



## ***2014 International Training Workshop on Natural Disaster Reduction***

***When Debris Flow Meets Coffee in Huahan  
-A regeneration village from debris flow disasters-***

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***October 31, 2014***



# Outline

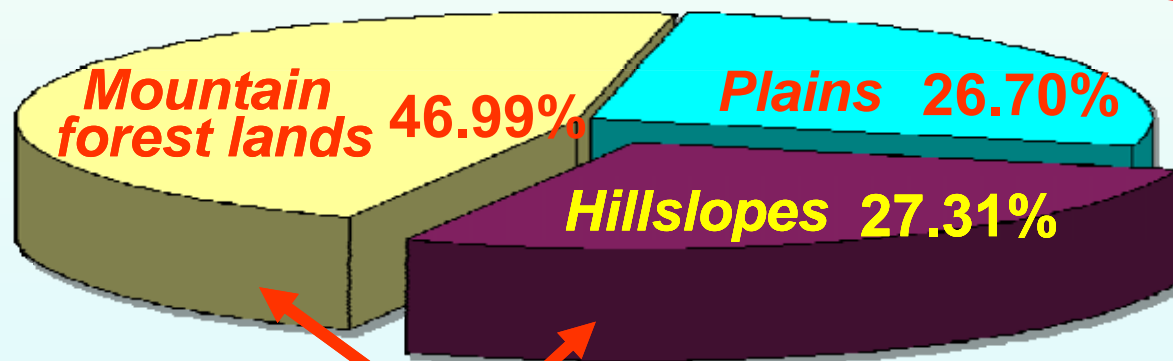
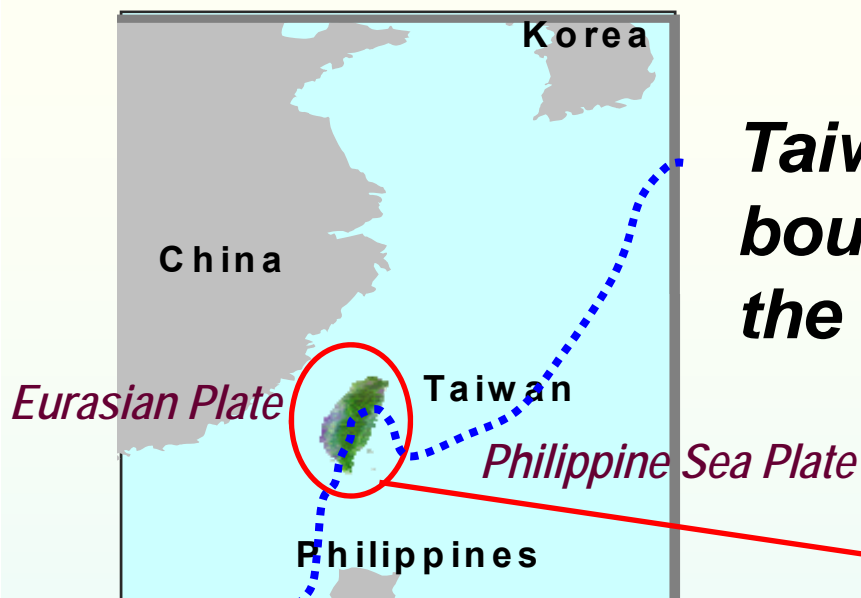
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1. ***Background Introduction***
2. ***Framework of Debris Flow Disaster Management***
3. ***Debris Flow Control Works in Huashan Village after Disasters***
4. ***Community Development and Rural Regeneration Project***
5. ***Future Perspective***



# Introduction

**Taiwan is located at the convergent boundary of the Eurasian Plate and the Philippine Sea Plate.**



**Slopelands 73.30%**

**Land Resources Distribution**





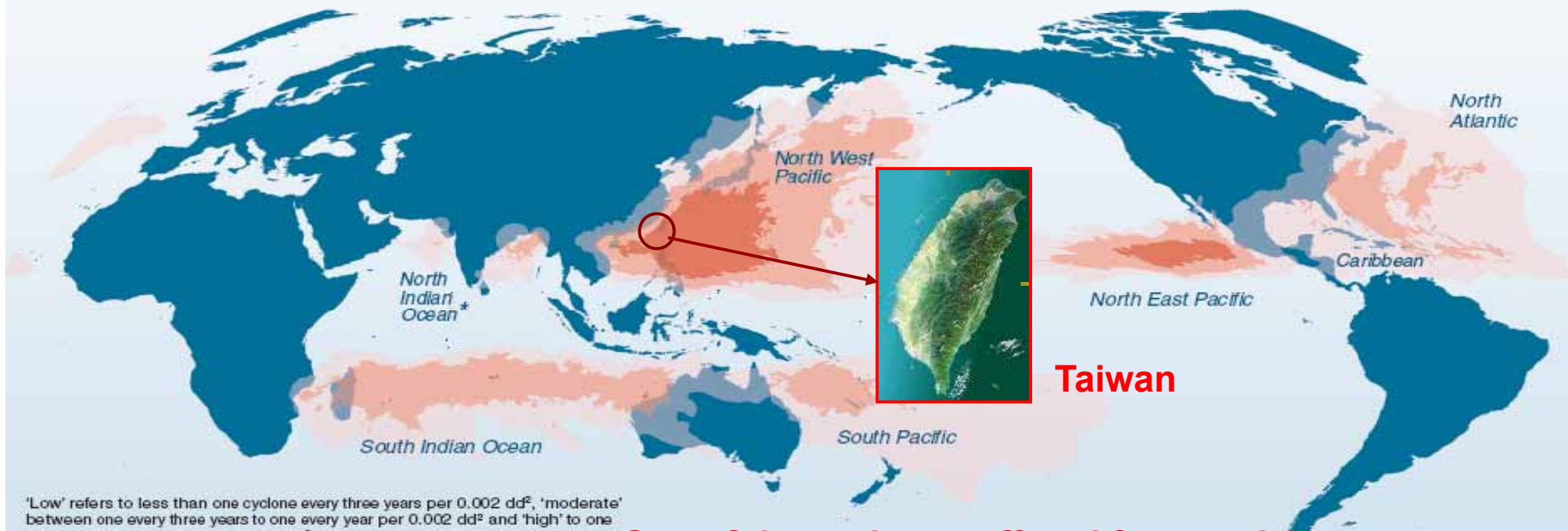
# Climate Change Impact

- ◆ Temperature increases about **1.4** in the last 100 years (1901-2006).
- ◆ Number of typhoons per year increased dramatically after 2000.  
From **N=3.2**(1951-2000) to **N=6.8** (after 2001)

## Tropical cyclone frequency

Average number of cyclones:  
(1980-2000)

low	moderate	high
light pink	medium pink	dark pink



'Low' refers to less than one cyclone every three years per 0.002 dd<sup>2</sup>, 'moderate' between one every three years to one every year per 0.002 dd<sup>2</sup> and 'high' to one to three cyclones per year per 0.002 dd<sup>2</sup>. The unit '0.002 square decimal degree (dd<sup>2</sup>)' is equivalent to 25 km<sup>2</sup> on the equator, diminishing as latitude gets higher.

\* average based on eight years only.

