



Taiwan's Response Action to Flood Prevention

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經濟部水利署



Outline

I. Preface

II. Flood Protection Strategies

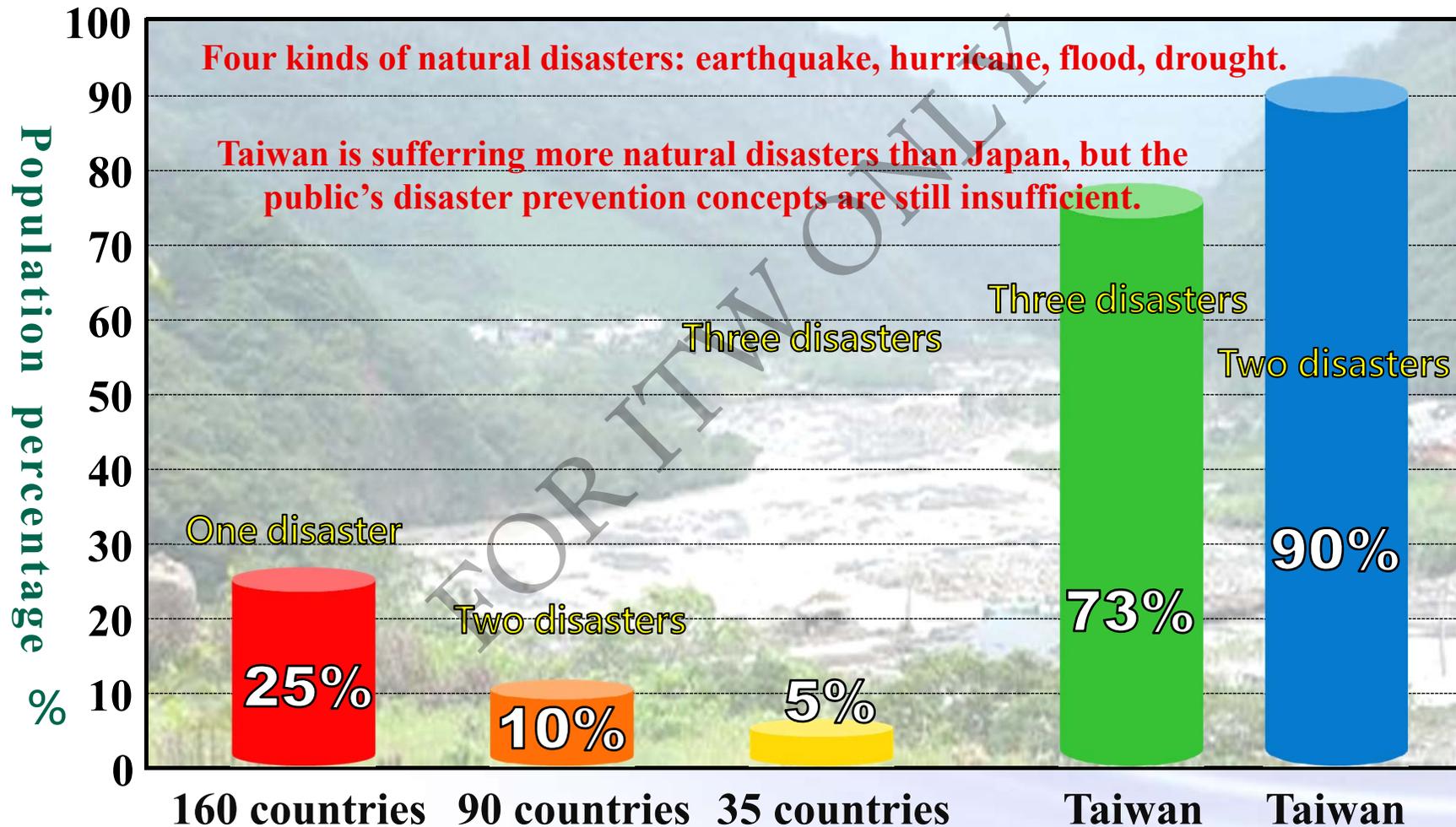
III. Disaster Prevention and Relief System

IV. Response Action to Flood Prevention

V. Conclusion

Taiwan is in the area threatened most severely by natural disasters.

More than 90% of the population is threatened by two types of disasters.

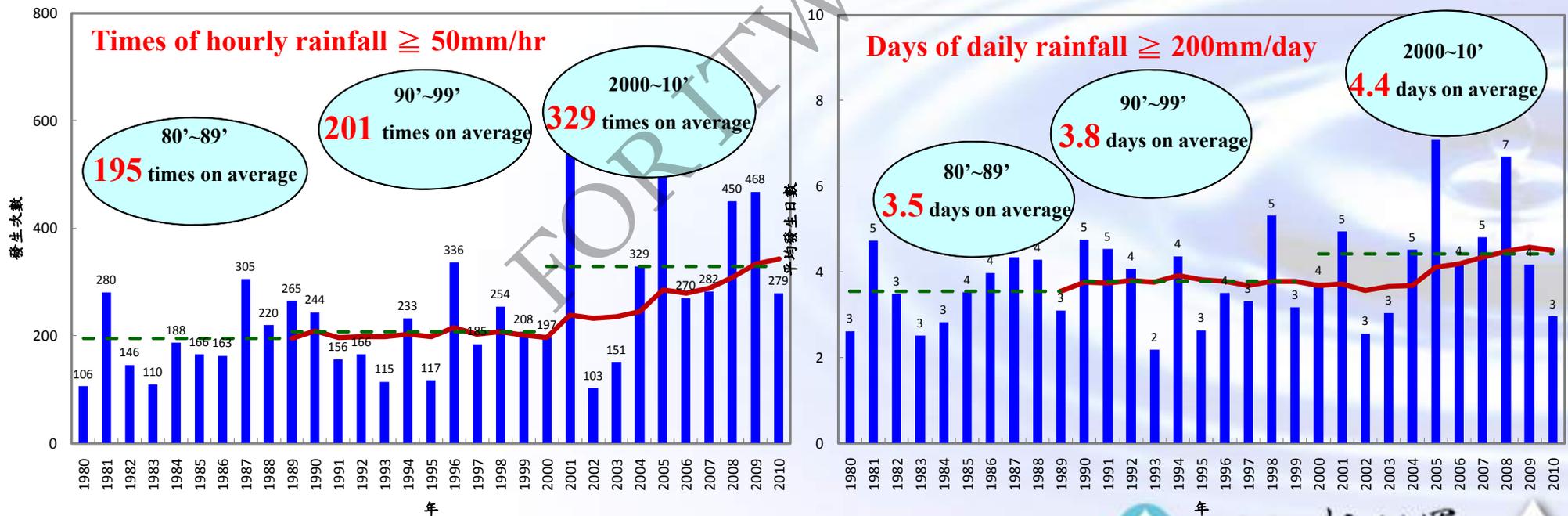


The World Bank Report (2005): National Disaster Hotspots – A Global Risk Analysis

行政院災害防救委員會

Analysis from 1980-2011 of 148 rainfall stations across Taiwan, with 10 years as a time interval, shows:

- Hourly rainfall $\geq 50\text{mm/hr}$, times of occurrence increased by **130 times compared to 20 years ago** (increased to 329 times a year in the past 11 years).
- Daily rainfall $\geq 200\text{mm/day}$, days increased by **0.9 days a year compared to 20 years ago** (averaging 4.4 days a year in the past 11 years).

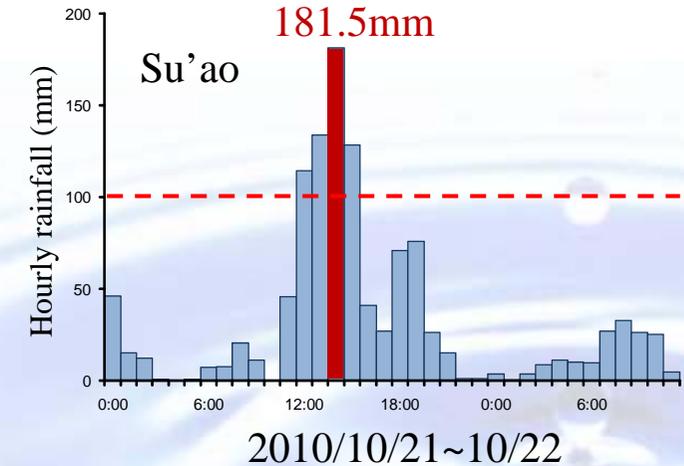
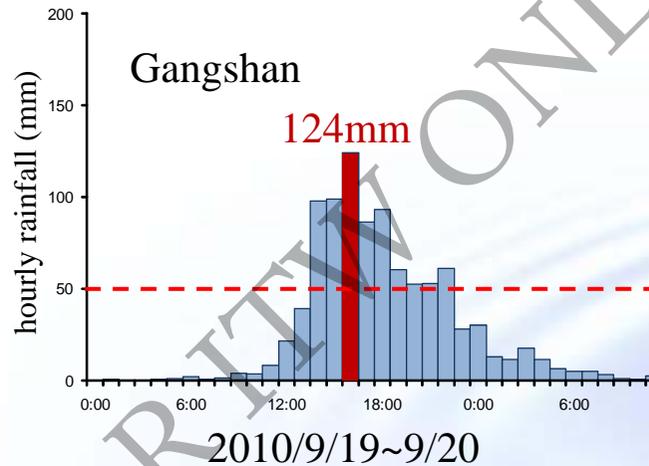
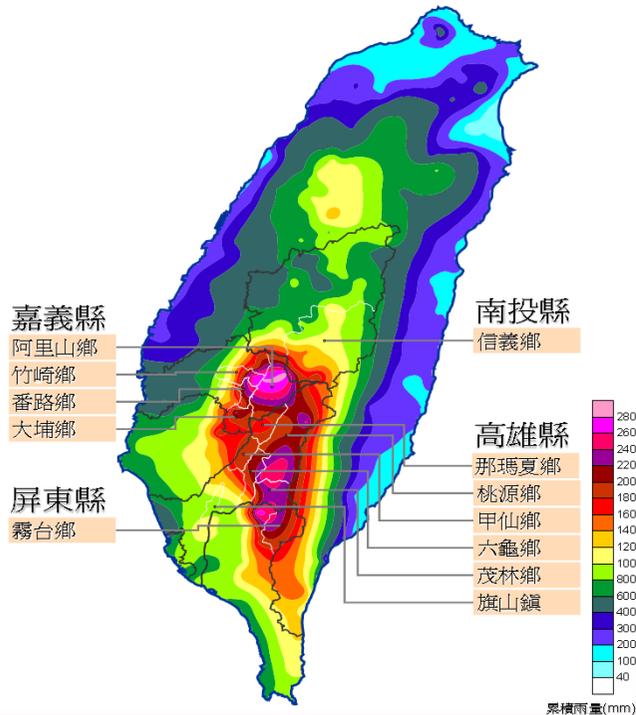


Historical rainfall records in recent years

2009 Typhoon Morakot

2010 Typhoon Fanapi

2010 Typhoon Megi



Typhoon Morakot rainfall characteristics

- Lasted a long time, high intensity, covered large areas
- Xinmajia, Taiwu (1) exceeded 50mm/hr. for 24 consecutive hours.
- Maximum cumulative rainfall of 2,884mm

