

# Flood Mitigation System & Flood Monitoring Technology

洪災應變體系及監測技術之應用

經濟部水利署

Water Resources Agency, MOEA

May 4, 2009

98年5月4日



經濟部水利署

# Outline

簡述



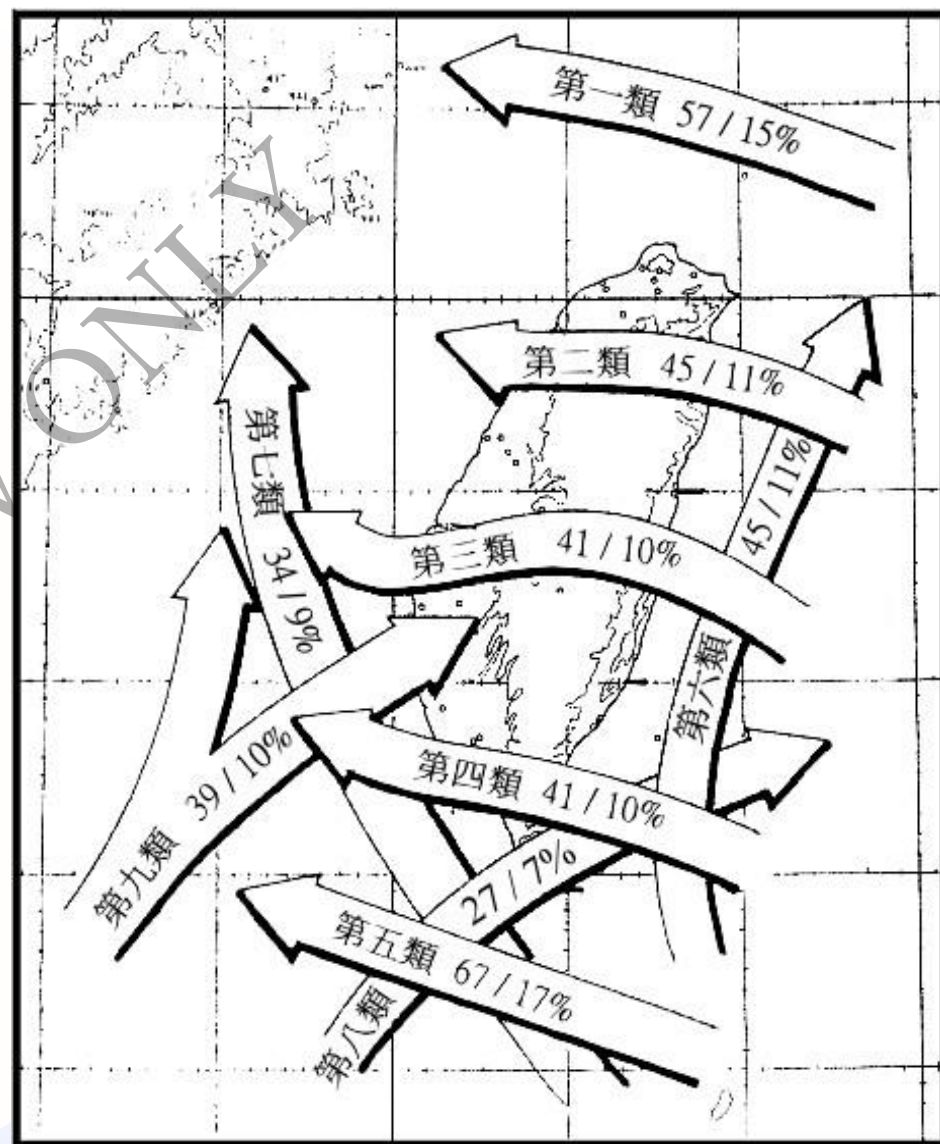
## Review Flood Disasters in Taiwan

- **Typhoon**
- **Extreme Rainfall**
- **High turbidity during typhoons**

## Flood Mitigation Efforts in Taiwan

- **Disaster Information System**
- **Portable Pumping Machine Support**
- **Inundation Area Flood Control Project**
- **Flood Control Facilities Preparedness**

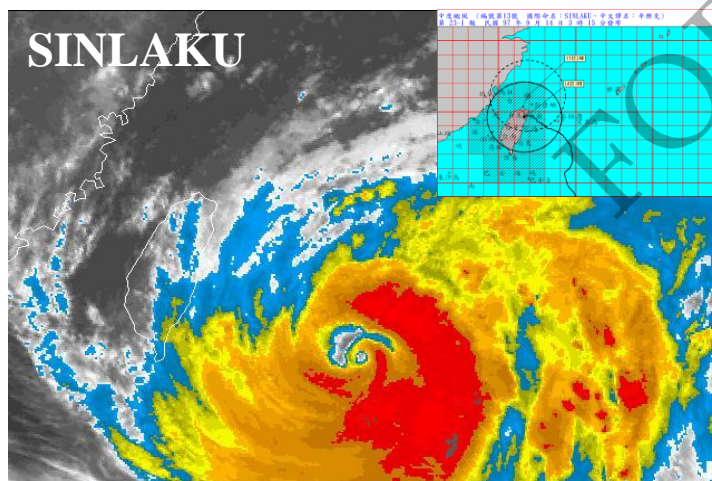
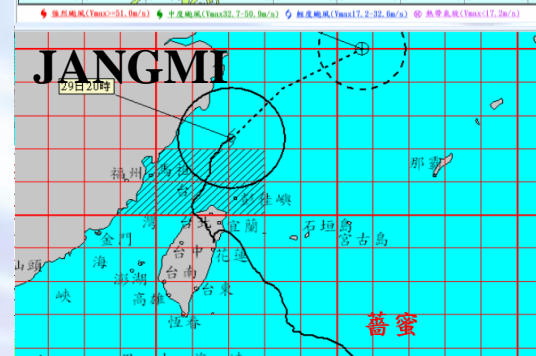
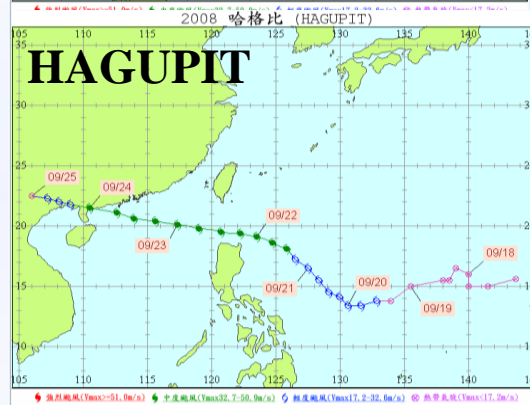
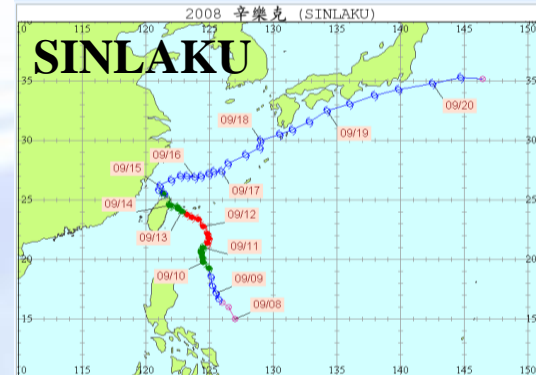
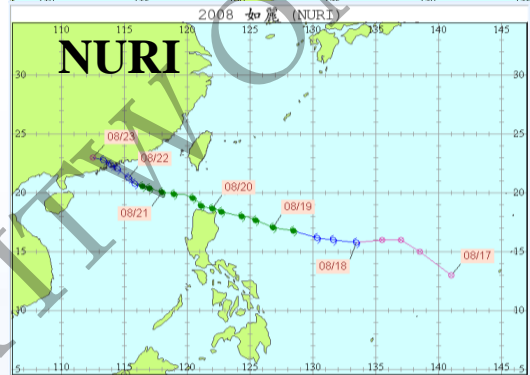
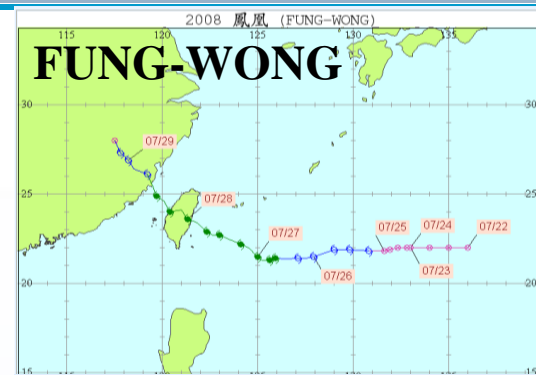
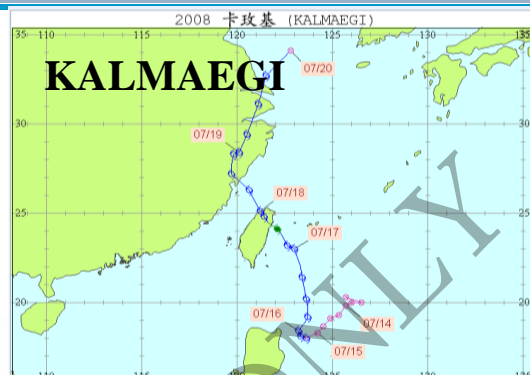
1. Taiwan Located on the Monsoon Asia & Western Pacific Typhoon's Track.
2. Averaged 3.37 typhoons per year will influence Taiwan.
3. There exists strong spring monsoon & summer storms which bring heavy rainfall.
3. Averaged 1.82 typhoons per year will cause damages.
4. Typhoons & heavy rainfalls induce averaged 17.4 billion loss per year. That is almost equal to 0.33% of national GDP.