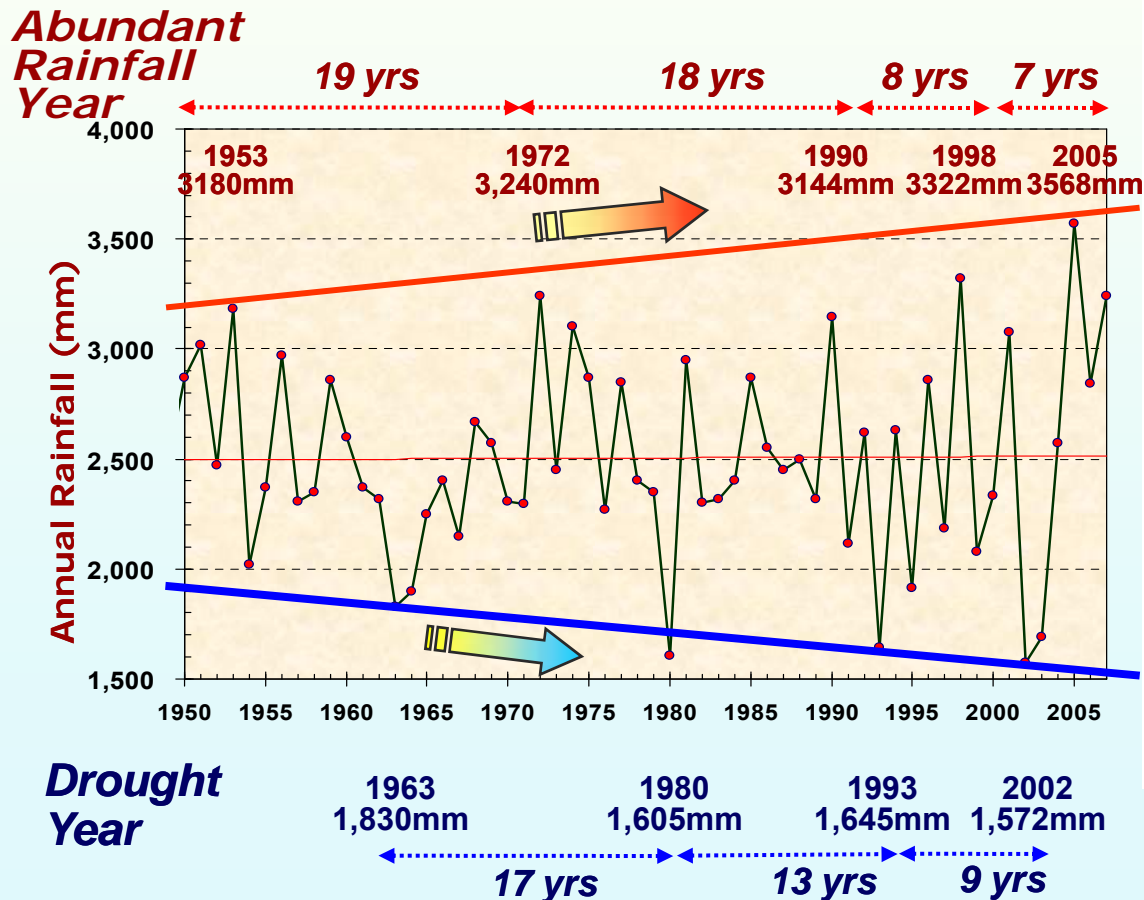
**One of the regions suffered from typhoons**

Sources: PREVIEW Global Cyclone Asymmetric Windspeed Profile, UNEP/GRID-Europe.