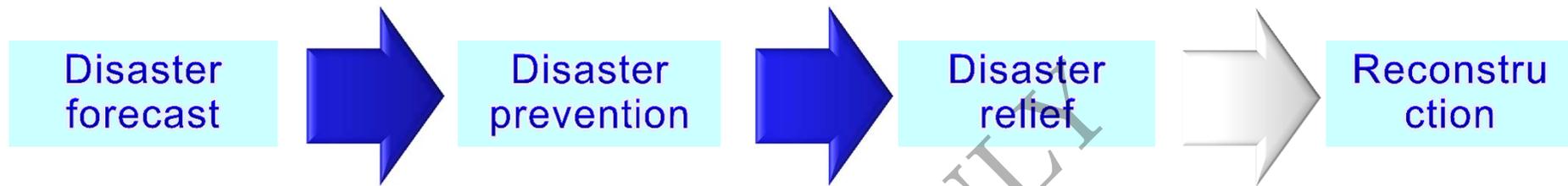
Typhoon Fanapi rainfall characteristics

- Gangshan station: Exceeded 50mm/hr. for 9 consecutive hours, reaching 124mm/hr.; Zuoying Station: Exceeded 30mm/hr. for 9 consecutive hours

Typhoon Megi rainfall characteristics

- Su'ao station: Exceeded 100mm/hr. for four consecutive hours, reaching 181.5mm/hr., 21 days cumulative rainfall reached 939.5mm (New record in the station)

Change the concept of disaster prevention, **actively prevent disasters instead of providing relief for them afterwards.**



◆ **Disaster forecast prior to disaster prevention**

- ◆ Climate is changing all the time → Estimate the disaster broadly, and seriously defend against the disaster
- ◆ Disasters are unpredictable → Zero casualties in floods → Preventive evacuation

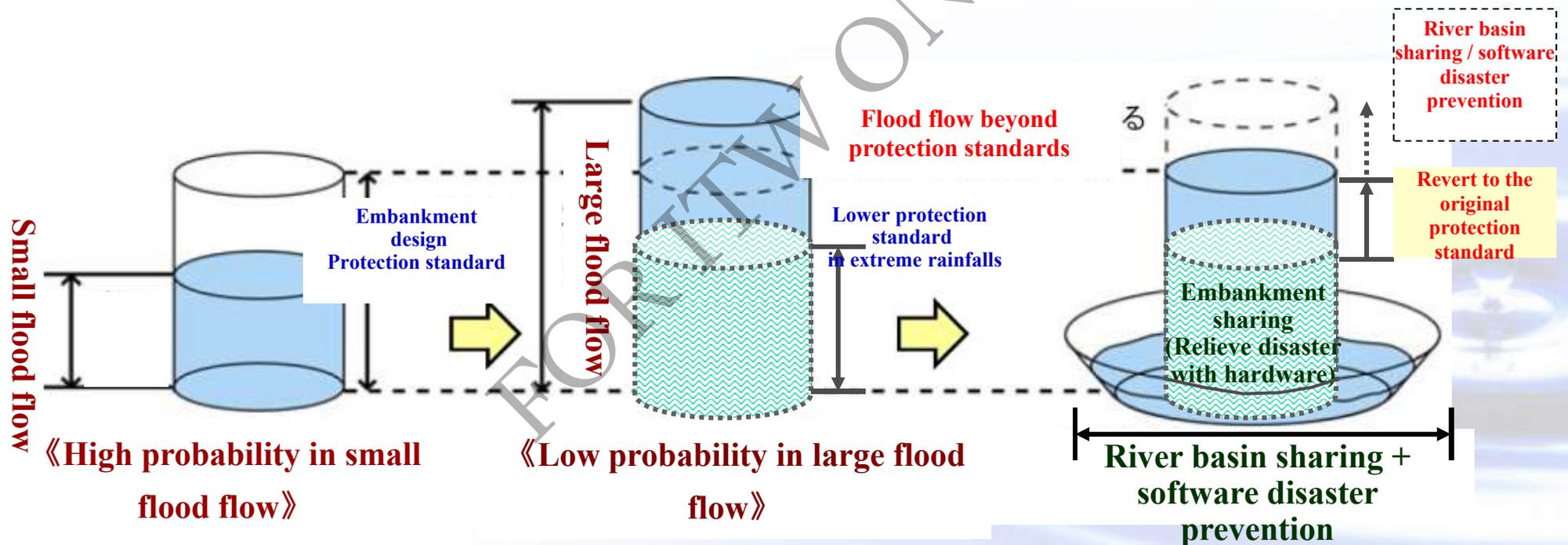
◆ **Disaster prevention prior to disaster relief and reconstruction**

- ◆ Comprehensively prepare for disaster prevention → Relieve disaster degree and losses → Reduce works of disaster relief and reconstruction

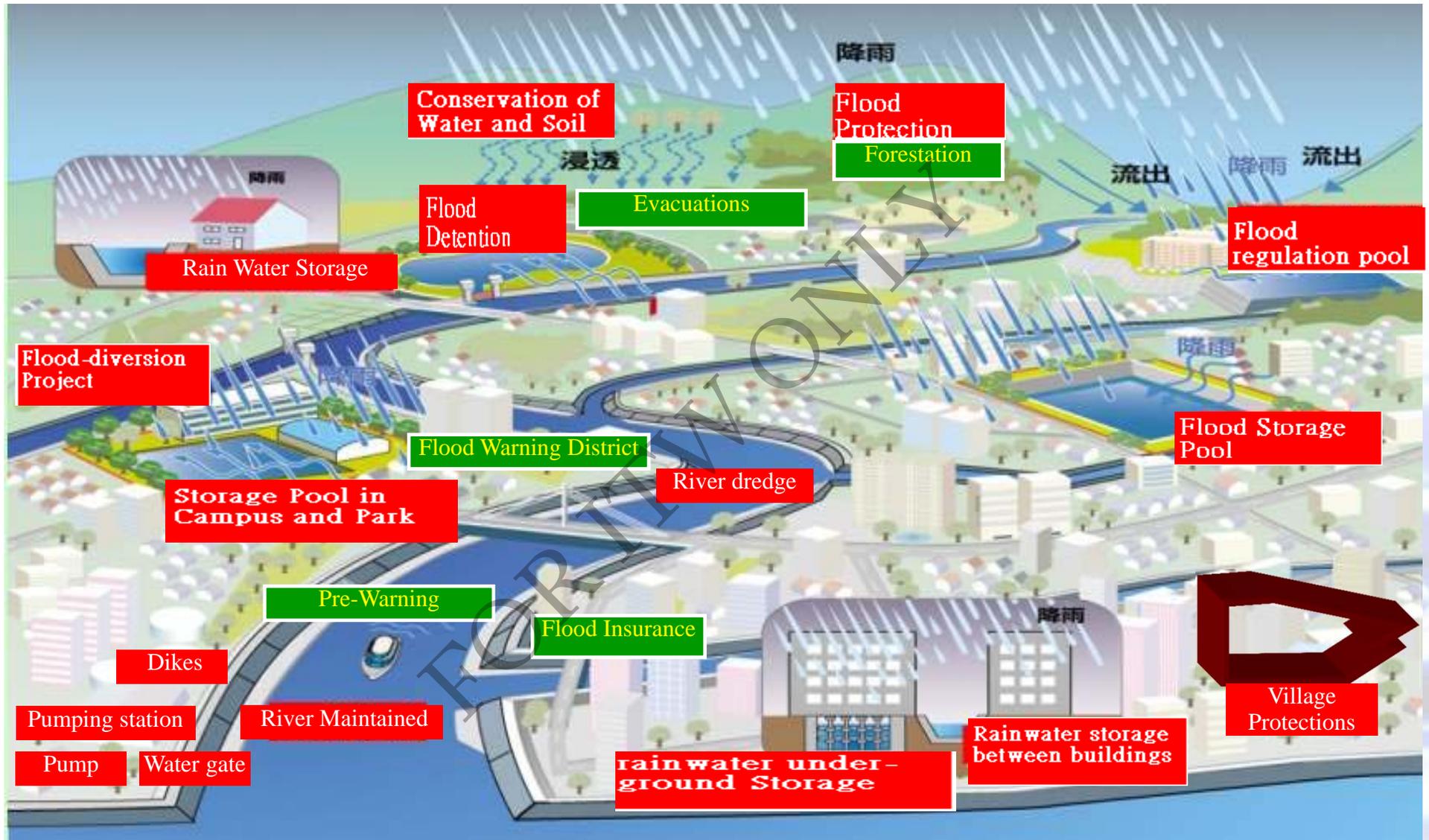
II. Flood protection strategies

Taiwan flood protection strategies – Promote comprehensive water control

- **Structural** - Do not fight against nature, ensure and strengthen the function of existing facilities, reduce flood potential.
- **Nonstructural** - coexist with water, restrict the development of sensitive areas in homeland planning.
 - coexist with disasters, conduct comprehensive water conservation along river basins and jointly share the flood.
 - Strengthen the preparation of disaster prevention and response measures, achieving the objective of “Zero casualties, less damage”.



(Revised from the local regeneration strategy in Japan, 2008)

