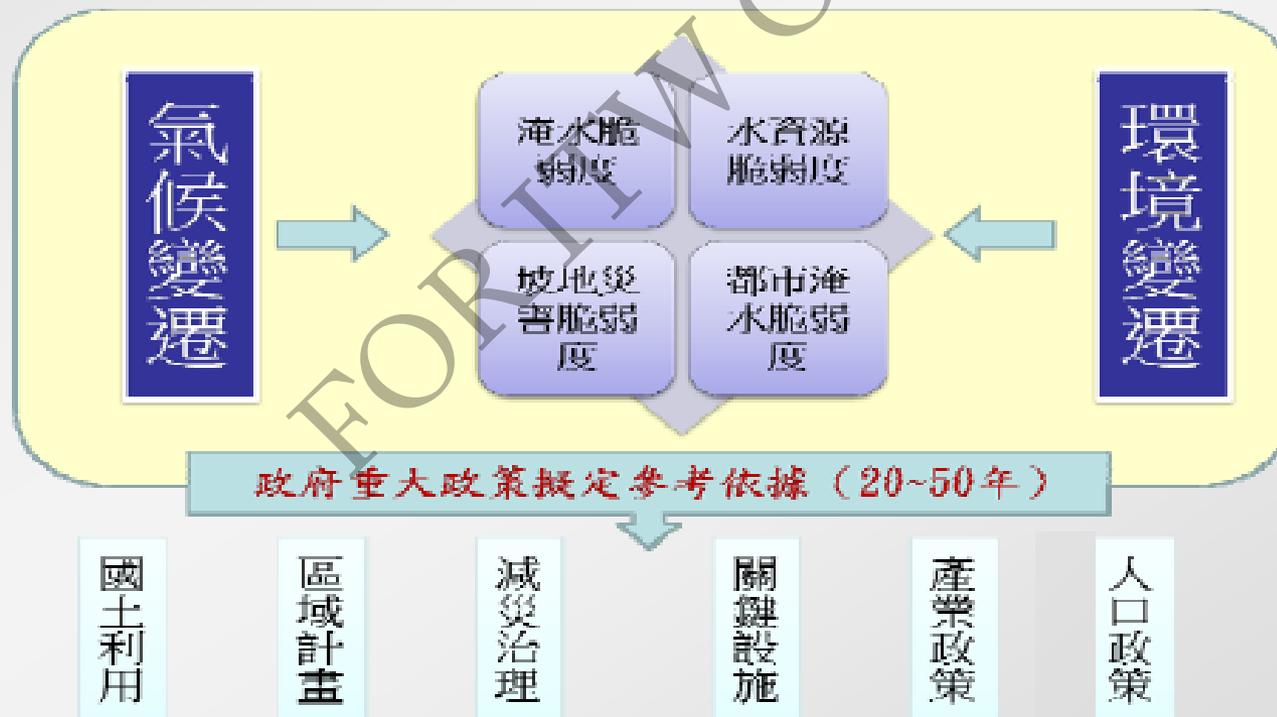
淹水\_降雨警戒值修訂

- 降雨預警技術  
精進研究
- 淹水預警技術  
精進研究
- 崩塌及土石流預  
警精進研究
- 重大災害遙測技  
術應用

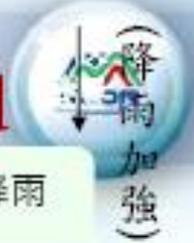
# Disaster Reduction Strategies Against Climate Change

## ■ 落實應用方式

- 綜合治水策略之氣候變遷因素政策評估與建議
- 水庫土砂災害治理政策評估建議
- 氣候變遷災害脆弱度地圖之應用



# Integrated Water Governance on Watershed



降雨



擋水  
抽、排水  
(堤防)  
(開門)  
(抽水站)

排水  
滯、調洪  
入滲

擋水  
排水  
疏、分洪

逕流  
蓄、泛洪  
入滲  
(補注)

涵養(水)

海水上升

海洋

海岸  
河口

平地  
都市化地區(鋪面化)  
(都市、鄉鎮)  
河川、補水系統  
滯洪、調洪設施

平原  
農田(水田)  
果園  
水塘、湖  
河流  
灌溉系統

坡地、丘陵  
林地、旱田  
果園、野溪、水庫

山地  
(森林)