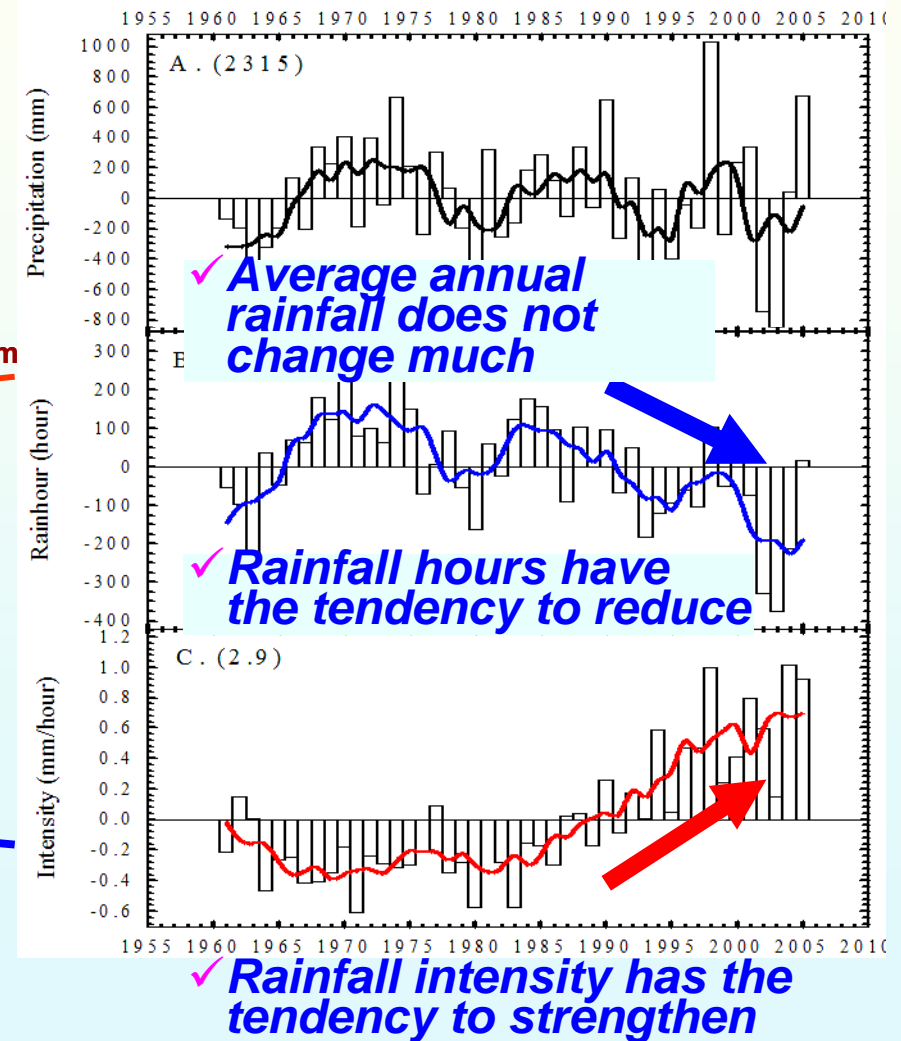


# Variation of rainfall pattern of Taiwan in the past 50 years

**Significant change of rainfall and dry-rainy seasons increases the risk of watershed hazards.**

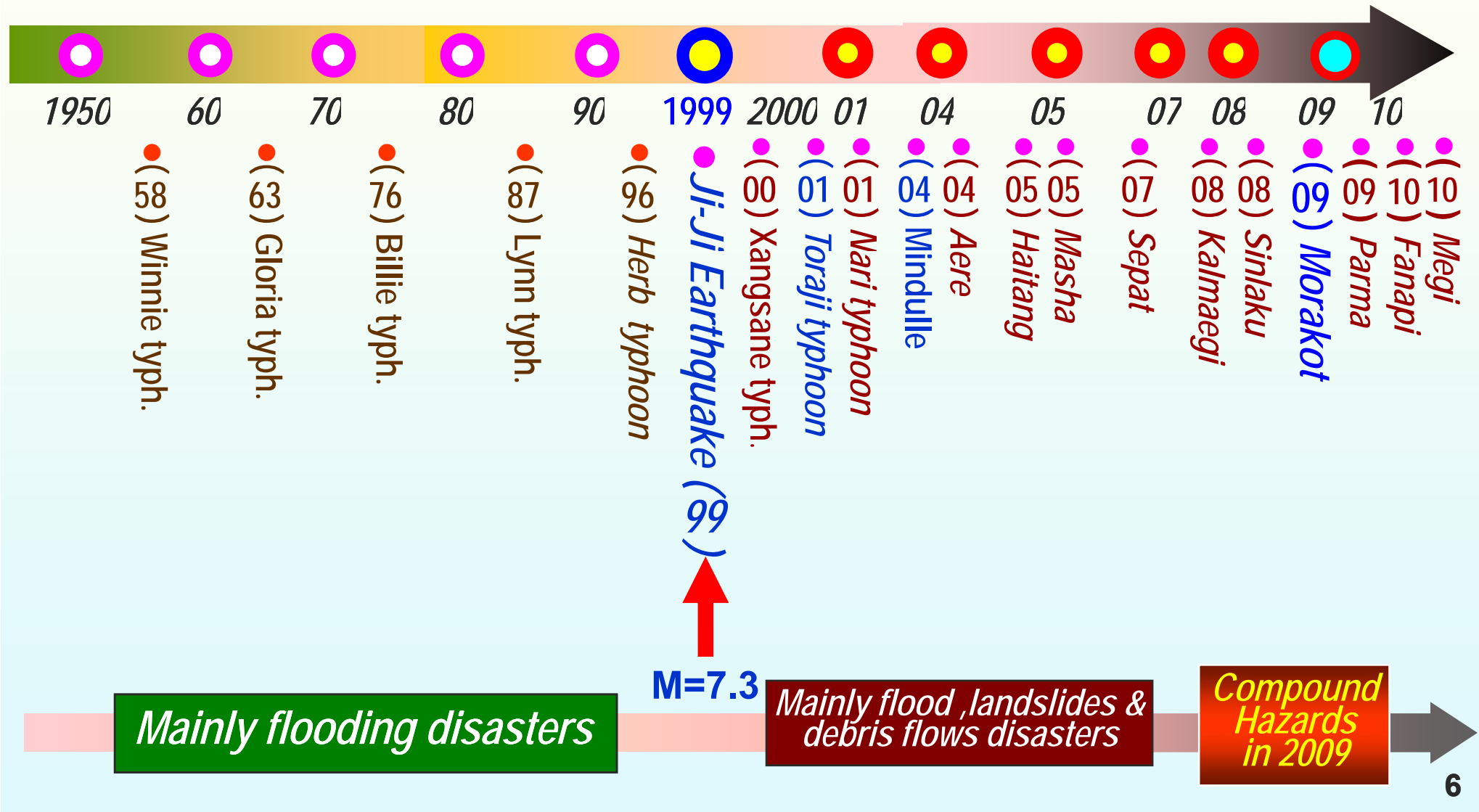


## Average annual rainfall in the past 50 years





# Historic Typhoon Disasters in Taiwan







Soil and Water Conservation Bureau (SWCB)

**1996-Herb**

## ***Debris Flow Disasters in Taiwan***



**2004-Mindulle**



**2009-Morakot**





Soil and Water Conservation Bureau (SWCB)

*Council of Agriculture*  
**Soil & Water Conservation Bureau**  
**Organization Chart**

Total personnel : 537

Annual Budget : 8.6 billion NTD







## ***2. Framework of Debris Flow Disaster Management***

**Debris flow event caused by typhoon  
Nanmadol in August, 2011(屏東縣滿州鄉)**

**Source area  
Landslides**

**Transportation part  
Channel erosion**

**Deposition(fan) zone  
Affected area**



**1,671  
Torrents**

**48,496  
People**

# Feedback

## Where?

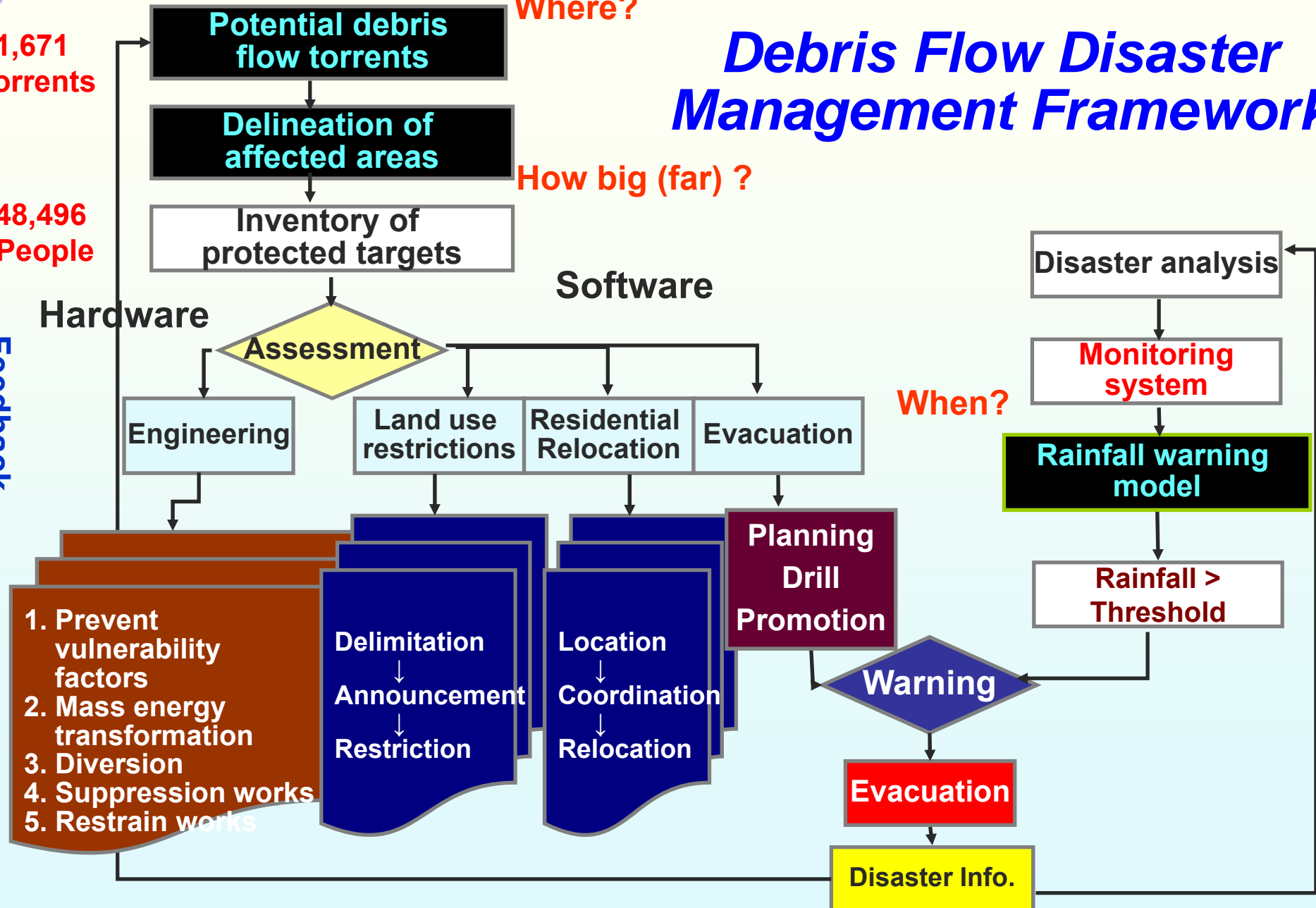
## How big (far) ?

# Software

## When?

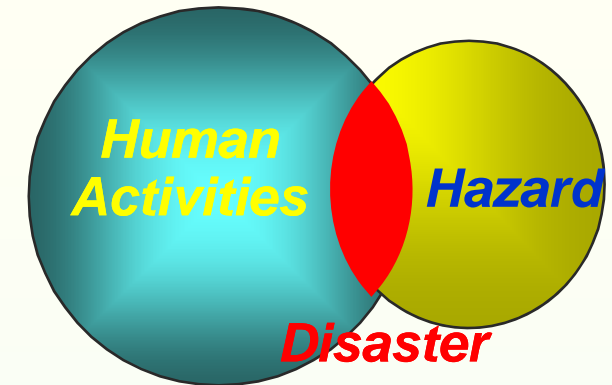
# Feedback

# ***Debris Flow Disaster Management Framework***





# Investigation of Potential Debris Flow Torrents



**Risk Degree = Occurrence degree X Degree of hazards on protected targets**

## Occurrence Degree

- ◆ Watershed area, landslide ratio, drainage slope, sedimentation amount, geological structure, vegetation, historical events

## Protected Targets

- ◆ Downstream fan areas
- ◆ People, living houses, public buildings, roads, bridges, other infrastructures

Risk Degree		Occurrence		
		Low	Mid	High
Protected Targets	Low	Low	Low	Mid
	Mid	Low	Mid	High
	High	Mid	High	High