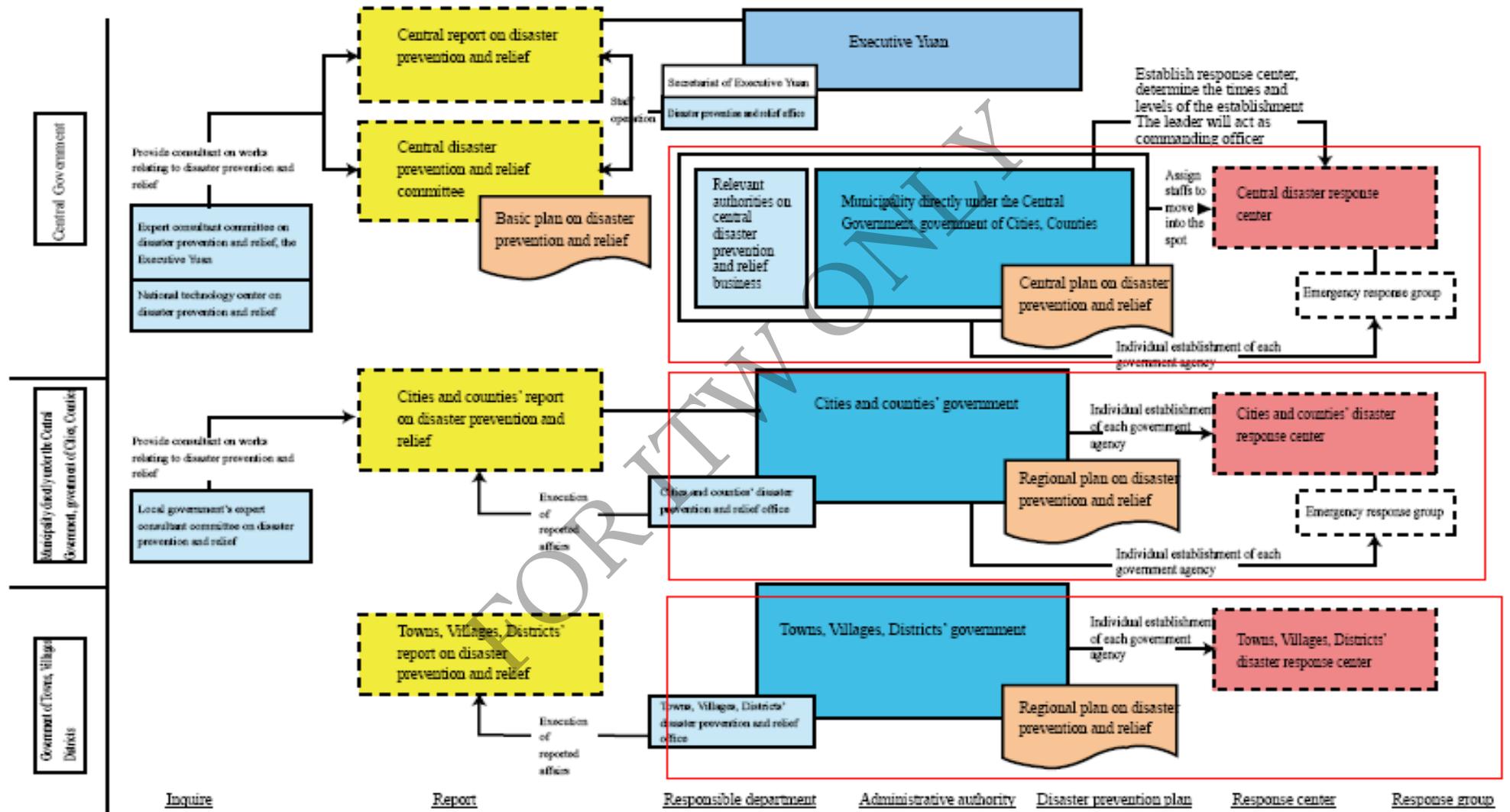


Structural
Hydraulic Facilities

Nonstructural
Non-hydraulic Facilities

III. Disaster Prevention and Relief System

Taiwan Disaster Prevention and Relief System (in three levels)



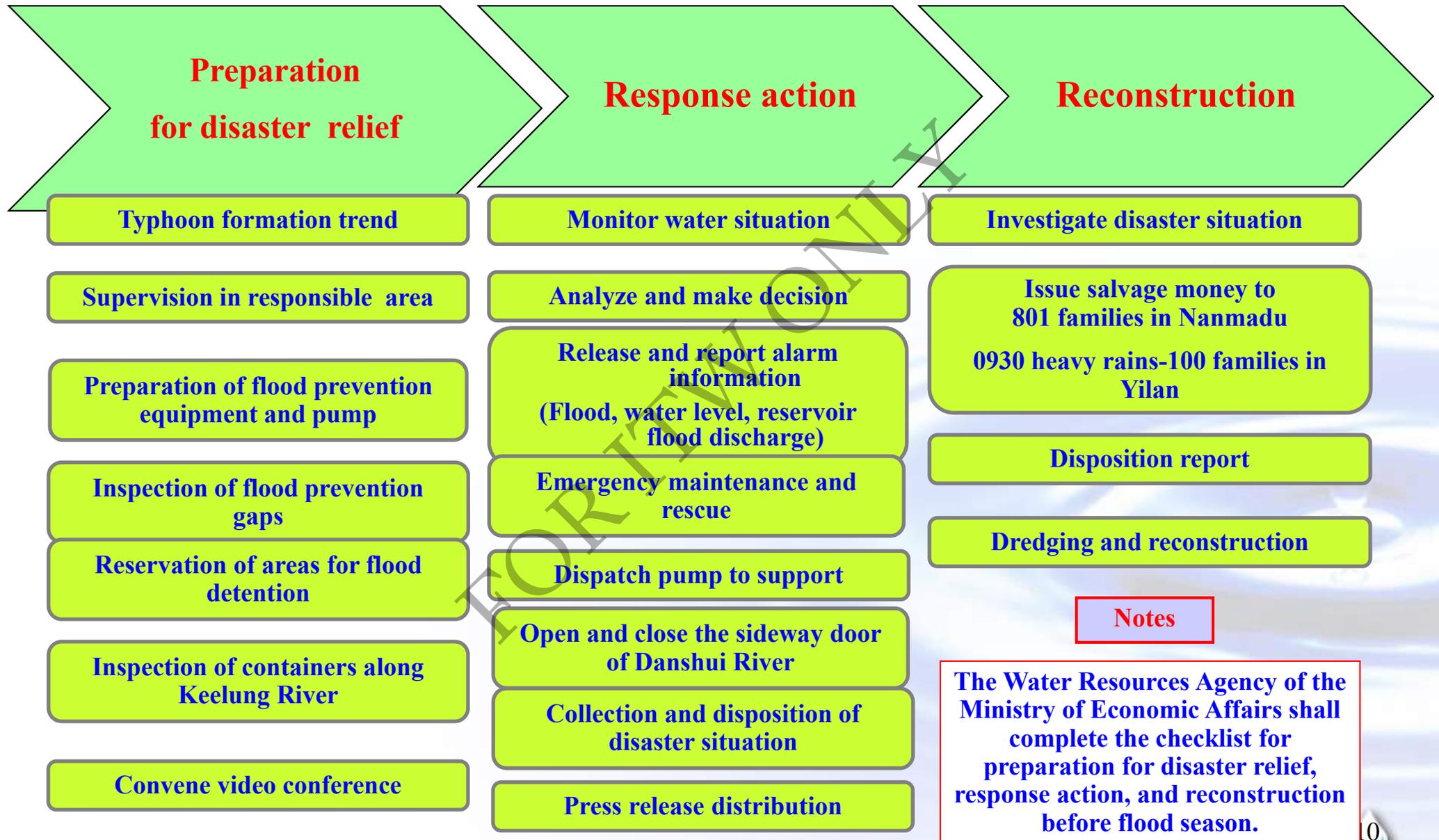


During flood season (May ~November) 24hr : Assign coordinator to move into central disaster response center



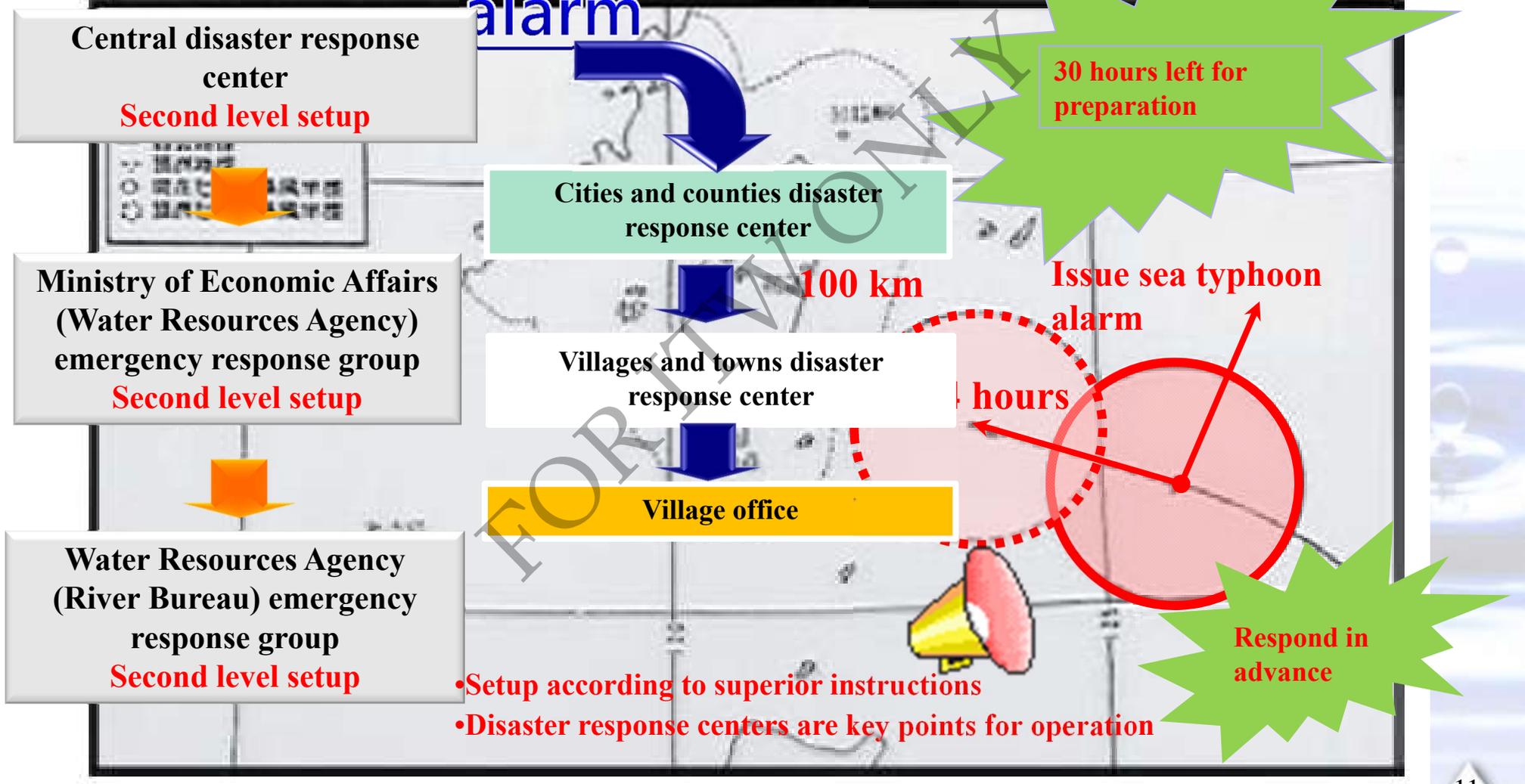
IV. Response Action to Flood Prevention

Key works in flood prevention response



颱風警報

Sea typhoon alarm



Central disaster response center
Second level setup

Cities and counties disaster response center

Ministry of Economic Affairs (Water Resources Agency) emergency response group
Second level setup

Villages and towns disaster response center

100 km

Issue sea typhoon alarm

Village office

hours

Respond in advance

Water Resources Agency (River Bureau) emergency response group
Second level setup

- Setup according to superior instructions
- Disaster response centers are key points for operation