# During 2008, 6 typhoons & 12 heavy rainfalls visited Taiwan

Typhoon	Warning period	Strength
KALMAEGI	7/16~7/18	Medium
FUNG-WONG	7/26~7/29	Medium
NURI	8/19~8/21	Medium
SINLAKE	9/11~9/16	Strong
HAGUPIT	9/21~9/23	Medium
JANGMI	9/26~9/29	Strong



- Typhoons, Spring monsoon and Summer storm often damage agriculture productions and result uncomfortable living.

**2007 Spring Summer Storm  
in Sih-hu township, Yun-lin County**



**Agricultural Disasters Estimated Loss**

Unit: billion NT\$

Year	Typhoon	Spring Monsoon	Summer Storm	Sum
2006	0.831	2.360	0.000	3.191
2005	12.586	5.285	0.000	17.871
2004	11.226	0.000	0.059	11.285
2003	3.135	0.058	0.000	3.193
2002	0.164	0.060	0.001	0.225
2001	14.510	0.138	0.031	14.679
2000	12.062	1.149	0.385	13.596
1999	1.989	0.000	1.285	3.274



**2007 Typhoon SEPAT  
in Mei-Nung Town, Kao-hsiung County**

# Typhoon induced damages in 2008

	KALMAEGI	SINLAKU	JANGMI
<b>Died, be missing, injured (man)</b>	<b>20, 6, 8</b>	<b>12, 11, 20</b>	<b>3, 2, 61</b>
<b>Traffic Interruption (event)</b>	<b>97</b>	<b>135(5 bridges )</b>	<b>102</b>
<b>Power Supply Cut off (household)</b>	<b>127,323</b>	<b>282,986</b>	<b>1,040,947</b>
<b>Water Supply Cut off (household)</b>	<b>671,673</b>	<b>81,480</b>	<b>6,492</b>
<b>Agriculture Loss (million NT\$)</b>	<b>837.95</b>	<b>670.41</b>	<b>1826.66</b>
<b>Inundation (event)</b>	<b>894</b>	<b>125</b>	<b>80</b>
<b>Hydraulic Facility damages (event)</b>	<b>42</b>	<b>20</b>	<b>10</b>
<b>Evacuation (man)</b>	<b>201</b>	<b>1,987</b>	<b>3,681</b>
<b>Victim Protection (man)</b>	<b>344</b>	<b>1,470</b>	<b>1,629</b>

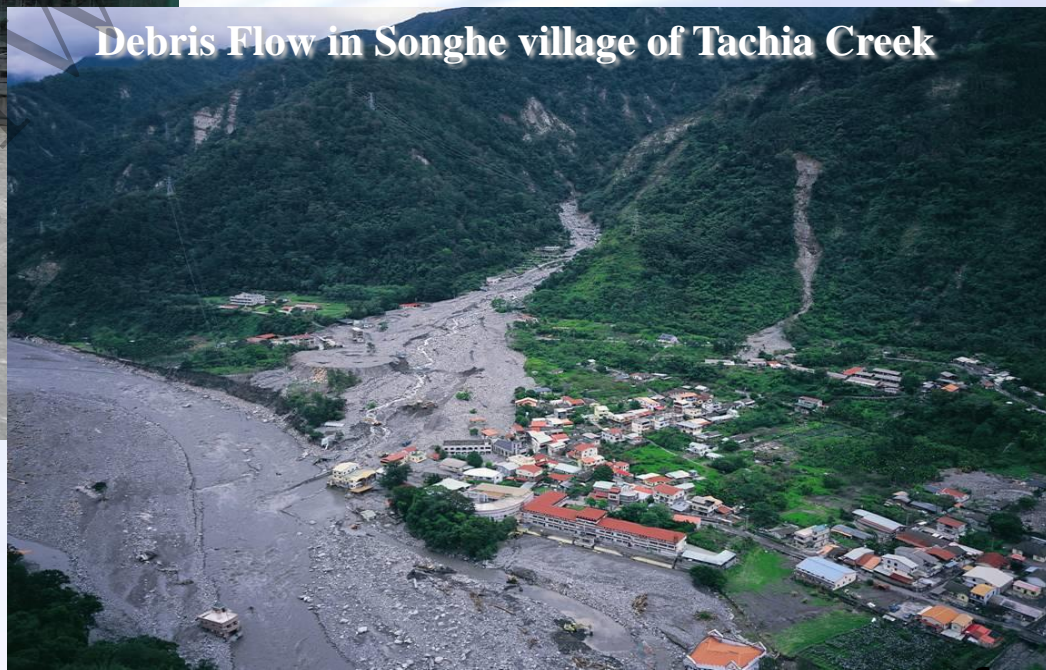


- Typhoons, Spring monsoon and Summer storm occasional bring serious land slides and debris flow in mountain area.
- In 2001, more than 200 people died or disappeared in Typhoon Toriji which induced huge landslides and debris flows.

Heavy Sediment Deposit in Guguan Hot Spring Area of Tachia Creek



Debris Flow in Songhe village of Tachia Creek





## High turbidity during typhoons affects water supply

- Water resources in Taiwan include 3 main parts: rivers, reservoirs and groundwater and surface runoff occupies **77%**. After 921 earthquake in 1999, the soil erosion problem became more severe. When a typhoon and heavy rain comes, it causes rising turbidity, and affects water supply.
- In 2004, Ely typhoon caused rising turbidity of Shimen reservoir and interrupted water supply for almost 30 days.