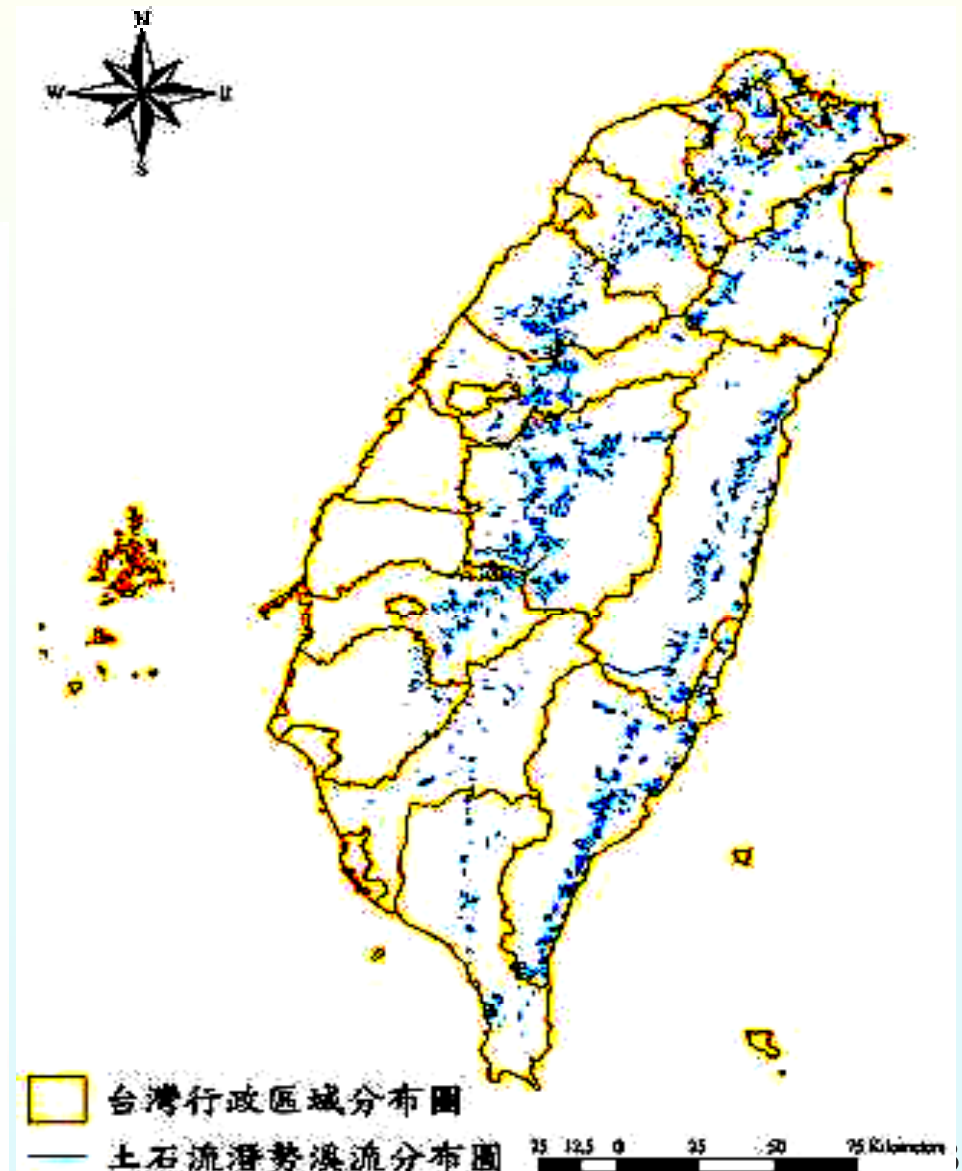
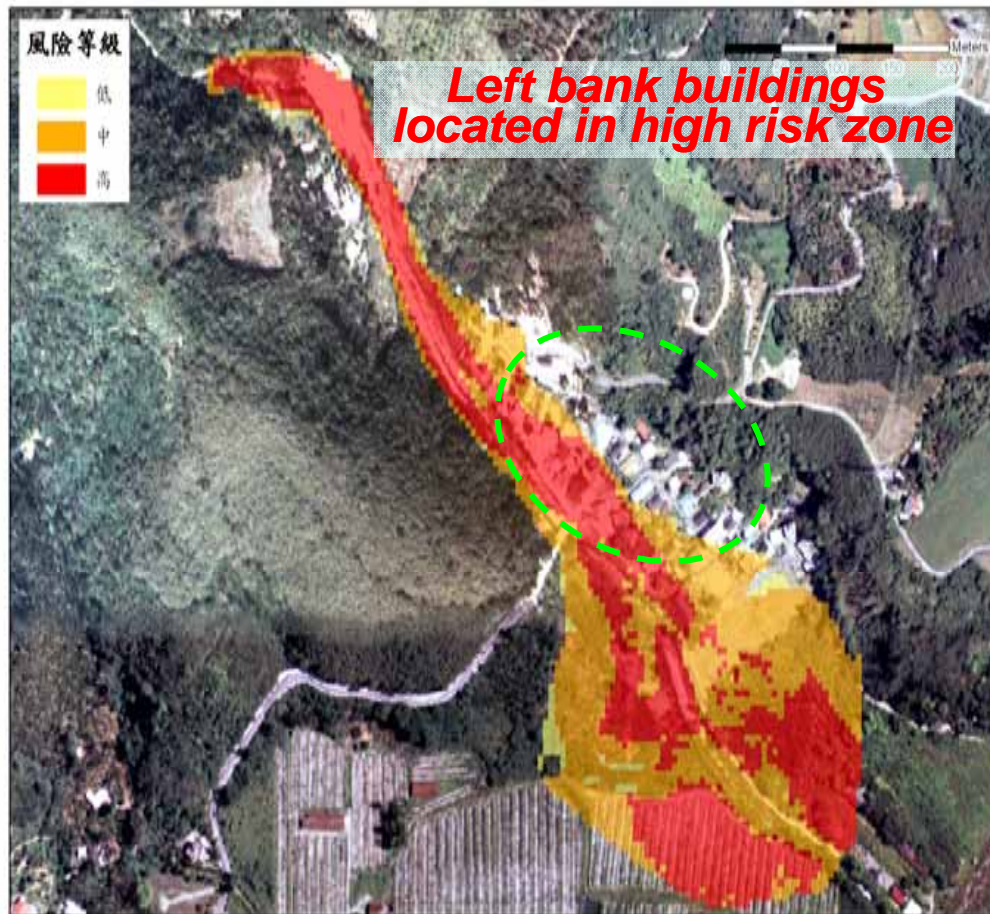




Soil and Water Conservation Bureau (SWCB)

## ***Distribution of 1671 Potential Debris Flow Torrents***

***Affected area zoning using  
historic events, semi empirical formula,  
FLO-2D simulation and on-site survey***





# Localized Rainfall-based Debris-flow Warning Model

- **Rainfall Triggering Index (RTI)**  
= **Rainfall intensity** × **Effective accumulated rainfall**