颱風警報

Sea and land typhoon alarm

Central disaster response center

First level setup

Ministry of Economic Affairs (Water Resources Agency) emergency response group

First level setup

Water Resources Agency (River Bureau) emergency response group

First level setup

Cities and counties disaster response center

Villages and towns disaster response center

Village office

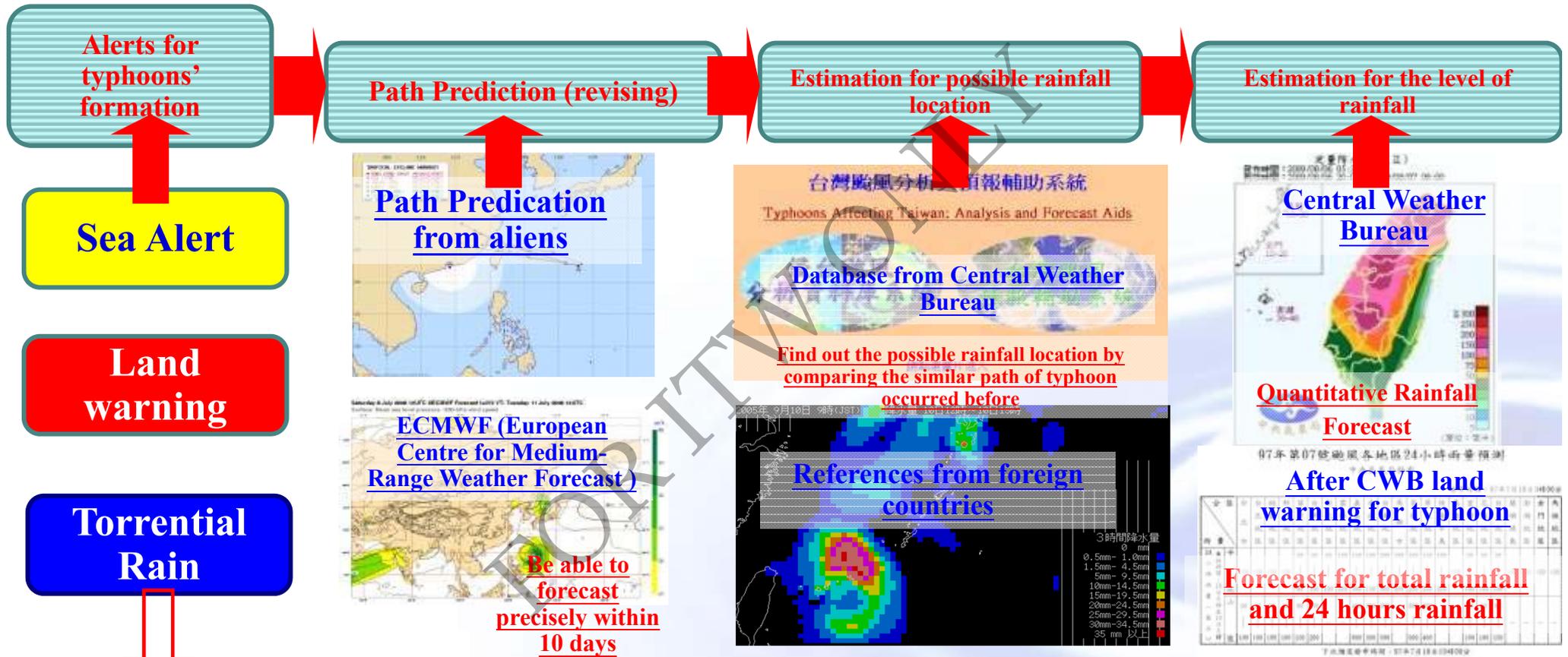
18 hours left for preparation

Issue sea and land typhoon alarm

Respond in advance

- Setup according to superior instructions
- Disaster response centers in each county and city are the key points for operation (for example: it is estimated that a level 7 typhoon will arrive in 8 hours)

Based on information about typhoon or torrential rain: **Predicting the possible flood-prone areas to carry out flood prevention response**



- 1.Focus on the warning district
- 2.Attention to the latest rainfall forecast
- 3.Flood prevention for targeting areas
- 4.Investigate disaster situation for targeting areas

Strengthen the preparation for flood and early dispatched mobile pumps

Report to the local government for early evacuation

【Preparation before flood season】

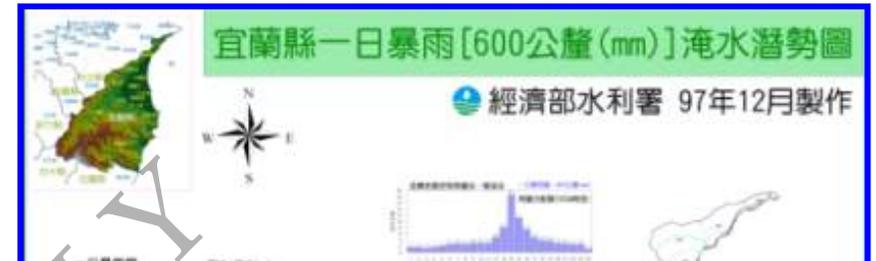
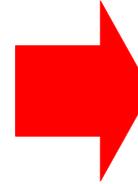
Preparation and application of flood trend charts

Flood trend charts on the county and city level



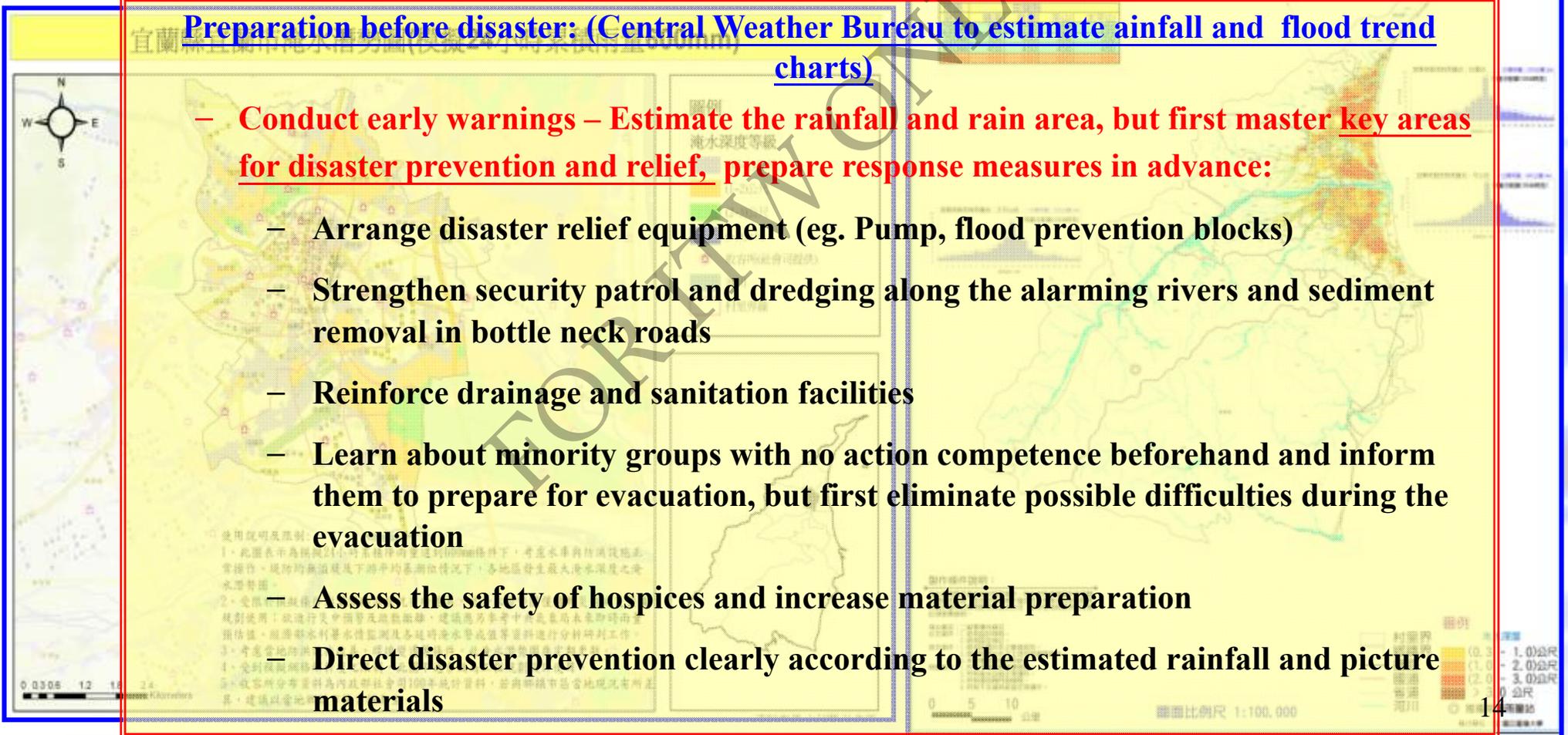
Plus

Flood trend charts on the town and village level

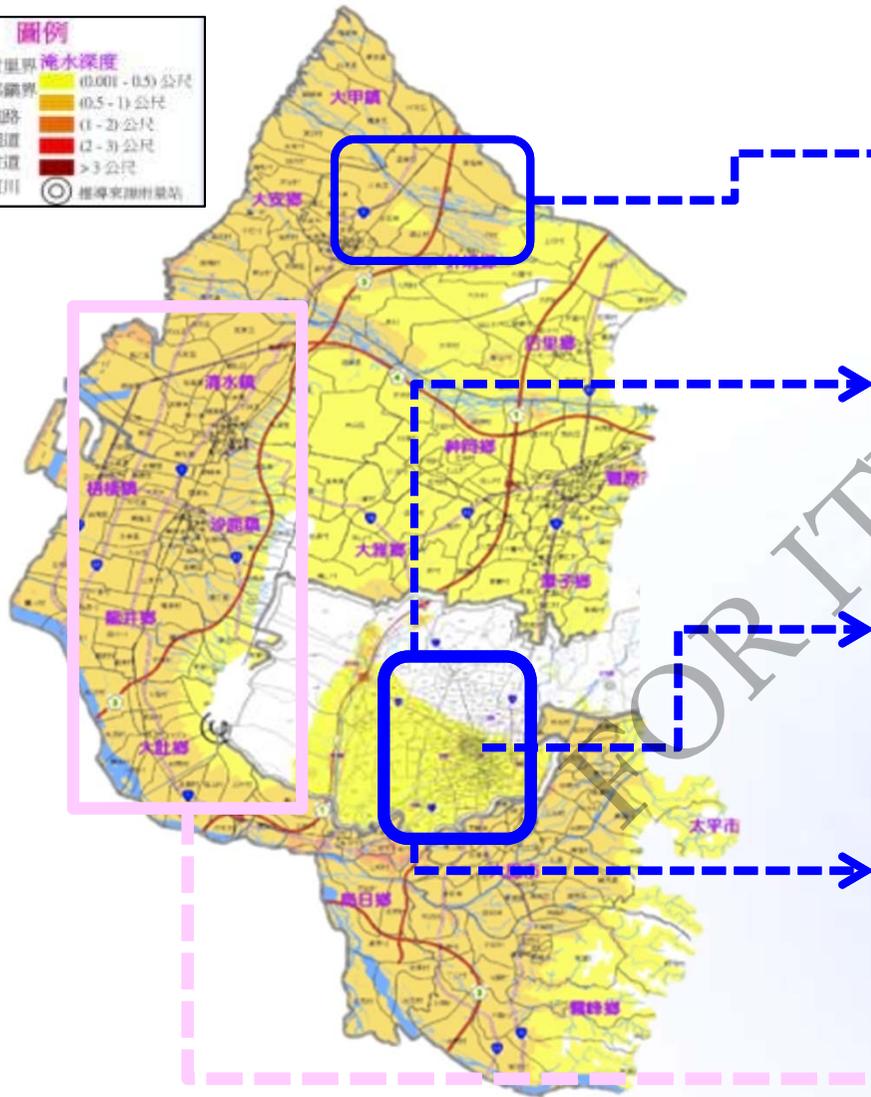


Preparation before disaster: (Central Weather Bureau to estimate ainfall and flood trend charts)