# Flood Mitigation System in Taiwan

台灣洪災應變體系

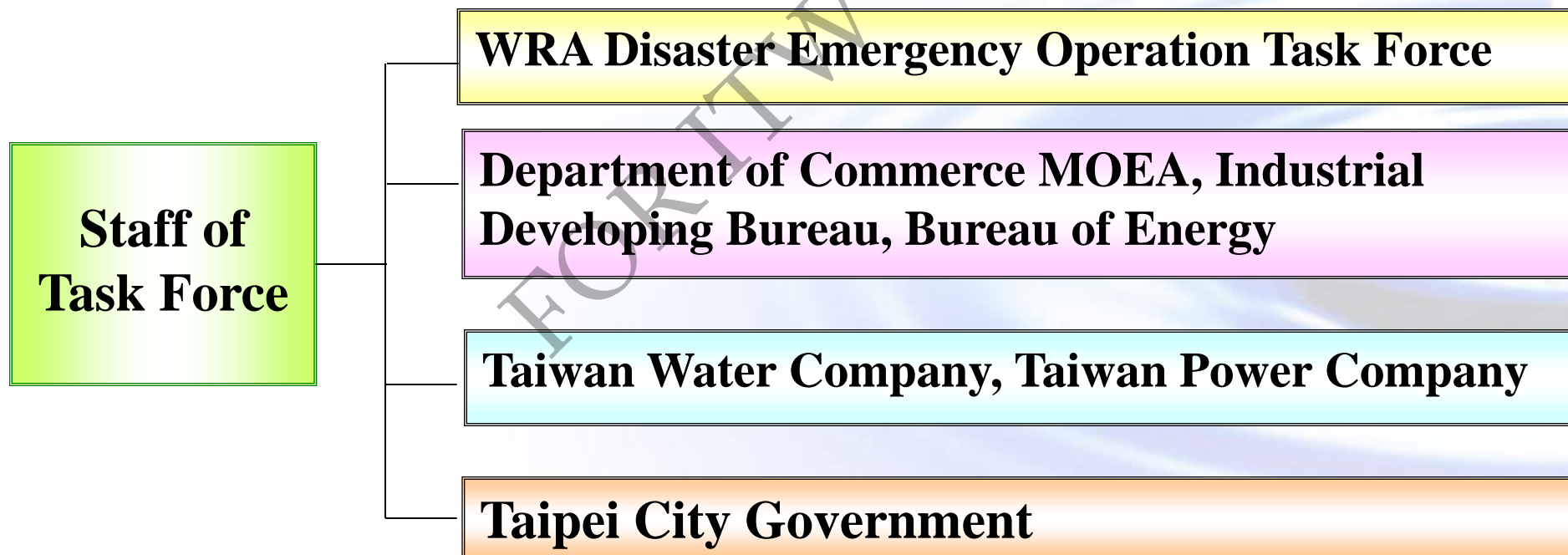


# MOEA Disaster Emergency Operation Task Force

**Leader : Minister of MOEA**

**Deputy Leader : Deputy Minister of MOEA**

**Executive Secretary : Director General of WRA**





# WRA Disaster Emergency Operation Task Force

**Leader : Director General of WRA**

**Deputy Leader : First Deputy Director General of WRA**

**Spokesman : Second Deputy Director General of WRA**

**Staff of  
Task Force**

**Information Analysis Team (分析研判組)**

**Hazard Warning Team (水情預警組)**

**Brief & Promulgating Team (簡報通報組)**

**Portable Pumping Machine Operation Team**

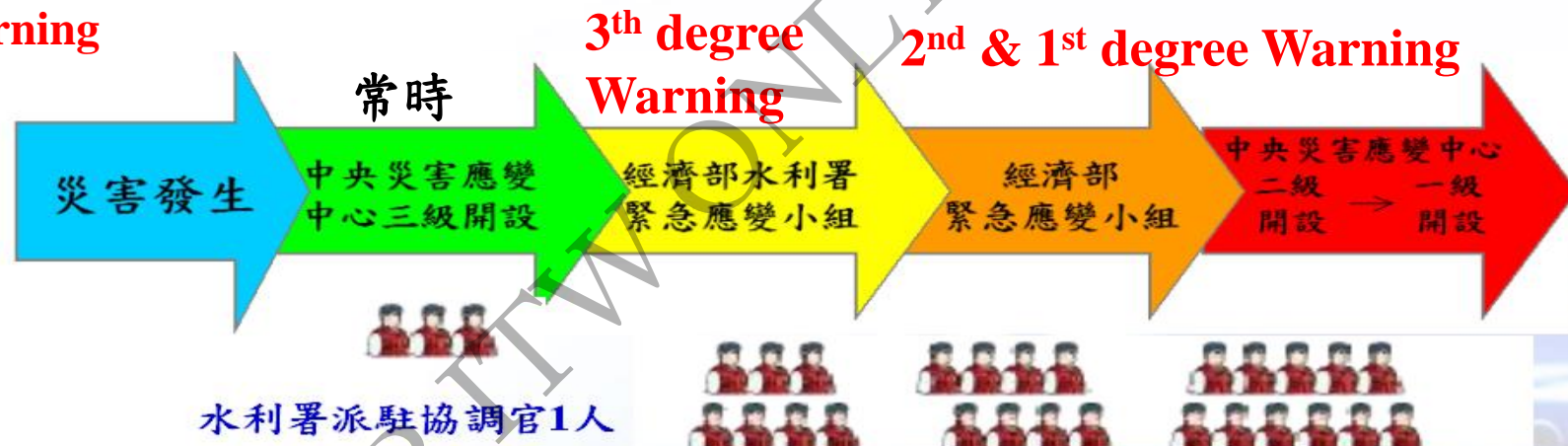
**Disaster Reporting Team (災情查報組)**



# Operation Rules of Task Force

- 24 hrs rainfall exceeds 130mm - Third degree emergency situation
- 24 hrs rainfall exceeds 200mm - Second degree emergency situation
- 24 hrs rainfall exceeds 350mm - First degree emergency situation

## Heavy Rainfall Warning



## Typhoon Alarm



**Sea Typhoon Alarm: Central Disaster Emergency Operation Center 2<sup>nd</sup> degree open**

**Land Typhoon Alarm: Central Disaster Emergency Operation Center 1<sup>st</sup> degree open**

# Responsibilities of Task Force

- **Operating Portable Pumping Machines**
- **Monitoring River Level and Sending Warning Messages**
- **Emptying Storage of Reservoir for Flood**
- **Ensuring Functions of Hydraulic Structures**
- **Operating necessary water resources**

# Operating Portable Pumping Machines

## Portable Pumping Machines Reduce the inundation situations

### ➤ Operated 1,823 portable pumping machines during 2008

✓ KALMAEGI : 373

✓ FUNG-WONG : 454

✓ SINLAKU : 348

✓ JANGMI : 452

❖ WRA portable pumping machines are ready to go in **10 minutes** if local Governments ask help.



聖帕颱風後0820豪大雨(雲林地區)



聖帕颱風後0820豪大雨(羌園地區)





640 portable pumping machines have been distributed to inundation area.