$$RTI = I \times R_t$$

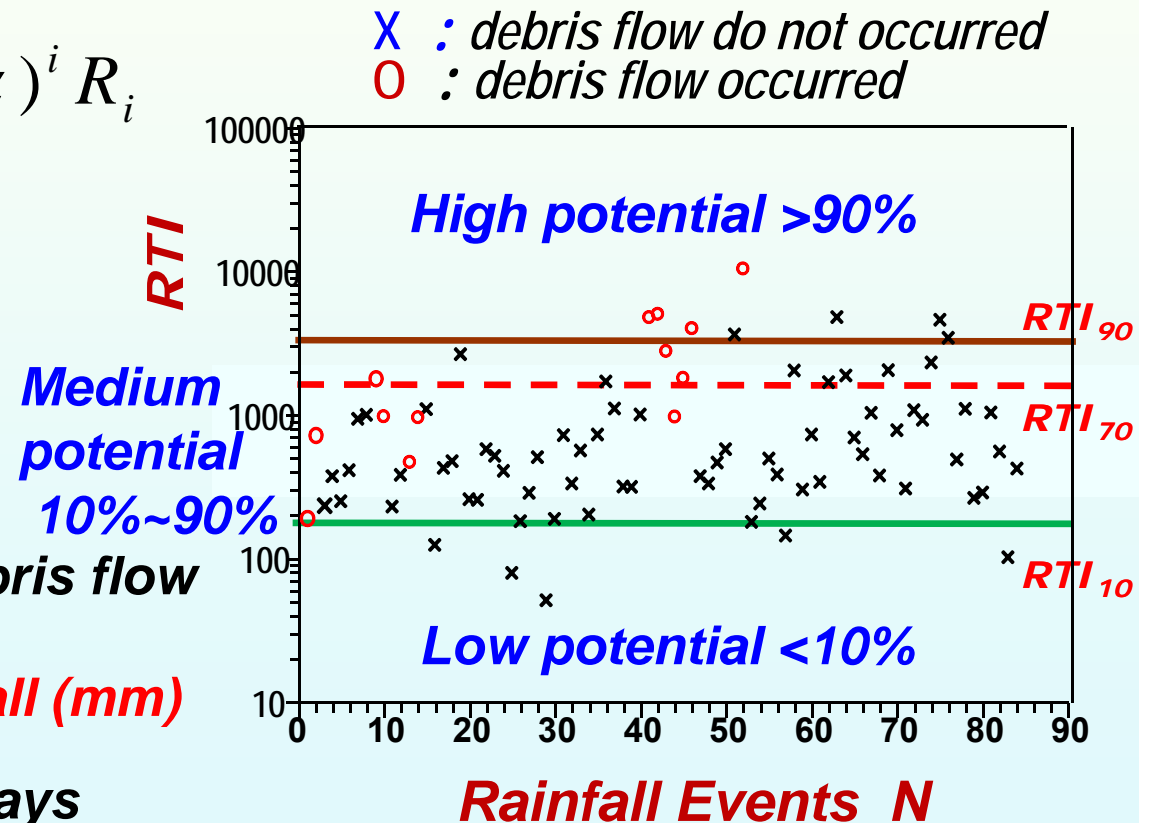
$$R_t = \sum_{i=0}^7 (\alpha)^i R_i$$

$\alpha$  is the decaying weighting factor = 0.7

$I$  : Rainfall intensity (mm/hr)

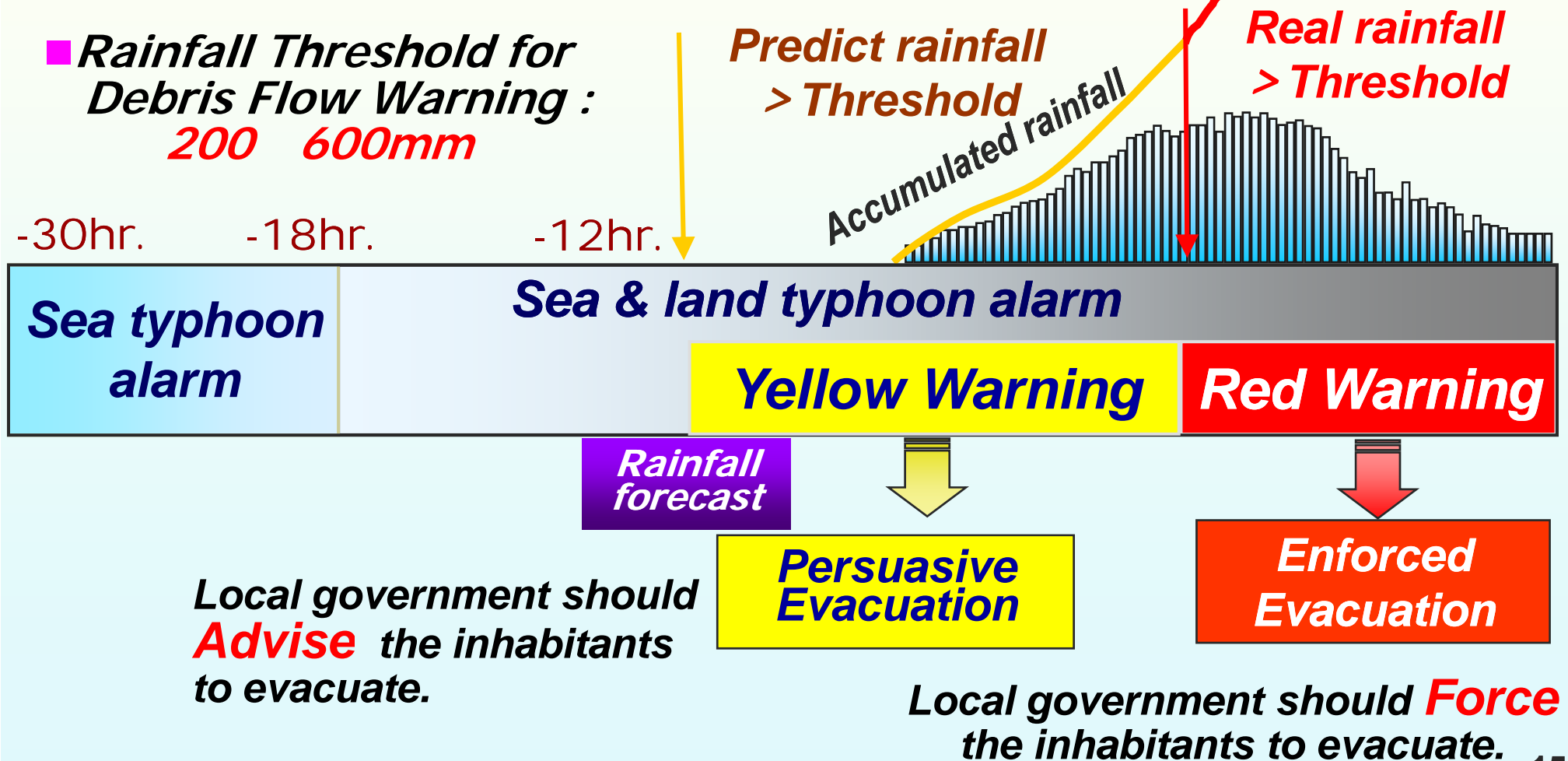
$RTI_{70}$  : 70% RTI value as the debris flow warning criteria

$R_t$  : Effective accumulated rainfall (mm)  
= Accumulated rainfall  
+ Preceding rainfall for 7 days





# Announcement of Debris Flow Warning in Taiwan







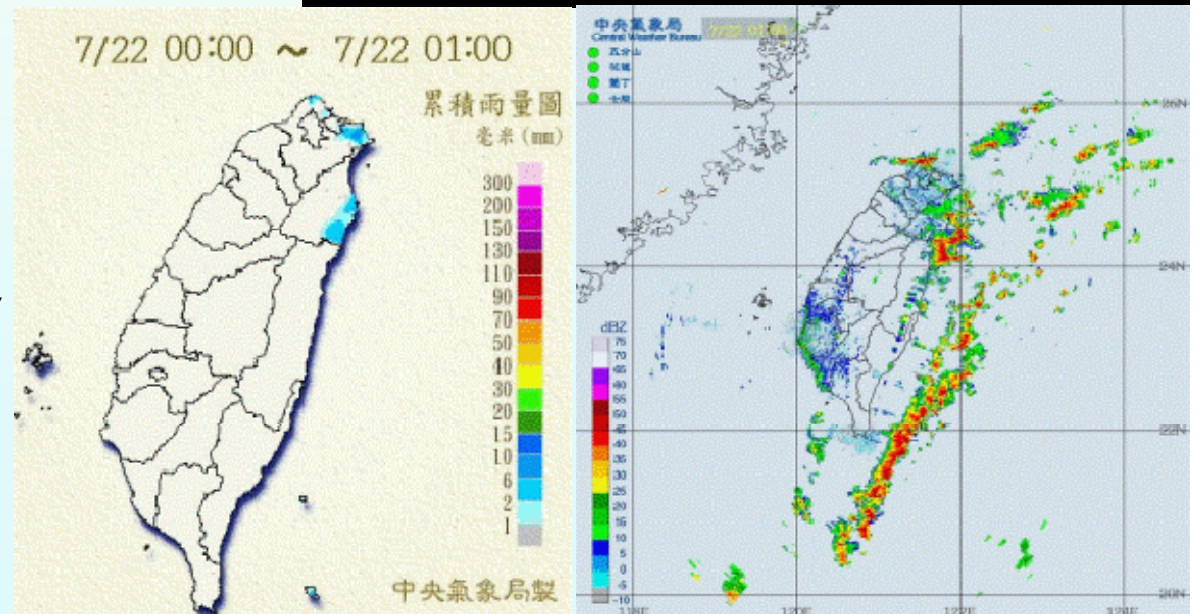
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# Debris Flow Emergency Operation Task Force of SWCB