- **Conduct early warnings – Estimate the rainfall and rain area, but first master key areas for disaster prevention and relief, prepare response measures in advance:**
 - Arrange disaster relief equipment (eg. Pump, flood prevention blocks)
 - Strengthen security patrol and dredging along the alarming rivers and sediment removal in bottle neck roads
 - Reinforce drainage and sanitation facilities
 - Learn about minority groups with no action competence beforehand and inform them to prepare for evacuation, but first eliminate possible difficulties during the evacuation
 - Assess the safety of hospices and increase material preparation
 - Direct disaster prevention clearly according to the estimated rainfall and picture materials



Application of flood trend charts (County and city flood trend charts)



Strengthen security patrol and dredging along the alarming rivers and **sediment removal in bottle neck roads.**

Arrange disaster relief equipment (eg. Pump, flood prevention blocks)

Learn about **minority groups with no action competence** beforehand and inform them to prepare for evacuation, but first eliminate possible difficulties during the evacuation

Reinforce **drainage and sanitation facilities**

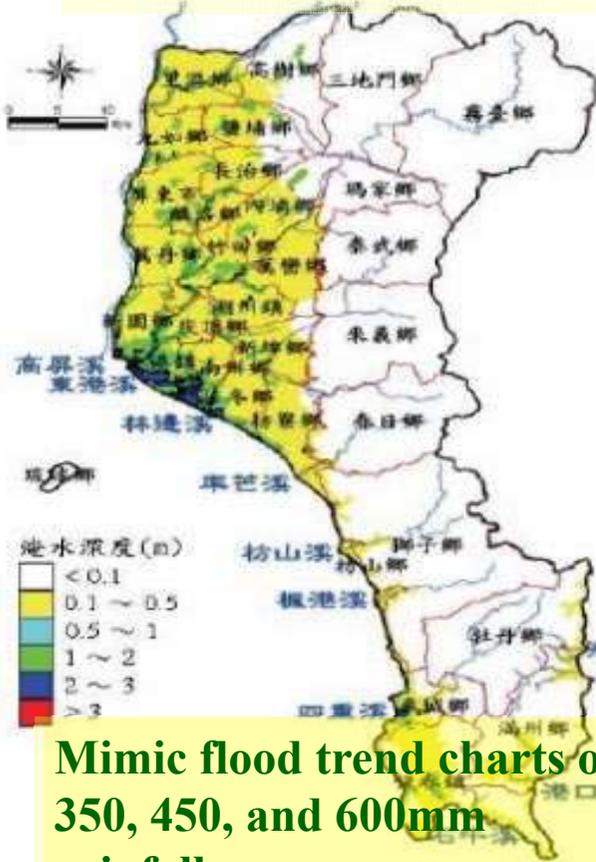
Enhance the preparation of goods and materials and the **planning of delivery routes**

【Disaster early warning】

Flood trend charts + 24-hour rainfall forecast

First master the flood-prone areas to carry out flood prevention response and evacuation

24-hour rainfall flood trend charts



Mimic flood trend charts of 200, 350, 450, and 600mm rainfalls

圖6-2-8 屏東縣600毫米未日降雨量之淹水潛勢圖

+

97年第07號颱風各地區24小時雨量預測

中央氣象局發布

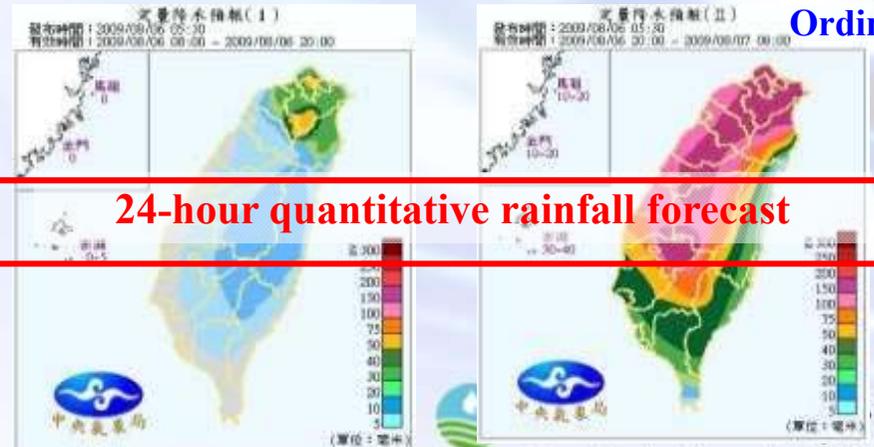
Land typhoon alarm

| 分區 | 台北 | 台中 | 台南 | 高雄 | 基隆 | 宜蘭 | 花蓮 | 台東 | 澎湖 | 金門 | 馬祖 |
|----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| 雨量 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 | <50 |
| 雨量 | 80 | 100 | 100 | 200 | 300 | 150 | 300 | 200 | 250 | 200 | 100 |
| 雨量 | 50 | 50 | 50 | 50 | 80 | 100 | 400 | 300 | 300 | 300 | 200 |
| 雨量 | 100 | 100 | 100 | 100 | 150 | 200 | 600 | 500 | 500 | 500 | 400 |

24-hour rainfall forecast

下次預定發布時間：97年7月18日10時00分

+



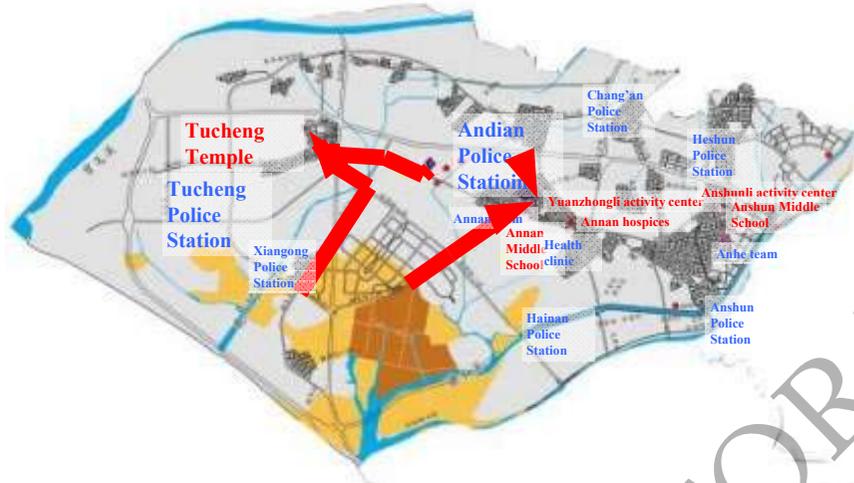
24-hour quantitative rainfall forecast

Ordinarily

Complete the prevention and relief plan for flood-prone areas before flood season

Prepare prevention and relief plan for flood-prone areas according to flood trend charts and historical flood experience

Annan District, Tainan City Flood-prone areas and evacuation map



- ▲ 水災收容所
 - ✚ 台南市醫療單位
 - ▲ 台南市消防單位
 - 台南市警察單位
 - 水系
 - 台南市廓面圖
 - 台南市安南區範圍
- 台南市淹水潛勢
日雨量450mm
- 0.0m - 0.5m
 - 0.5m - 1.0m
 - 1.0m - 2.0m
 - >2.0m
- 疏散路線

Master beforehand the flood-prone areas and relevant prevention and relief objects, hospices, evacuation routes, and the location of mobile pumps, sand bags and gabions, etc.

表 2-1 屏東縣水災危險潛勢地區保全計畫表

| 水災危險潛勢地區 (鄉鎮市-村里) | 保全 戶數 | 保全 人數 | 避難處 所 | 避難所地址 | 疏散撤離通報人員 (村里長) | 聯絡電話 |
|----------------------|----------|----------|--------------|------------------------|-------------------|--------------------------|
| 里港鄉-中和村 | 330 | 1887 | 土庫國小 | 里港鄉中和村(路)35 | 村長：尤啓精 | 0939360106 08-7731717 |
| 里港鄉-彌力村 | 177 | 1056 | 三和國小 | 屏東縣里港鄉土庫路 111-3 號 | 村長：梁崑宗 | 0935460956 08-7731520 |
| 鹽埔鄉-洛陽村 | | | 洛陽村社區 | 鹽埔鄉洛陽村四維路 103 號 | 村長：黃錦達 | 0953272936 08-7031406 |
| 九如鄉-大坵村 | | | 老人文康 活動中心 | 九如鄉大坵村大仁街 70 | 村長：許新米 | 0938581617 08-7392646 |
| 九如鄉-後庄 | | | | 九如鄉後庄村後庄路 173 號 | 村長：陳權華 | 0956687685 08-7757693 |
| 九如鄉-九明村 | 558 | 1887 | 老人文康 活動中心 | 九如鄉九明村九龍路 55 號 | 村長：陳復 | 0937389123 08-7390928 |
| 九如鄉-三塊村 | 504 | 1913 | 三多國小 | 屏東縣九如鄉三塊村三 民路 307 號 | 村長：葉天任 | 0937574873 08-7750873 |
| 九如鄉-洽興村 | 468 | 1800 | 洽興社區 活動中心 | 九如鄉洽興村平和路 22 之 1 號 | 村長：陳朝評 | 0935905277 08-7752571 |
| 九如鄉-玉水村 | 169 | 1572 | 玉水社區 活動中心 | 九如鄉玉水村清水路 73 號 | 村長：吳清吉 | 0911716532 08-7391636 |
| 屏東市-海豐里 | 295 | 1056 | 海豐國小 | 屏東市海豐街 3 號 | 里長：施世男 | 0918236929 08-7376190 |

Minority groups needed to be assisted shall be specially marked

【Early warning during disaster】 Initially provide the latest information on the water situation and release real time alarm information

| Alarm Category | Release 2nd level alarm | Release 1st level alarm |
|------------------------------------|---|--|
| Flood alarm (internal water) | Real time rainfall > alarm rainfall (2 nd level rainfall alarm) | Real time rainfall > flood and ponding rainfall (1 st level rainfall alarm) |
| Water level alarm (external water) | Observed water level > 2nd level alarm water level | Observed water level > 1st level alarm water level |
| Reservoir flood discharge alarm | Prepare for flood discharge | Start flood discharge |
| Reservoir turbidity alarm | - | Reservoir turbidity > alarm turbidity |