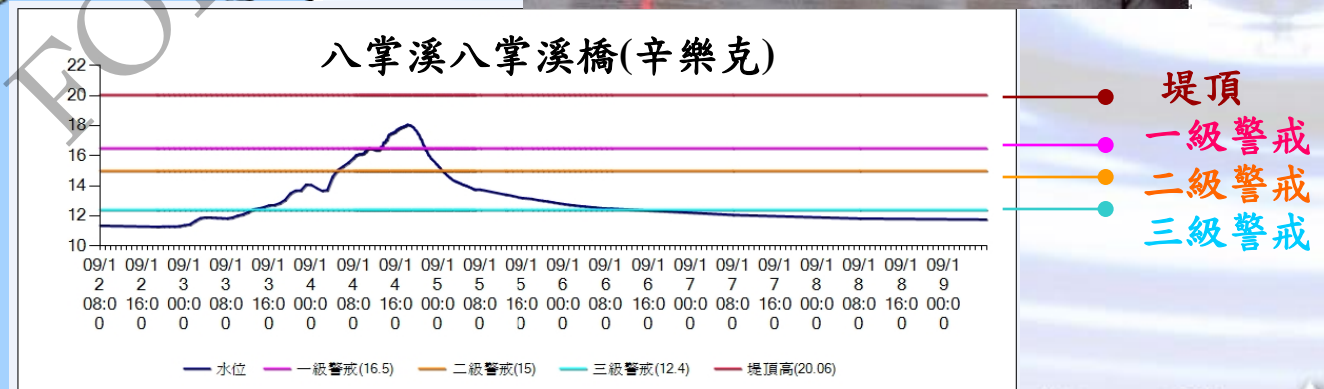
(501 machines are provided by WRA)



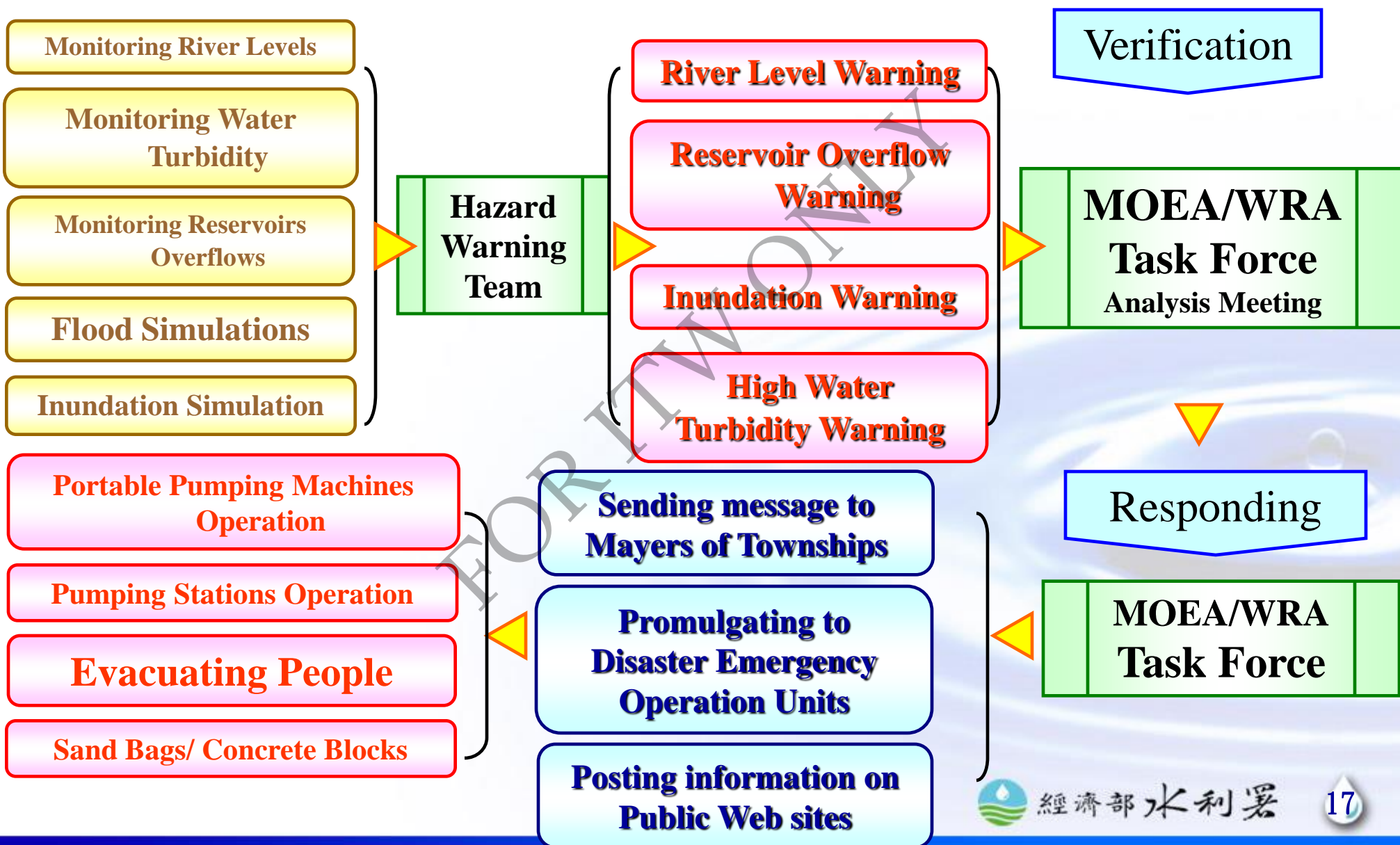


# Monitoring River Level and Sending Warning Messages

☁ High water level messages were sending to Traffic Agencies to cease the bridge transportation.



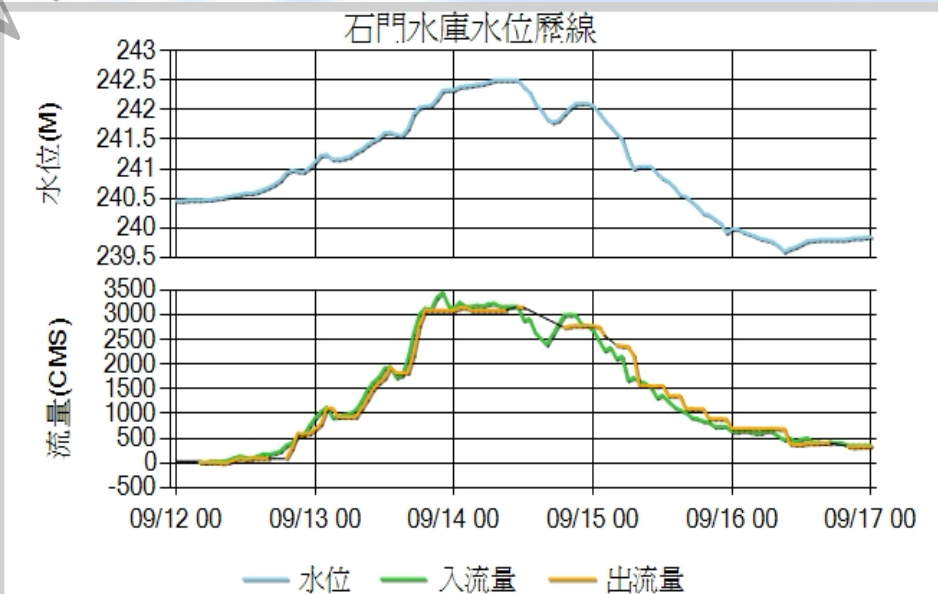
# Promulgating Warning Messages



# Emptying Storage of Reservoir for Flood

☁ 15 reservoirs overflowed during 2008.

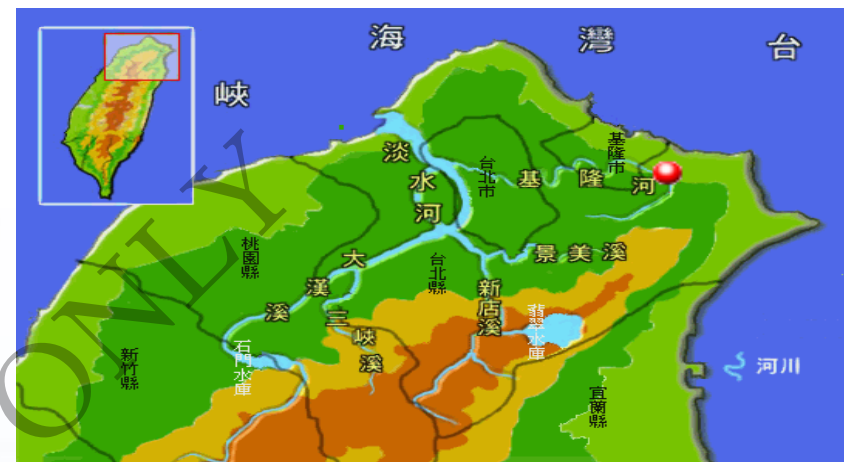
☁ Max. overflow discharge of Shimen & Chengwen reservoirs approached 3400cms & 2840 cms during SINLAKU Typhoon.