<http://fema.swcb.gov.tw>

- Real-time weather condition: typhoon route and rainfall prediction
- Real-time rainfall data over **368** on-site auto-rain-gauges: refresh every 10 min
- **Debris flow warning announcement**

*Traditional:* TV news, radio broadcast, website, telephone,  
*Auto-system:* email sender, on-line fax, voice broadcast and short message service







# Evacuation Routes and Drills for Debris Flow Disaster Mitigation

- 947 **Evacuation routes** planned
- 649 debris flow **evacuation drills** held
- 1387 **Debris Flow Volunteer Specialists**

## Evacuation Route Map



宜蘭縣大同鄉松羅村土石流疏散避難圖

本圖係由宜蘭縣政府水土保持局提供  
 本圖係由宜蘭縣政府水土保持局提供

宜蘭縣大同鄉松羅村土石流疏散避難圖  
 1. 疏散避難路線  
 2. 疏散避難地點  
 3. 疏散避難時間  
 4. 疏散避難人數  
 5. 疏散避難物資  
 6. 疏散避難車輛  
 7. 疏散避難費用  
 8. 疏散避難其他事項



圖例  
 疏散避難路線  
 疏散避難地點  
 疏散避難時間  
 疏散避難人數  
 疏散避難物資  
 疏散避難車輛  
 疏散避難費用  
 疏散避難其他事項

行政院農業委員會水土保持局  
 提供  
 中華民國100年1月

## Debris Flow Volunteer Specialist





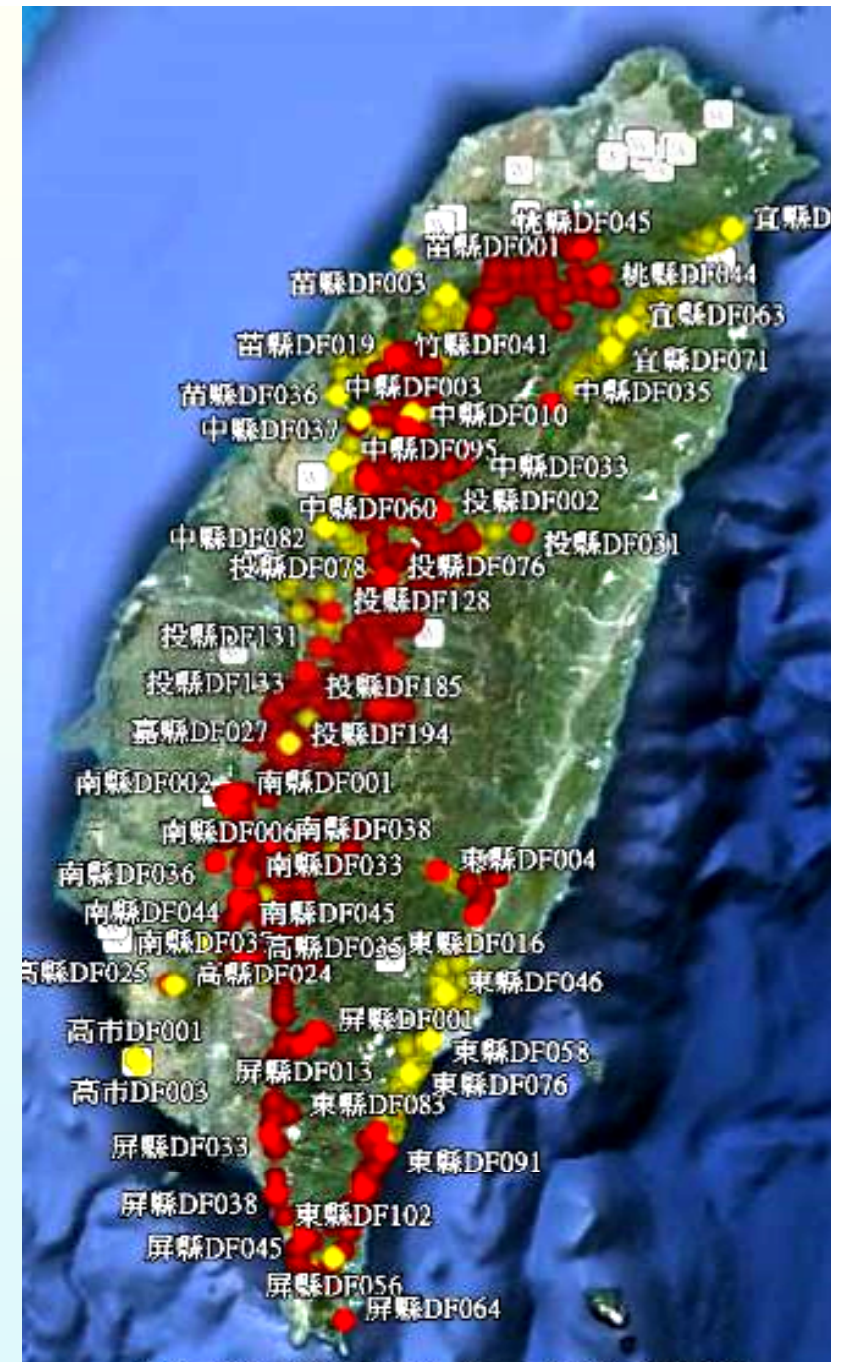
Soil and Water Conservation Bureau (SWCB)

## ***Debris Flow Warning and Evacuation***

- ◆ During the typhoon Morakot period (2009), the SWCB had issued **21 debris flow warnings** to the public and local governments based on the real-time weather information from CWB.

<i><b>Debris flow warning</b></i>	<i><b>Warning ravines</b></i>	<i><b>County (City)</b></i>	<i><b>Town</b></i>	<i><b>Village</b></i>
<i><b>Red alarm</b></i>	<i><b>519</b></i>	<i><b>12</b></i>	<i><b>61</b></i>	<i><b>230</b></i>
<i><b>Yellow alarm</b></i>	<i><b>338</b></i>	<i><b>14</b></i>	<i><b>58</b></i>	<i><b>163</b></i>

**9,100 people** were evacuated by local governments according to the warning. Among them, **1,046 people** escaped from the possible casualties.