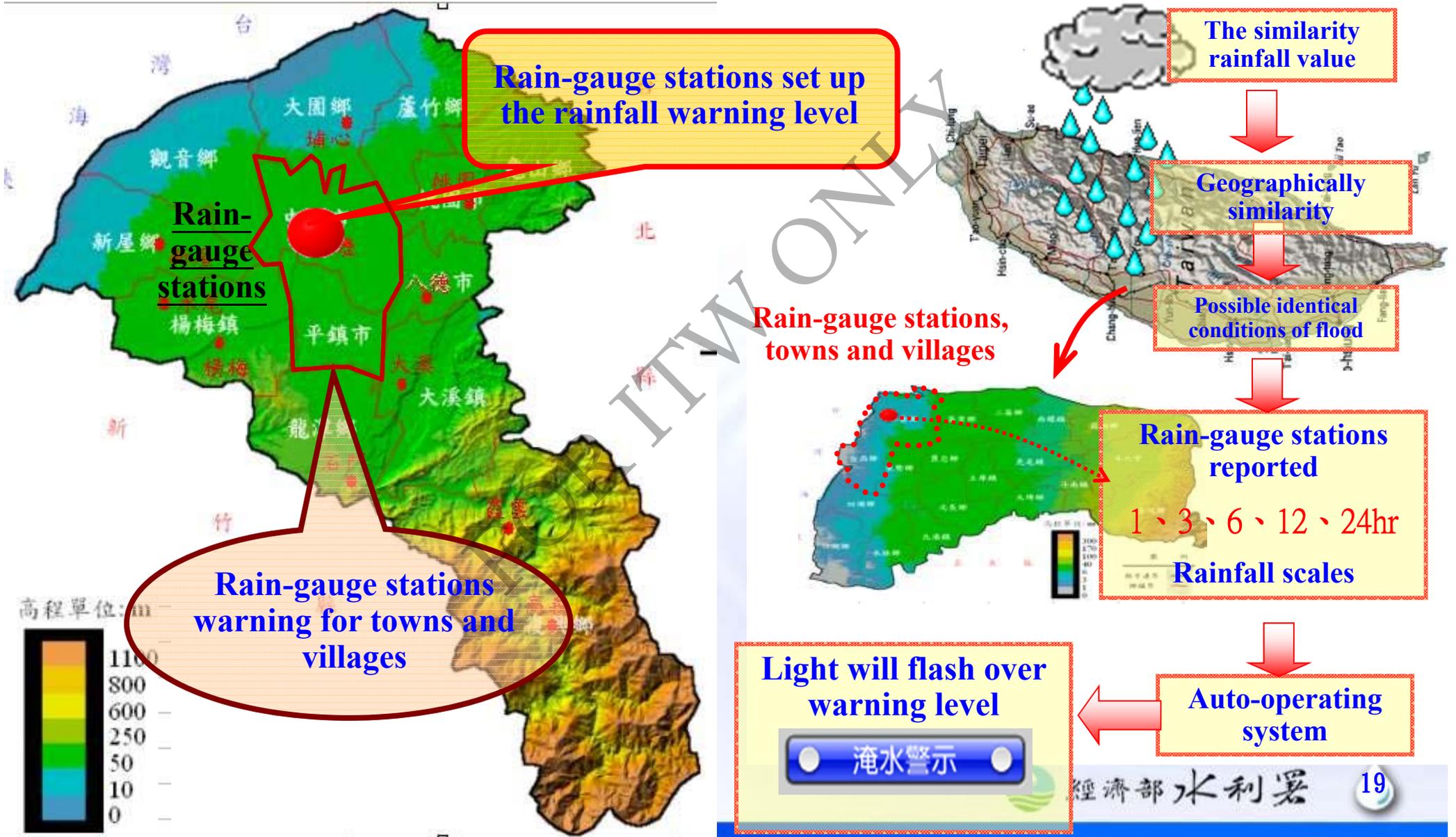
Definitions of flood alarm grading:

- **2nd level alarm:** if the area (city, county, town, district) issuing the flood alarm suffers from **sustained rainfall** and **70% possibility** that flood-prone areas within the administrative area will be **ponding and flooded within 3 hours** .
- **1st level alarm:** if the area (city, county, town, district) issuing the flood alarm suffers from **sustained rainfall** and **70% possibility** that flood-prone areas within the administrative area **have already begun ponding and flooded**.

Notes: The accuracy of the flood alarm is affected by such factors as uneven distribution of rainfall, density of rainfall station, water level of the rivers, sea level, blocks in water discharge routes, etc. It can be made according to the monitoring of real time rainfall (eg. QPESUMS) and local rainfall situations.

Flood Warning System (Internal Water)

National rainfall warning level and flood forecasting system- invented by the Water Disaster Mitigation Center from Water Resource Agency of Taiwan

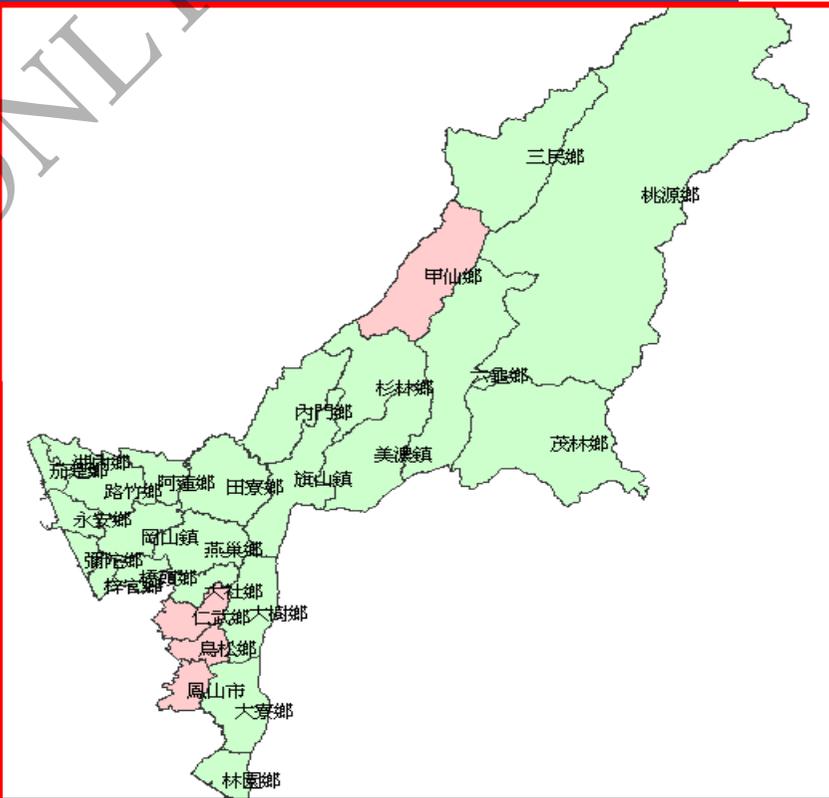
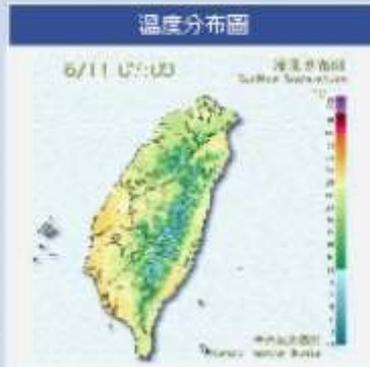


經濟部水利署 防災資訊服務網

淹水警示
 水位警示
 水庫淹洪警示
 水庫濁度警示

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[淹水潛勢](#)
[相關網站](#)
[災害緊急應變系統登入](#)
[防汛志工通報登入](#)

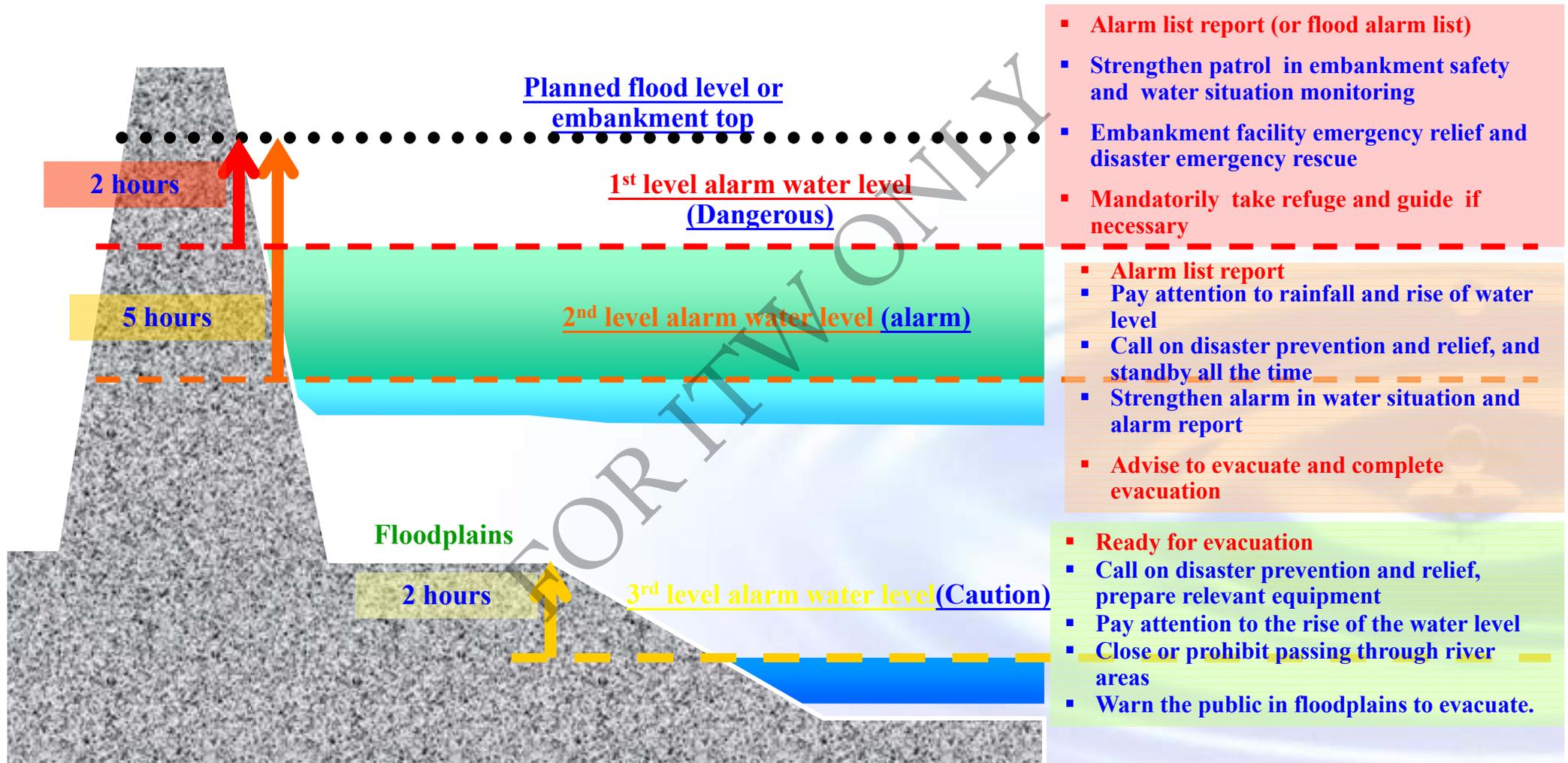
Light will flash over warning level



- ☔ **Island-wide advance warning (Comprehensive)**
- ☔ **Instant warning (Timeliness)**
- ☔ **Warning on village level**
(Facilitated with local governments)
- ☔ **Provide information to flood- stricken villages**
(Notification)
- ☔ **Implementation since 2009 (Efficacious)**
- ☔ **Annual Review and updates (Warning levels in villages)**

Early warning for external water floods (alarm for river water level)

Rivers under central administration have **setup water level stations** and stipulated **alarm water levels (3 levels)** to coordinate to monitor **OPESUMS real time rainfall**, conduct **early warning for river (external water) floods and report the disposition**.