# Ensuring Functions of Hydraulic Structures

Year	Events	Operation Time	Max. Dis.
2004	0911 H.R.	4 (hr)	200 (cms)
	納坦	7	600
	南瑪都	19	450
2005	海棠	21	211
	馬莎	18	78
	泰利	31	382
	龍王	4	115
2006	0910 H.R.	10	140
2007	0615 H.R.	1.5	35
	韋帕	12.5	76
	柯羅莎	21.5	636
	米塔	25	91
2008	FUNG-WONG	6.5	75
	SINLAKU	50	247
	JANGMI	24.5	351



**110.65 million m<sup>3</sup> flood was drained by the KeeLong River Diversion Tunnel**



# Operating necessary water resources



石門水庫

石岡壩

高屏溪攔河堰



## Shimen Reservoio

- ✓ Max. Turbidity : 19,040NTU
- ✓ Backup Pumping Facilities

## ShiGan Weir

- ✓ Max. Turbidity : 17,000NTU
- ✓ Backup Water Supply System

## KaoPin Creek Weir

- ✓ Max. Turbidity : 20,500NTU
- ✓ Backup Water Supply System



# CCTV Disaster Monitoring System

CCTV 災害監測系統

# Water CCTV Disaster Monitoring System



經濟部  
水利署

## 水災災害即時影像監視及應變決策資訊系統

即時水情  
羌園村抽水機

系統說明
行動水情
即時影像
帳號管理

測站名稱：江長抽水站(旋)      所屬流域：淡水河

測站位置：X：315740 Y：2774330

測站簡介：本站架設於江長抽水站，可了解基隆河水位狀況

24小時累積雨量(mm)	
● 不顯示	
○ 0-150	○ 150-300
○ 300-450	○ 450-600
■ 僅顯示高程	
(m)	
● 無	○ 以上
○ 以下	
套疊	
淹水深度(m)示意色階	
0-0.1	
0.1-0.3	
0.3-0.6	
0.6-1	
1-2	
2-5	
5以上	

江長抽水站(旋)



JiangChang Fri Dec 28 09:51:17 2007



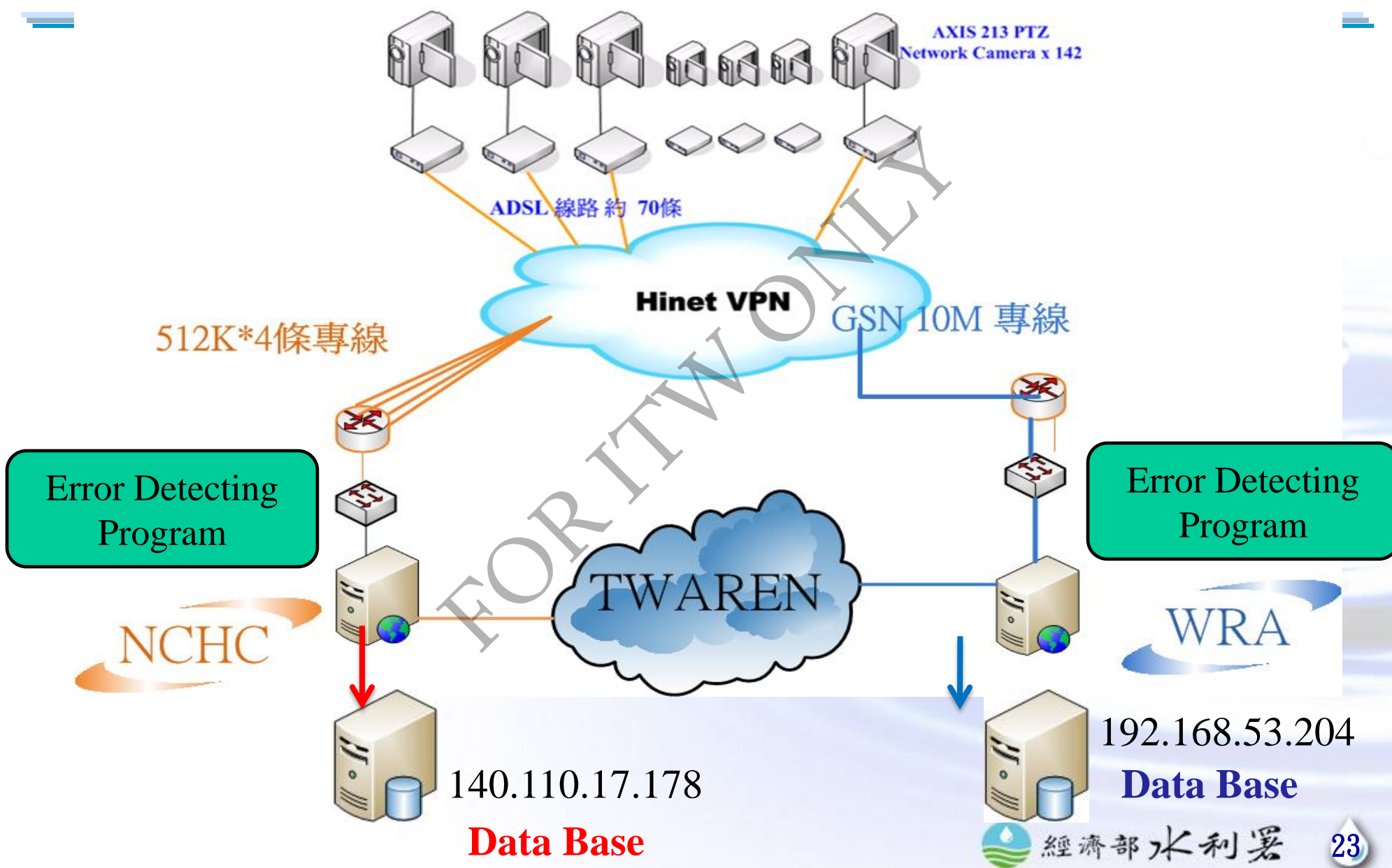
左
下
右
近
遠
明
暗

高程 8—29 m





# Framework of CCTV Monitoring System



查詢

確定

行政劃分

選擇

地理劃分

選擇

設施劃分

選擇

狀態列

系統資訊

水林鄉-萬興閘門橋 網路異常  
後湖堤防 網路異常  
蘭陽橋 網路異常  
曾文二橋 網路異常  
玉峰大橋 網路異常  
四汴頭 網路異常  
曾文水庫 網路異常

(274155,2634898)

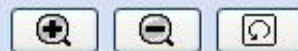


展示區

圖層

- ☐ 雨量站
- ☐ 河川局
- ☐ 水庫集水區
- ☐ 水庫堰壩
- ☐ 水門
- ☐ 抽水站
- ☐ 河川
- ☐ 水位站
- ☒ 監視站
- ☐ 超過警戒水位