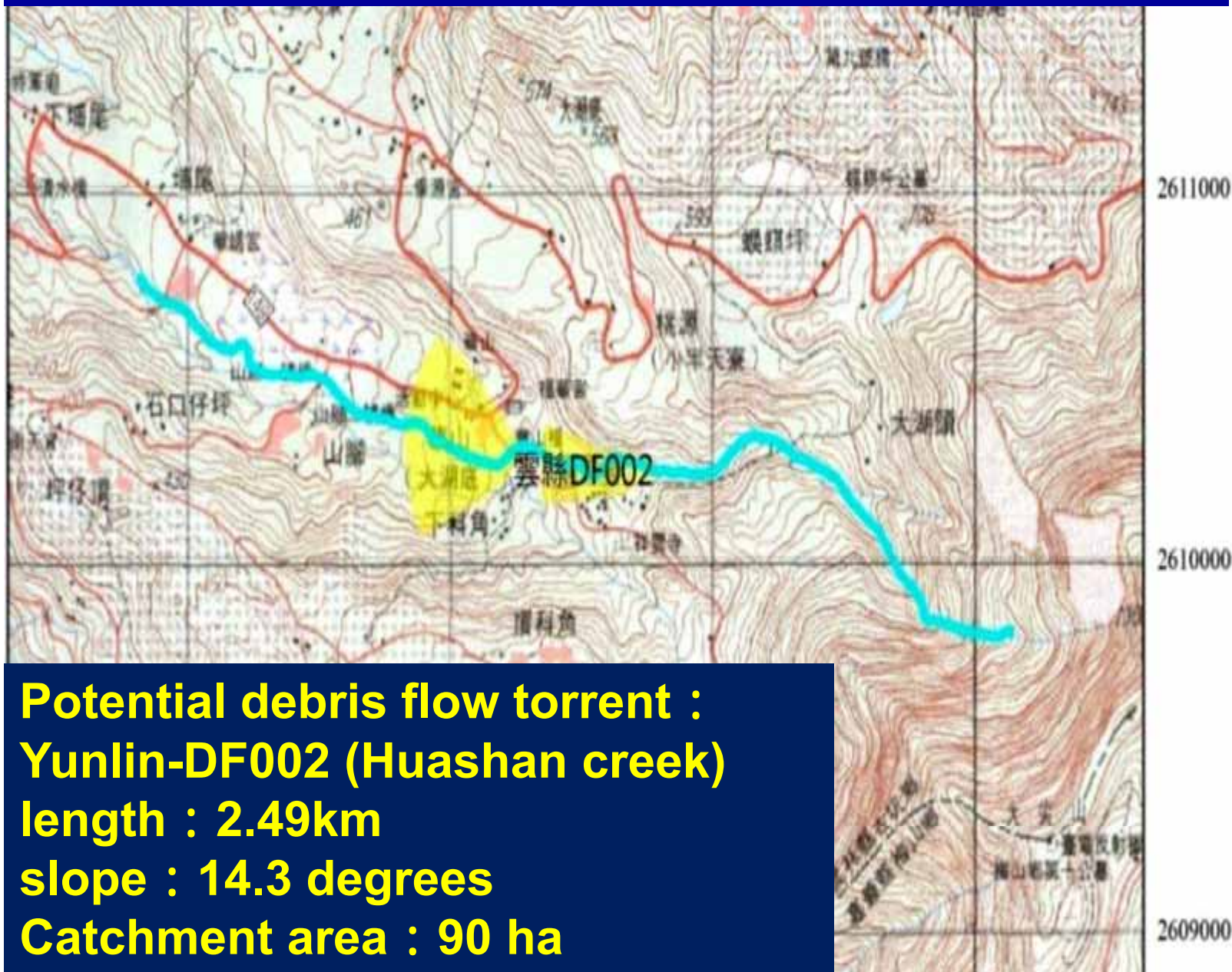




### ***3. Debris Flow Control Works in Hwashan Village after Disasters***



## Hwashan village, Gukeng township, Yunlin County



土石流潛勢溪流自然潛勢

高

中

低

持續觀察

土石流影響範圍



行政院農業委員會水土保持局 編製

中華民國 94 年 3 月 出版





## Protected Targets in Hwashan Village

- **50 houses**
- **Infrastructures**  
elementary school,  
walking trails  
roads  
bridges  
temples







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## **Historic Disasters in Hwashan Creek(Yunlin-DF002)**

**Sep. 21, 1999 Ji-Ji earthquake(M=7.3)**

Serious landslides occurred in upstream areas and resulted in a lot of loose materials accumulated in Hwashan creek.

**June 25, 2000 Torrential rainfall (accumulated rainfall 104mm)**

Small-scale debris flow occurred in Hwashan creek and damaged several houses and roads along the river.

**Sep. 17, 2001 Typhoon Nari (accumulated rainfall 848mm)**

Large-scale debris flow occurred in Hwashan creek again.

About 60,000 m<sup>3</sup> sediments flushed to the downstream areas and buried tens of houses and roads.







## ***Source treatment in upstream landslide areas***

***Government hires local residents to fill up the cracks.***



***Paling with areca stems***



***Paling, wattling and establishing drainage system on slope surface***







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## ***Channel dredging and cleanout***

***To prevent the blockage of the creek from overflow***

## ***Serial check dams***

***To adjust channel gradient as well we to slow down the water and debris flow velocity for erosion reduction***







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## **Slit dam(permeable & open type)**

**The purpose of slit dam is to block big boulders. Small sediments can pass by the dam in order to maintain the normal sediments transportation.**

### **Used tire**

**Take advantage of used tires to protect the upstream side of the dams**

## **Concrete slit dam**



## **Grid-type steel dam**







# ***Eco-friendly Design***

## ***Economy***

*Use the debris flow materials to build rockery bank revetment to reduce the concrete amount economically.*

## ***Ecology***

*Mild slope, rough and porous surface design of the bank revetments in order to enrich the biological diversity .*





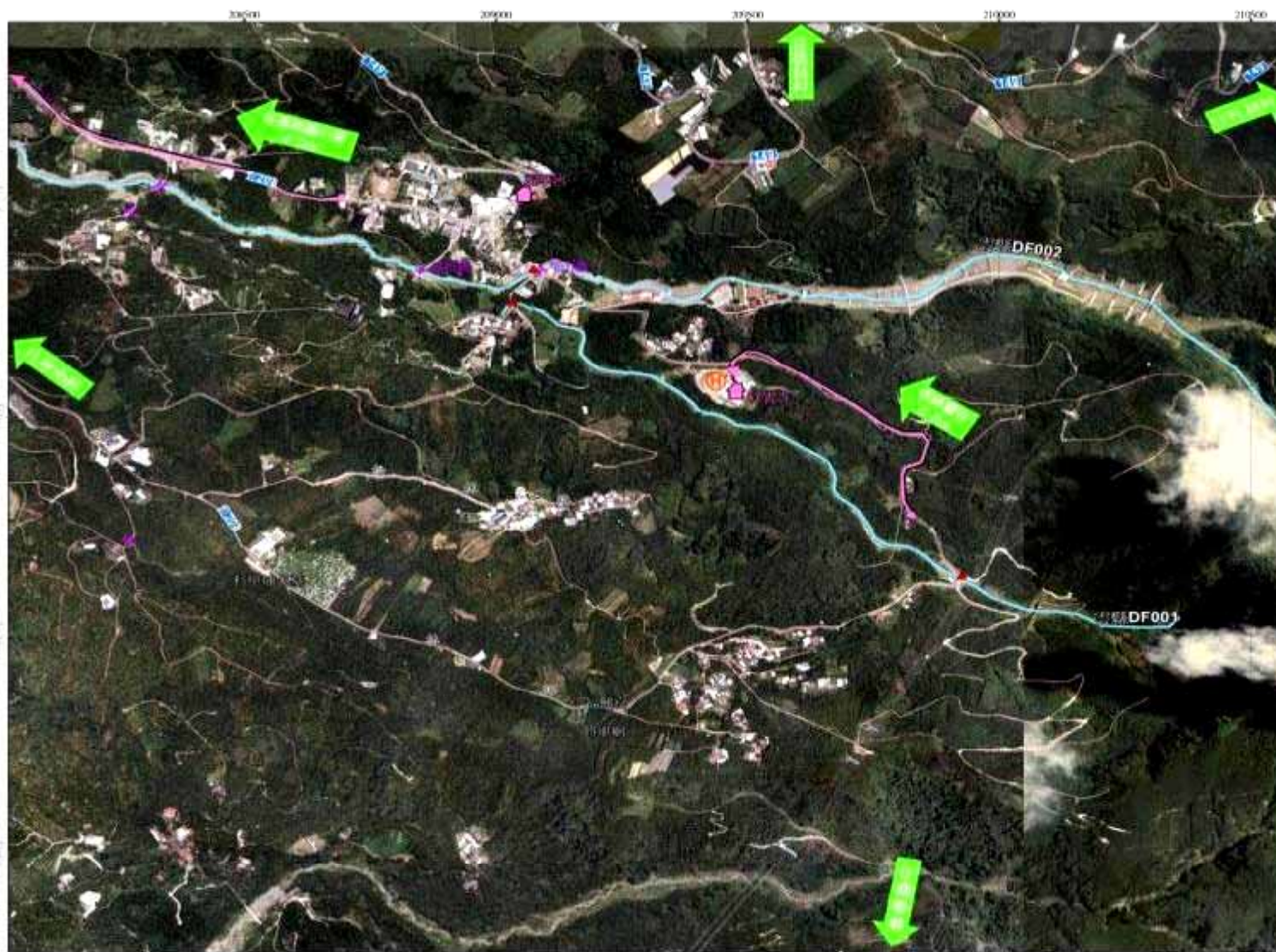
## ***Deployment of debris flow control works***