- Rivers under central administration have already setup alarm water levels.
- Rivers under county and city administration have not yet setup alarm water levels.

Reservoir flood discharge alarm

Reservoir flood discharge operation procedures



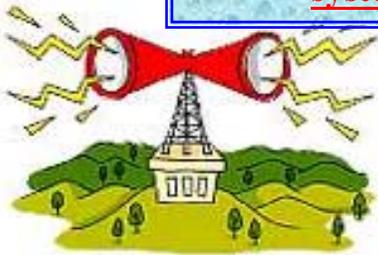
Monitoring and judgment on water situation (master any time)

Flood discharge according to Reservoir Flood Prevention Operation Regulations

Complete downstream and notice report 1 hour before flood discharge

Report to and notify relevant authorities in downstream and activate downstream flood discharge alarm system

Activate downstream flood discharge alarm system



River Bureau disaster emergency response group
County and city disaster emergency response groups
County and city fire prevention bureaus, police stations
County and city water resources bureaus (department)
Relevant irrigation and water conservation associations and water supply companies
Downstream village and town disaster emergency response center
Other relevant departments and downstream village offices

Reservoir flood discharge alarm

Reservoir flood discharge report list

Response group of Water Resources Agency

Release flood discharge information through communication media



【 Establishment of diversified information services 】



Internet

Everyone (Media)



Mobile water situation App
Smart phone



Flood, water level: Exceeds alarm standards
Reservoir flood discharge: informed by the Water Resources Bureau

Message

Ordinary mobile phone(website)

Fax notice

Disaster prevention and relief personnel

LBS in specific areas to uncertain people

1. Leader of the city, county or bureau
2. Leader of the village, town
3. Disaster prevention office, Executive Yuan
4. Ministries (Ministry of Defense, Ministry of Communication)
5. Personnel from Water Resources Agency and River Bureau

1. County and city governments
2. River Bureau
3. Media, news bureau (flood discharge, flood diversion)
4. Disaster prevention office, Executive Yuan
5. Central response center

Reservoir flood discharge / emergency evacuation



Village broadcasting system to deliver notice

■ Automatically promptly, rapidly, and effectively deliver the notice

Automatically create contents of notice list

Automatically create contents of message

經濟部暨水利署災害緊急應變小組警示單

發布時間: 年月日時分

類型: 淹水潛勢 水庫洩洪 水庫濁度 警戒水位

警戒區域: 詳如附件之主要警戒單位

警戒事項: 依經濟部水利署降雨-淹水預警系統, 00雨量站過去0時累積降雨0公厘, 下列地區未來一小時內有較高淹水潛勢:

(一) 臺北市: 公館鄉-台六線福星隧道、標東村、福星村、標南村、五谷村、玉谷村、仁安村、大坑村; 士林區-社子島地區、橋林里、臨溪里、社子島(官洲里、福安里)、豐源街、中山北路附近(德行里、忠誠里、國慶里)、中山北路、延平北路七、九段、承德路、德行東路口; 內湖區-大湖山莊街、康寧路三段(南湖國小)、康寧街一、二、東湖路、安康路、內湖路一段91巷; 南港區-研究院路一段南港、...

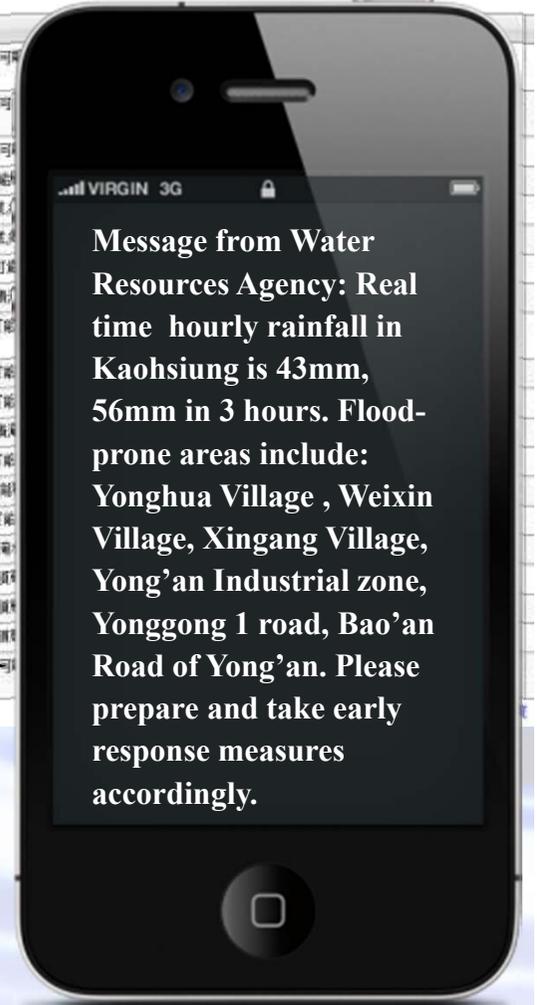
Fax report system

(Delivered to central disaster response center and relevant disaster prevention departments and governments)

| 序號 | 內容 |
|----|--|
| 1 | 水利署訊花蓮縣吉安鄉12小時雨量130.5達二級警戒,可能發生山崩、土石流,請注意防範 |
| 2 | 水利署訊花蓮縣花蓮市12小時雨量191.5達一級警戒,可能發生山崩、土石流,自由街、順美街請加強巡邏 |
| 3 | 水利署訊花蓮縣鳳林鎮12小時雨量212.5達二級警戒,可能發生山崩、土石流,請注意防範 |
| 4 | 水利署訊花蓮縣光復鄉6小時雨量172達一級警戒,可能發生山崩、土石流,請注意防範 |
| 5 | 水利署訊社寮水庫調節性洩洪影響範圍因重演洪災,可能發生山崩、土石流,請注意防範 |
| 6 | 水利署訊社寮水庫調節性洩洪影響範圍因重演洪災,可能發生山崩、土石流,請注意防範 |
| 7 | 水利署訊花蓮縣瑞穗鄉6小時雨量130.5達二級警戒,可能發生山崩、土石流,請注意防範 |
| 8 | 水利署訊花蓮縣光復鄉6小時雨量172達一級警戒,可能發生山崩、土石流,請注意防範 |
| 9 | 水利署訊台東縣台東市12小時雨量183達二級警戒,可能發生山崩、土石流,請注意防範 |
| 10 | 水利署訊台東縣卑南鄉12小時雨量183達二級警戒,可能發生山崩、土石流,請注意防範 |
| 11 | 水利署訊台東縣成功鎮12小時雨量201達一級警戒,可能發生山崩、土石流,請注意防範 |
| 12 | 水利署訊台東縣太麻里鄉雨量41.5達二級警戒,可能發生山崩、土石流,請注意防範 |
| 13 | 水利署訊台東縣成功鎮12小時雨量200達二級警戒,可能發生山崩、土石流,請注意防範 |
| 14 | 水利署訊台東縣卑南鄉12小時雨量183達二級警戒,可能發生山崩、土石流,請注意防範 |
| 15 | 水利署訊台東縣成功鎮12小時雨量201達一級警戒,可能發生山崩、土石流,請注意防範 |
| 16 | 水利署訊台東縣太麻里鄉雨量41.5達二級警戒,可能發生山崩、土石流,請注意防範 |
| 17 | 水利署訊台東縣成功鎮12小時雨量200達二級警戒,可能發生山崩、土石流,請注意防範 |
| 18 | 水利署訊台東縣卑南鄉12小時雨量183達二級警戒,可能發生山崩、土石流,請注意防範 |
| 19 | 水利署訊台東縣成功鎮12小時雨量201達一級警戒,可能發生山崩、土石流,請注意防範 |
| 20 | 水利署訊台東縣太麻里鄉雨量41.5達二級警戒,可能發生山崩、土石流,請注意防範 |

Automatic message report

(Delivered to central disaster response center and the leader of relevant disaster prevention departments and governments)





2012.1.1
正式推出

- Location based service (LBS): area information and alarm situation.
- Water situation information: provide information on rainfall, water levels and reservoir situations, etc.
- Alarm situation: provide alarm information about floods, river water levels, and reservoirs.
- Picture material (weather): provide query on pictures relating to alarms, weather forecasts, etc.
- CCTV monitoring: provide CCTV monitoring image to master on-site situations.
- Information delivery: actively deliver messages and integrate the information of disaster prevention related departments.

Water Resources Agency 「Mobile water situation」 App installation(4 steps)



1. Click "App Store"



2. Search "mobile water situation"



3. Click "FREE"



4. Click "INSTALL"





Ordinary Mobile Phone

Flood Alert at Hand. Just by Making a Call

Three easy steps to receive flood warning and protection information



Notes: email info isn't a necessary requirement



Flood Discharge Emergency Notification

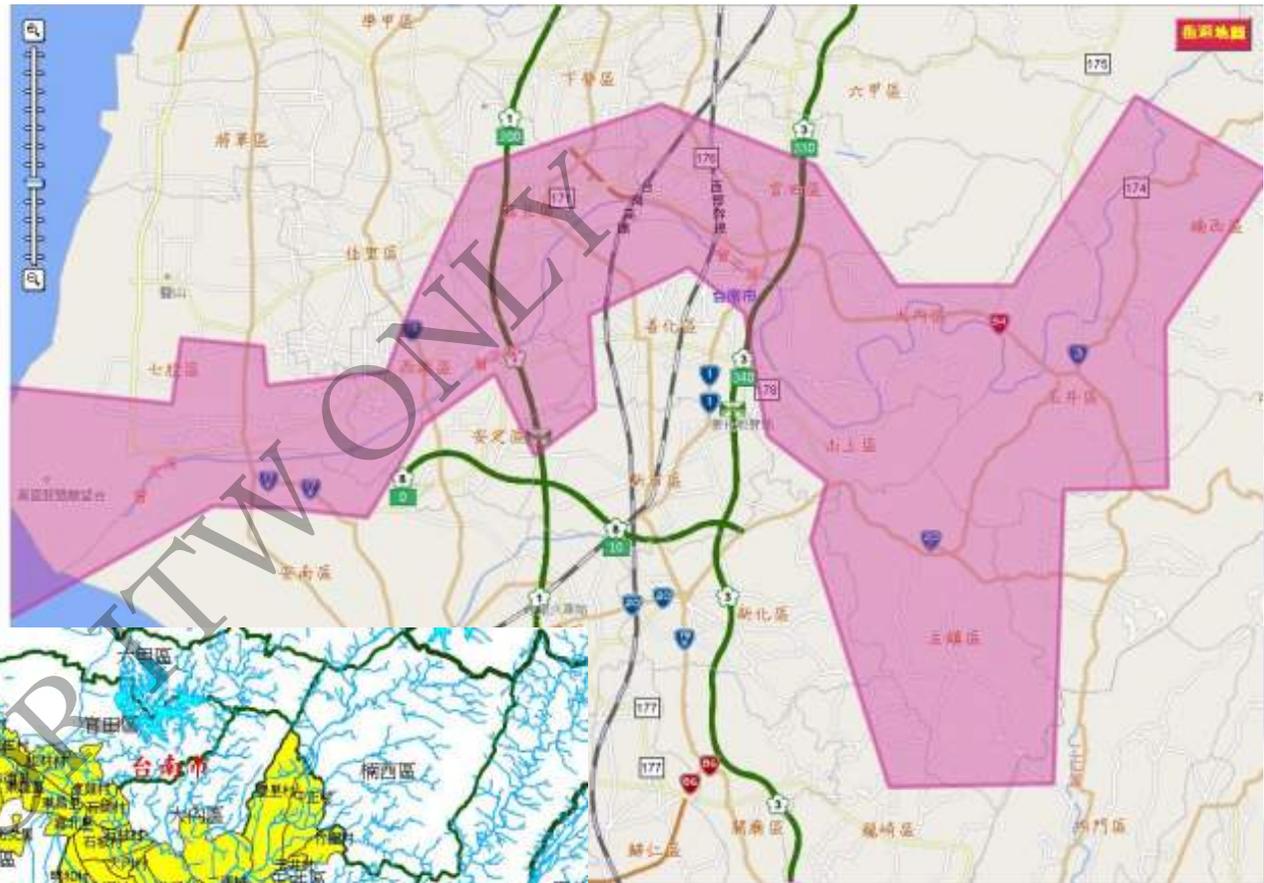
For nonspecific individuals in a designated warning area.