GIS控制



影像控制





2009-04-21 12:54:38

Tue Apr 21 12:47:37 2009

Tue Apr 21 12:43:00 2009

Tue Apr 21 12:46:05 2009

Yuan Shan Yan Tue Apr 21 1

## 江長抽

ShiMenShuiKu Tue Apr 21 12:00:00

220

243.22

2009-04-21 12:52:12

瓦瑤溝

Tue Apr 21 12:43:00 2009

新埔橋

Sin Pu Qiao 2009-04-21 12:4

三峡鎮

瓦瑤溝

Tue Apr 21 12:43:00 2009

玉成抽水站

yU Cheng Tue Apr 21 12:54

寶橋水位站(固)

2009-04-21 12:52:13

石碇堤

**翡翠水庫**

開始

下午 12

星期



監視站 行動站

用戶(單位): 事件:

選擇 請選擇

政劃分: 標籤:

選擇 請選擇

始: 結束:

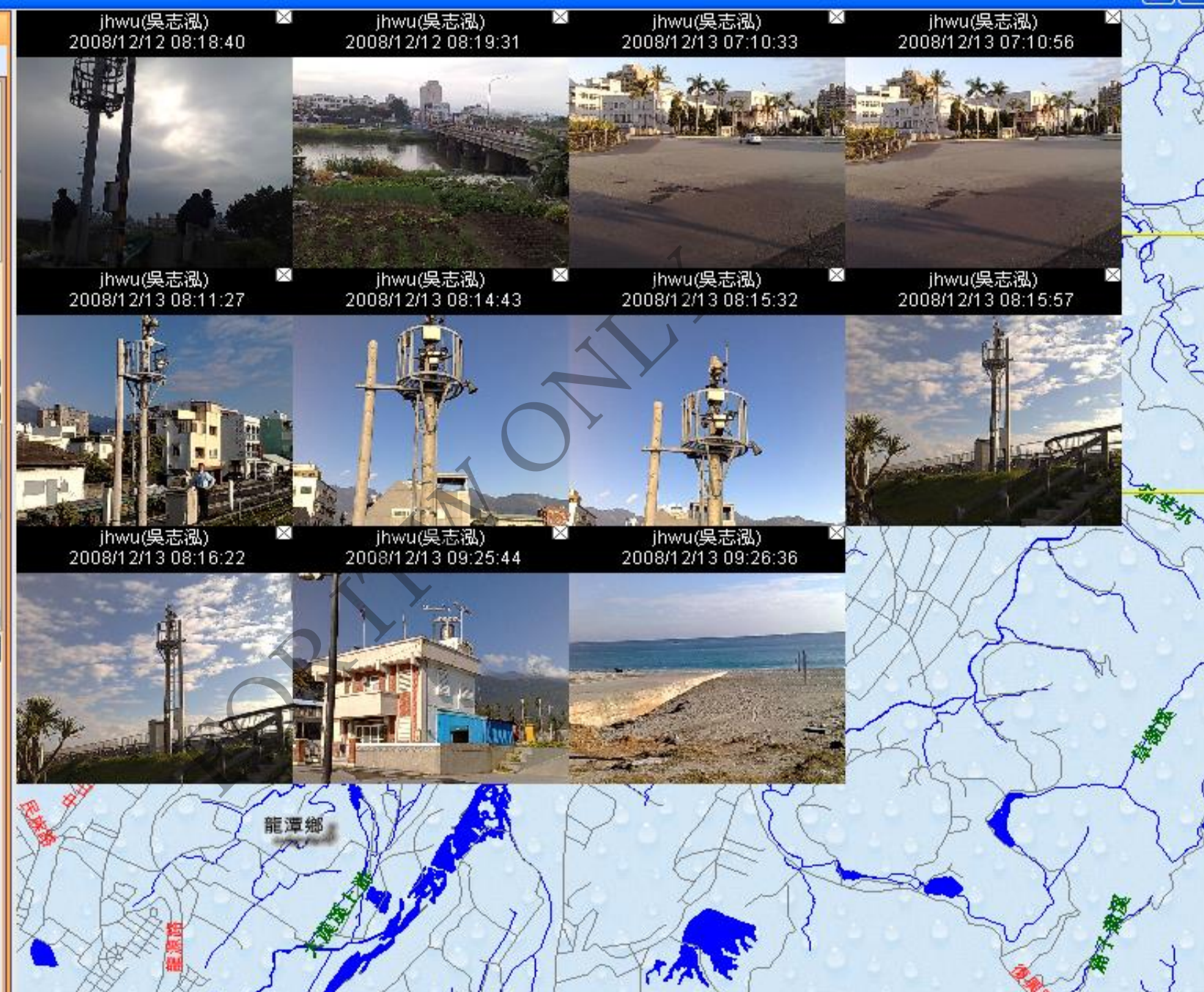
08/4/21 2009/4/21

查詢

全選 清除

件	行...	日期	備註	顯示
E...	請選擇	2008/...		✓
E...	請選擇	2008/...		✓
E...	請選擇	2008/...		✓
E...	請選擇	2008/...		✓
E...	請選擇	2008/...		✓
E...	請選擇	2008/...		✓
E...	請選擇	2008/...		✓
E...	請選擇	2008/...		✓
E...	請選擇	2008/...		✓
E...	請選擇	2008/...		✓