地下水補注

脆弱性增加 恢復力降低

集中降雨 災害強度增強

土地超限利用

地層下陷  
海岸退縮

都市化  
程度增強

入滲能力減弱  
地表逕流增加  
集流時間縮短  
內、外水衝突擴大

農地開放、用途變更  
休耕/廢耕

河川逕流量增加  
蓄洪防洪能力降低  
河床淤積、底床增高  
河川通水面積減少  
地下水補助量減少

森林砍伐  
坡地開發

地震與坡地災害影響  
土石鬆動  
涵水能力降低

河川流域諸多課題

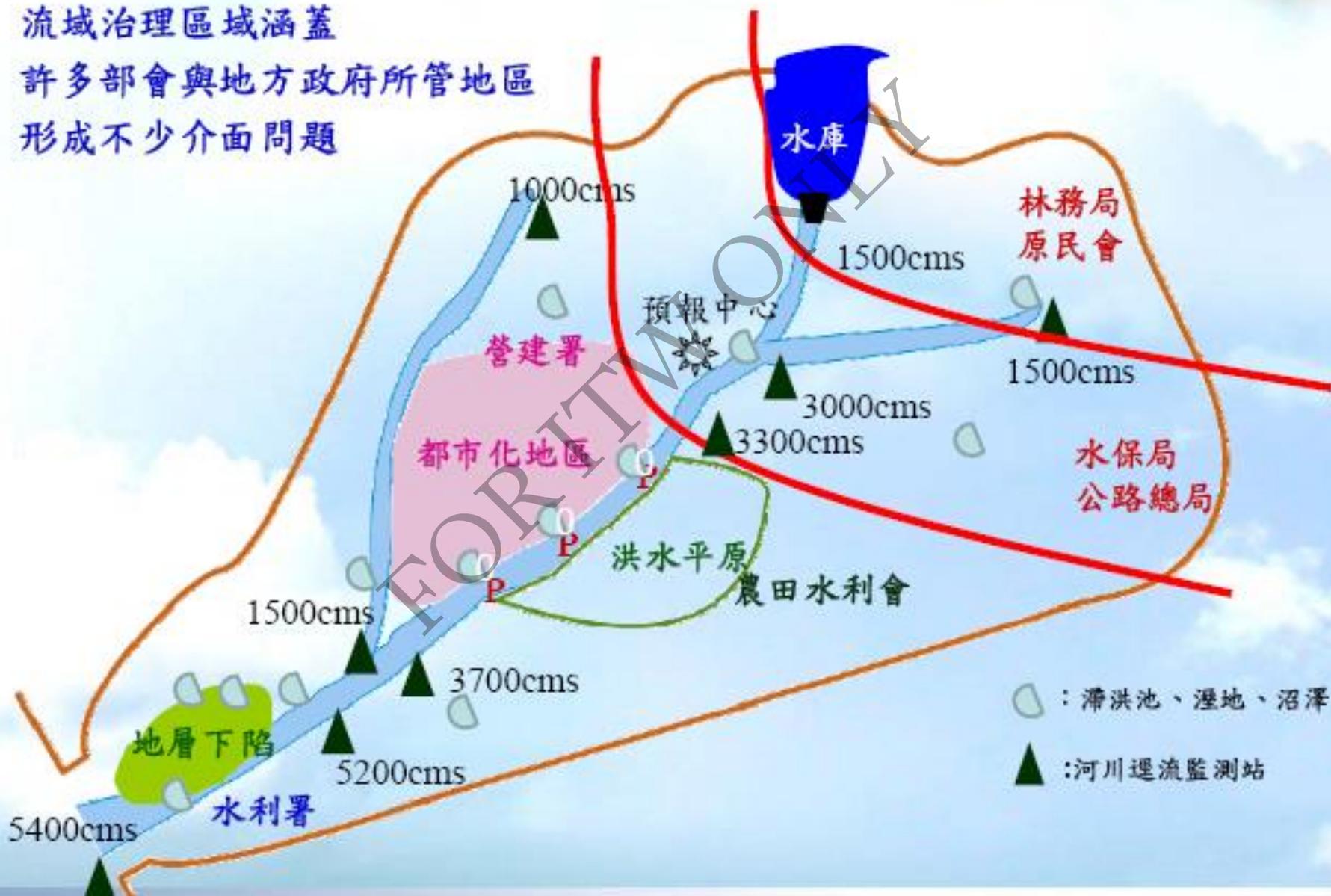
# Integrated Water Governance on Watershed



流域治理區域涵蓋

許多部會與地方政府所管地區

形成不少介面問題





# Future Works

FOR ITW ONLY

# Future Works



- 1. Information update, risk classification and further applications of the inundation potential maps
- 2. Application of the flood forecasting and warning model in Taiwan
- 3. Establishment of the drought index and the forecasting model for the reservoirs during drought period
- 4. Help to set up the disaster morning and advanced warning systems
- 5. Enhancement of the abilities of local governments for disaster prevention and emergency rescue
- 6. Support of emergency response actions
- 7. Help to build the flood and drought disaster information sharing and maintenance systems
- 8. Assistance of setting up of the standard operation procedures for flood and drought disaster prevention and rescue
- 9. Evaluation of the effectiveness of research and development plans for flood and drought disaster reduction and mitigation



**Thanks for  
your  
attention.**

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