(Begin in Tseng-Wen Reservoir area)

For the Tseng-Wen Reservoir spillway, people receive the spillway alarm once they enter the alert zone.

With the help from Chunghwa Telecom this system now can reach 80% of population living or travelling in the flood –warning area.

Alert text message for a designated area



Setup a flood prevention volunteer service team

- Assist in inspection of water conservation facilities
- Assist in disaster report
- Assist in evacuation
- Assist in communication



Independent flood prevention community
(Independent alarm and evacuate)

港墘社區 水災防災地圖

緊急避難點
0929-288668

港墘國小
065-379-5350

港墘國中
065-379-3564

港墘活動中心
065-373-2201

港墘村公所
065-230-4403

0800-015237

港墘社區災害防救中心
065-362-0333

2011 防災社區 建立平安家園

1月：舉辦社區防災講座
2月：舉辦社區防災講座
3月：舉辦社區防災講座
4月：舉辦社區防災講座
5月：舉辦社區防災講座
6月：舉辦社區防災講座
7月：舉辦社區防災講座
8月：舉辦社區防災講座
9月：舉辦社區防災講座
10月：舉辦社區防災講座
11月：舉辦社區防災講座
12月：舉辦社區防災講座

Bring together the help from 7-11 stores and gas stations across the island in gathering up-to-the-minute flood information



Public and Corporation

- Volunteers : 1428
- 7-11 stores : 4890
- Gas stations : 2137
 - Chinese Petroleum Corp : 690
 - CPC Franchise: 1374
 - Taiwan Surgar Corp: 73
- Manufacture : 7
- Industry area: 138



8,600

Flood reporting stations

Independent Alarm Broadcast



Cash register

Information Sending system



Display system

Flood Alarm

Flood investigated

Telephone survey

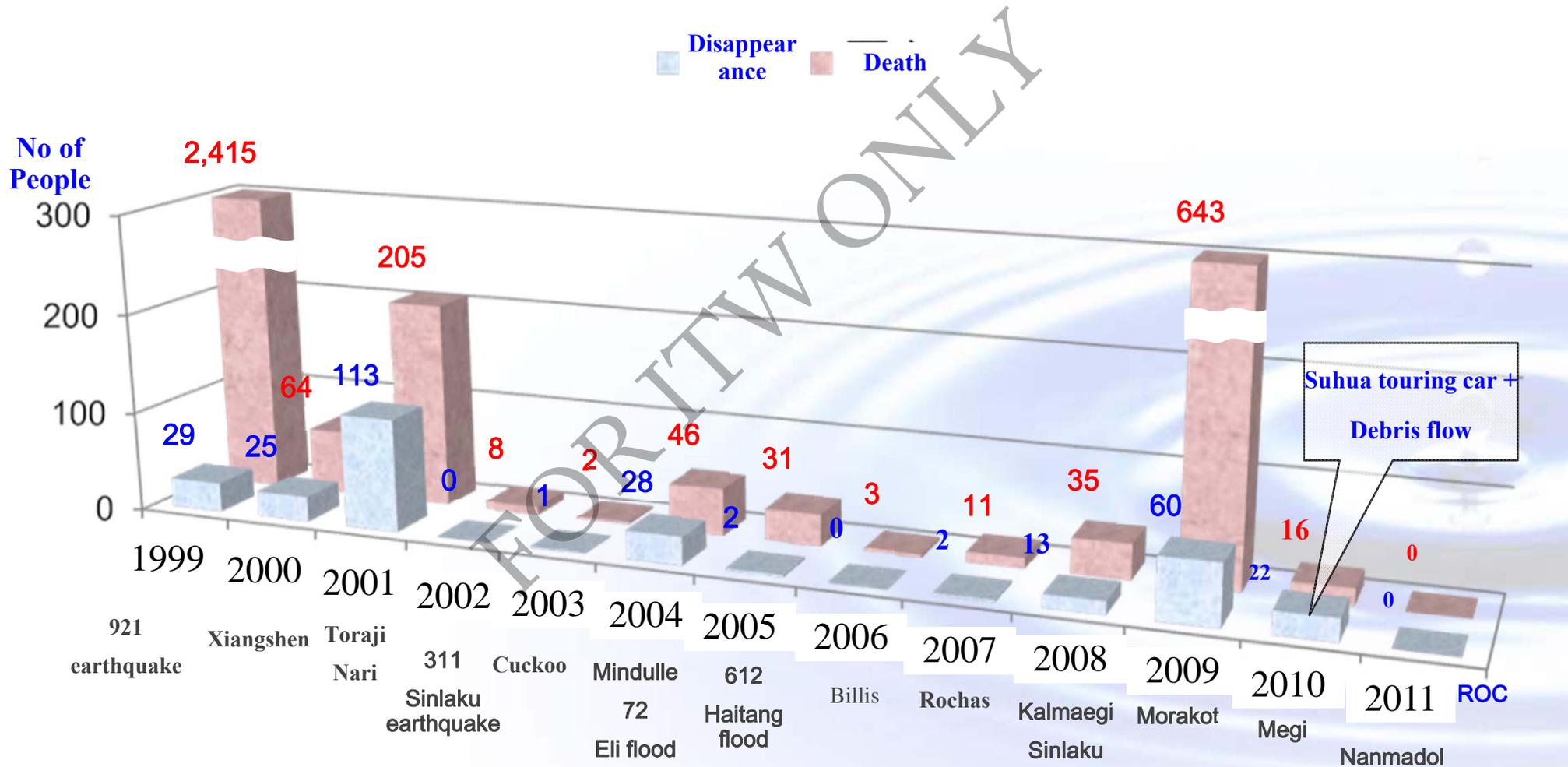
Flooding condition report

Internet reporting system

V. Conclusion

Achieving the objective of “Zero casualties in floods”

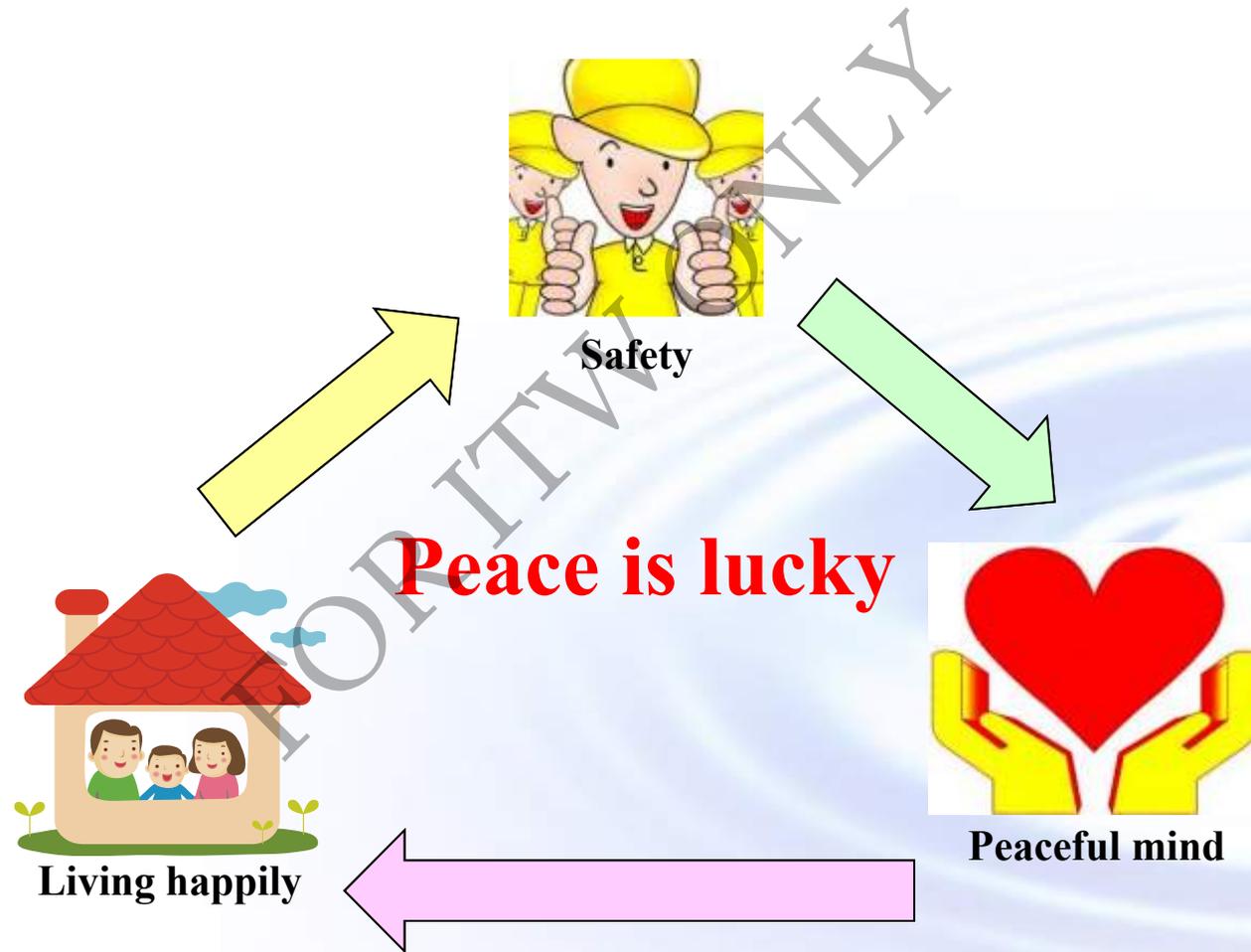
Substantially reduce the potential of flooding and losses





Actively prevent disasters instead of providing relief for them afterwards

Make a safe and better environment for living happily





**May good weather
always stay with us**

Thank you.
Please advise