確定





# Emergency Management Information System

災害緊急應變作業系統





# Flood Emergency Information System



Weather Information



Precipitation Monitoring



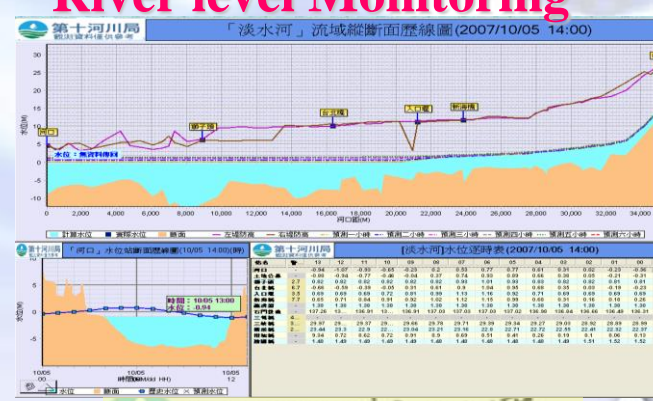
River level Monitoring



Reservoir Monitoring



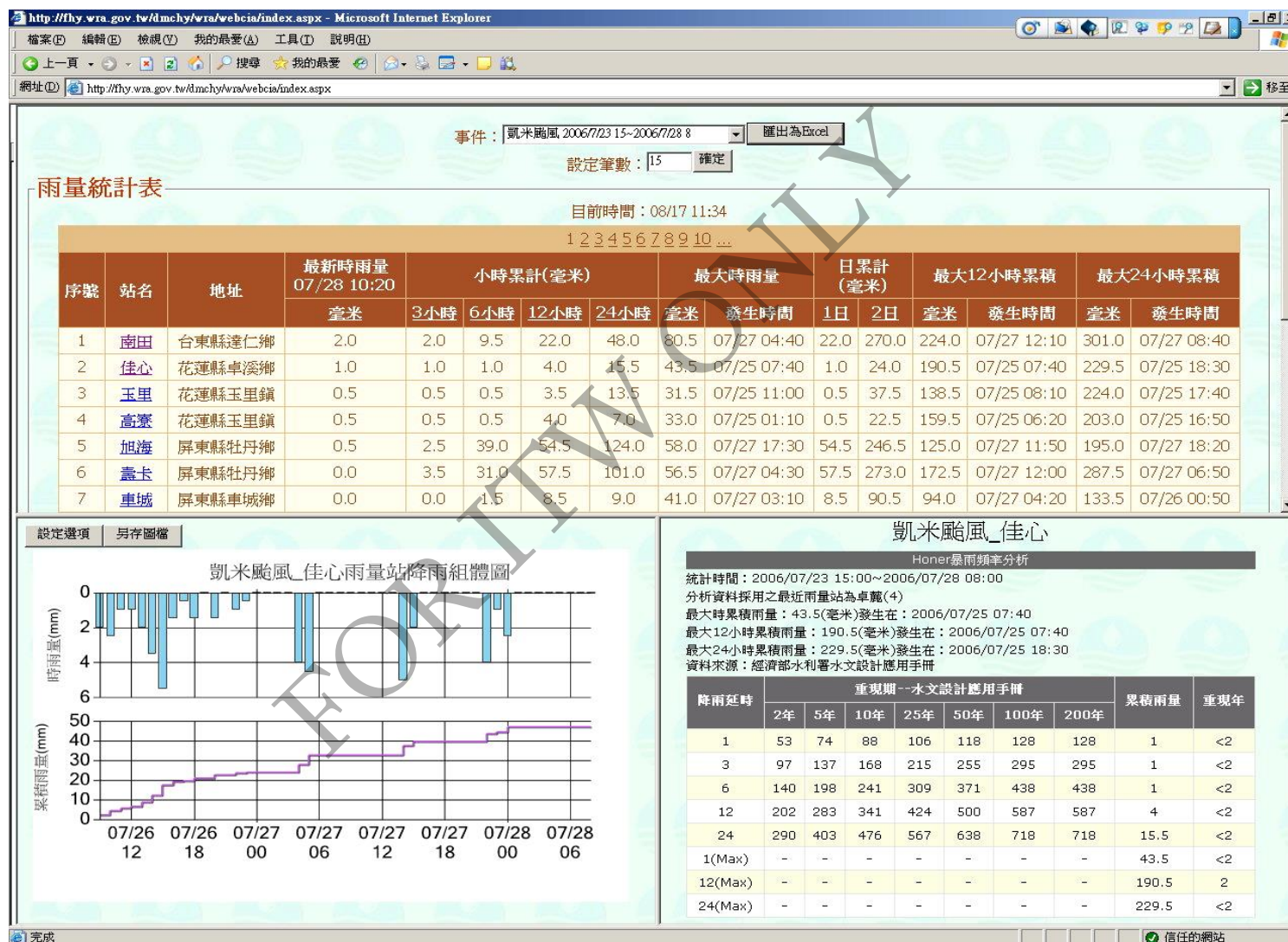
Coastal Monitoring



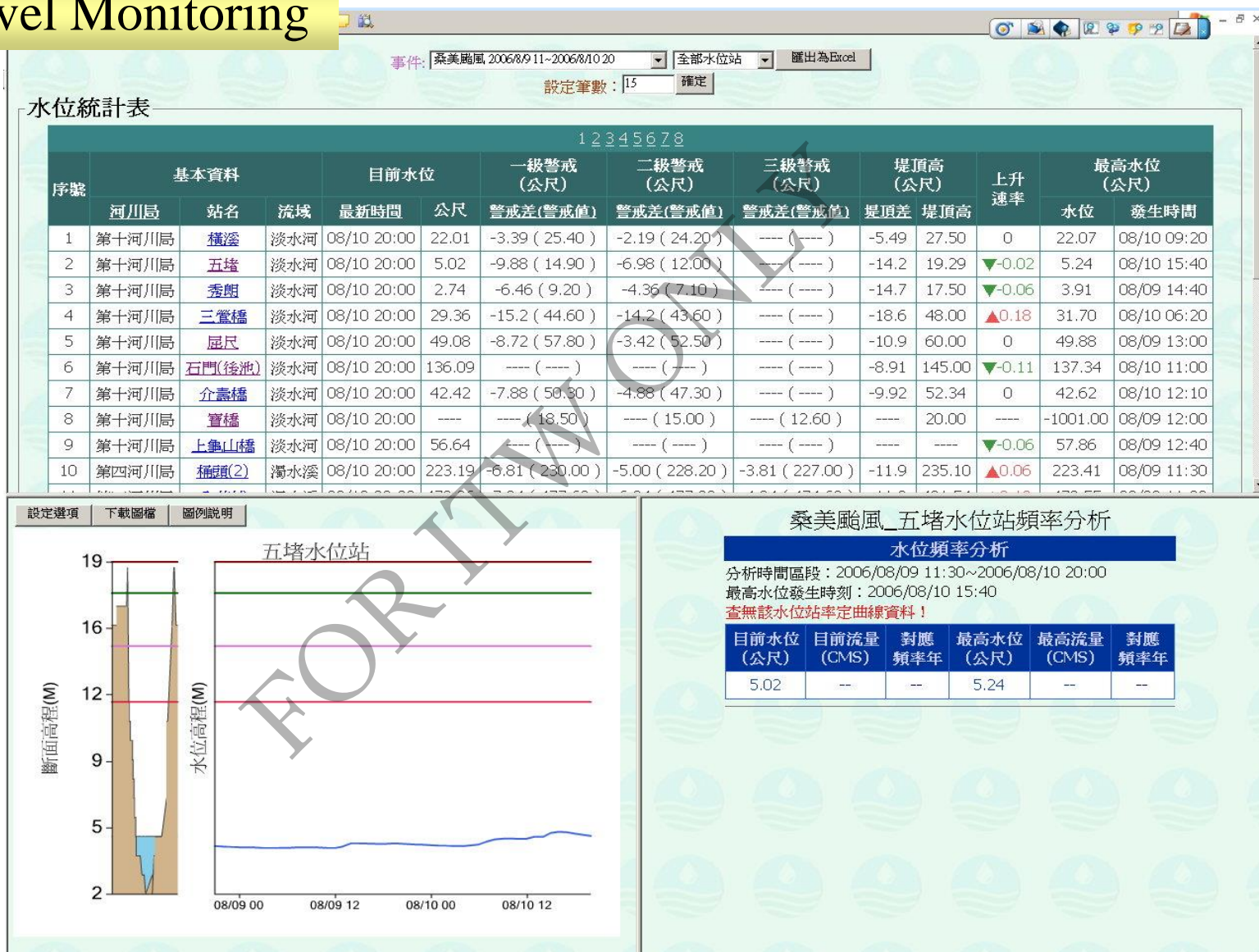
Flood Forecasting



# Precipitation Monitoring



# River Level Monitoring





# Reservoir Monitoring

水庫統計表

水庫名稱	水情時間	目前水位 (M)	滿水位 (M)	入流量 (cms)	出流量 (cms)	目前蓄水量 (萬立方公尺)	有效蓄水量 (萬立方公尺)	蓄水百分比 (%)	颱風期間總累積雨量 (毫米)	目前水庫狀態	預計洩洪時間	濁度
高屏溪攔河堰	07/28 08:00	17.06	----	----	13.15	----	----	----	----	--	----	濁度
牡丹水庫	07/28 08:00	136.03	142.00	49.75	95.4	2142.30	2907.93	73.67	2142.3	洩洪中	----	濁度
仁義潭水庫	07/28 07:00	104.67	105.00	7.00	2.89	2432.58	2506.00	97.07	50.5	--	----	濁度
曾文水庫	07/27 21:00	224.94	227.00	95.00	48	54726.00	58314.00	93.84	1.1	--	----	濁度
白河水庫	07/27 06:00	107.90	109.00	----	0	926.00	1203.00	76.97	51.0	--	2006/07/27 05:00	濁度
烏山頭水庫	07/26 14:00	57.28	58.18	----	30	7603.00	8375.00	90.78	145.0	--	----	濁度
德基水庫	07/26 00:00	1396.10	1408.00	135.00	40	12369.17	17317.04	71.42	----	--	----	濁度
石門水庫	07/26 00:00	241.16	245.00	80.05	12.37	18674.50	21963.00	85.05	40.1	--	----	濁度
谷關壩	07/26 00:00	929.33	950.00	60.00	65	----	11428.82	----	----	--	----	濁度
天輪壩	07/26 00:00	745.68	749.00	80.00	85	----	54.00	----	----	--	----	濁度
馬鞍壩	07/26 00:00	551.70	557.90	100.00	106	----	41.10	----	----	--	----	濁度
阿公店水庫	07/25 20:00	27.43	37.00	1.55	10.99	68.33	1837.00	35.88	40.1	--	----	濁度

切換水庫

詳細濁度資料

石門水庫[2005/10/3 8:00:0]

放水量 (cms) 36.07

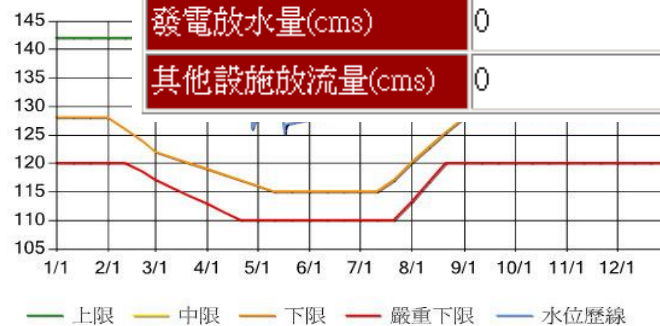
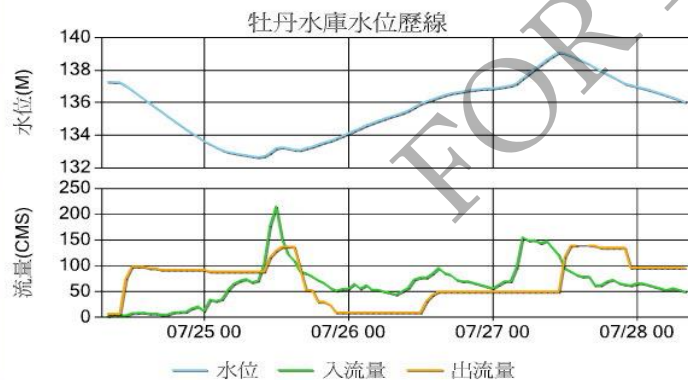
排洪量(cms) 356.33

排沙道放流量(cms) 0

發電放水量(cms) 0

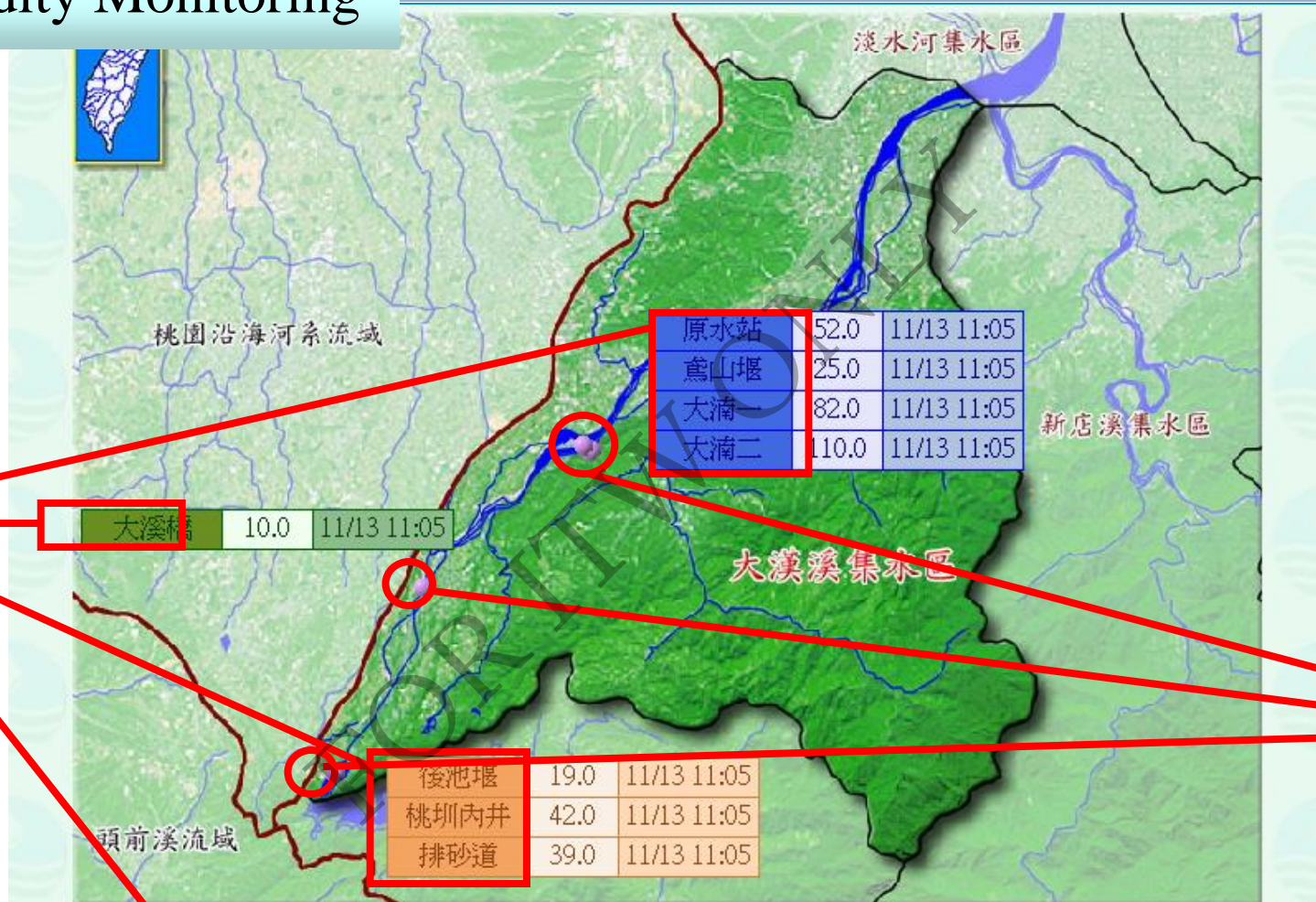
其他設施放流量(cms) 0

詳細放流量





# Turbidity Monitoring



原水站	52.0	11/13 11:05
鳶山堰	25.0	11/13 11:05
大溝一	82.0	11/13 11:05
大溝二	110.0	11/13 11:05

大漢橋	10.0	11/13 11:05
-----	------	-------------

後池堰	19.0	11/13 11:05
桃圳內井	42.0	11/13 11:05
排砂道	39.0	11/13 11:05

測站	後池堰	桃圳內井	排砂道	大漢橋	原水站	鳶山堰	大溝一	大溝二
濁度	19.0	42.0	39.0	10.0	52.0	25.0	82.0	110.0
時間	11/13 11:05	11/13 11:05	11/13 11:05	11/13 11:05	11/13 11:05	11/13 11:05	11/13 11:05	11/13 11:05

※濁度單位：NTU，資料來源：北區水資源局

濁度測站

# Coastal Monitoring



海岸水位推估

模式預測資料

現場即時影像

海堤資料

歷史海岸災害





# Integrated Demonstration

雨量、水位、水庫篩選條件

即時資訊列表





## Conclusion

- **Modern Flood Mitigation Activities require Reliable, Powerful & User-Friendly Monitoring, Simulation and Information Exchange services.**
- **Grid framework can support Flood mitigation, preparedness and response operations in Taiwan.**
- **Urban inundation problems and highland inundation problem will be the most important issue in the coming decade.**

簡報完畢  
恭請裁示



經濟部水利署