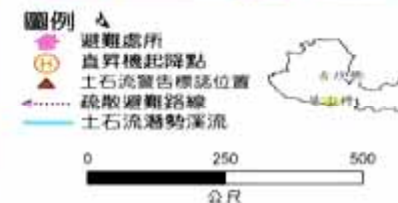




# Evacuation Route Maps of Hwashan village



- 災害通報單位**
- 林坑鄉災害應變中心  
地址: 林坑鄉華山村華山6號  
電話: 05-5901997
  - 林坑鄉災害應變中心  
地址: 林坑鄉華山村華山34-1號  
電話: 05-5901886
  - 林坑鄉土石流災害緊急應變小組  
地址: 林坑鄉華山村華山10-1號  
電話: 05-5901833
  - 林坑鄉土石流災害緊急應變小組  
地址: 林坑鄉華山村華山28號  
電話: 05-5901529
- 緊急聯絡人電話**
- 林坑鄉  
地址: 林坑鄉華山村華山6號  
電話: 05-5901997
  - 華南國小  
地址: 林坑鄉華山村華山28號  
電話: 05-5901329
- 避難處所**
- 林坑鄉(可容納200人)  
地址: 林坑鄉華山村華山6號  
電話: 05-5901997
  - 華南國小(可容納40人)  
地址: 林坑鄉華山村華山34-1號  
電話: 05-5901886
  - 南天宮(可容納50人)  
地址: 林坑鄉華山村華山10-1號  
電話: 05-5901833
  - 華南國小(可容納200人)  
地址: 林坑鄉華山村華山28號  
電話: 05-5901529
- 直昇機起降點**
- 林坑鄉  
地址: 林坑鄉華山村華山6號  
電話: 05-5901997
  - 華南國小  
地址: 林坑鄉華山村華山28號  
電話: 05-5901329
- 醫療單位**
- 古坑鄉衛生所  
地址: 古坑鄉西平村中山路391號  
電話: 05-5821132
  - 古坑鄉衛生所  
地址: 古坑鄉西平村中山路393號  
電話: 05-5821537
  - 華山派出所  
地址: 林坑鄉華山村華山50號  
電話: 05-5901317
- 土石流警戒基準值: 350 mm**  
**土石流歷史災害: 民國89年**  
**二月至六月、民國89年六月至**



雲林縣古坑鄉華山村土石流疏散避難圖

• 方格線黑色數字為TWD97坐標  
• 方格線灰色數字為TWD67坐標

行政院農業委員會水土保持局  
資料更新日期102年9月  
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Soil and Water Conservation Bureau (SWCB)

## ***Demonstration and workshop of debris flow disaster mitigation in Hwashan village***





## ***Hwashan Village during Typhoon Morakot, 2009***

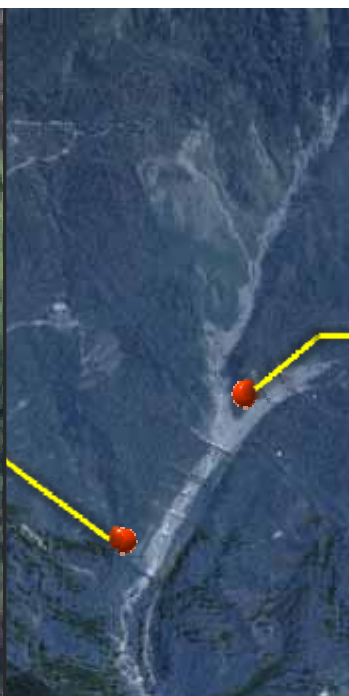
***On August 2009, typhoon Morakot brought torrential rain (accumulated rainfall 1,357mm) to Hwashan area and caused 3 landslides in the Hwashan creek catchment. About 120,000 m<sup>3</sup> debris flow sediments flushed to the downstream area and piled in the main channel.***







*Photo of UAV Aug. 12*



*Photo of UAV Aug. 12*



*Photo of UAV Sep. 3*











## ***Successful Evacuation during Typhoon Morakot in Hwashan Village***

### ***1st evacuation (Aug. 9)***

***The SWCB issued debris flow red warning at 11:00 on Aug. 8. The village head and Mr. Wu(debris flow volunteer specialist) kept an eye on the flow condition in Hwashan creek. The water level increased in the early morning on Aug. 9, they called the residents and helped the villagers evacuate to shelters successfully.***

### ***2nd evacuation (Aug. 11)***

***The torrential rain occurred in the morning on Aug. 11, so village head and Mr. Wu again evacuated the residents in Hwashan village automatically. No one was hurt due to the immediate evacuation.***



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# Debris Flow Monitoring during Typhoon Morakot

## Upstream CCD camera

7:30 Aug. 9



9:30 Aug. 9

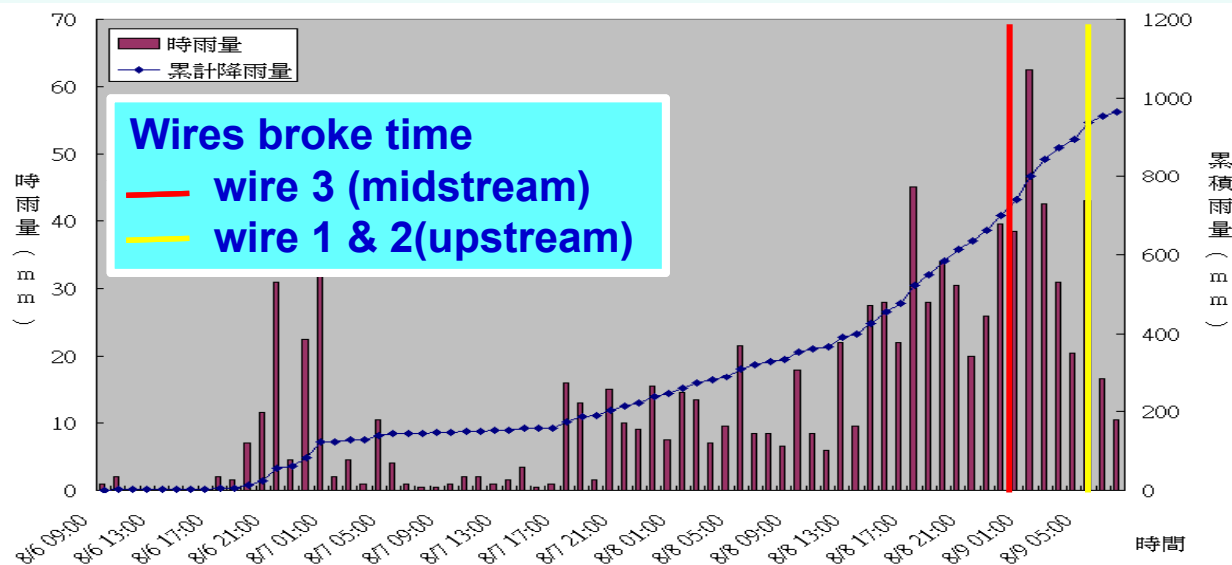


## Midstream CCD camera

8:00 Aug. 9



9:30 Aug. 9



**Accumulated rainfall : 1357mm**  
**Peak rainfall intensity : 62.5mm**  
**Wires broke time**  
1) 5:23, Aug. 9  
2) 5:23, Aug. 9  
3) 00:48 Aug. 9



## ***4. Community Development and Rural Regeneration Project***



# When Debris Flow Meets Coffee

- *Debris flow disaster management + Rural regeneration = an opportunity for integrating debris flow mitigation works, ecological engineering concepts, leisure industry and tourism management.*

華山







**Afternoon break**



**Debris flow outdoor classroom**



**Hwashan night scene**







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## Reputation for Coffee Festival

Hwashan village holds the **Taiwan coffee festival** every year and earns a famous reputation -- **Hometown of Taiwan Coffee**

The coffee industry not only enhances the **commercial profits** but creates quite a few **employment opportunities**.





# 華山經典農村

*Awarded the Top 10 Rural Villages*





## ***5. Future Perspective***





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# On-line Education of Debris Flow Knowledge

Education videos uploaded on Youtube



Disaster prevention knowledge



土石流防災親子網



Parent-child interactive website

土石流防災資訊網  
http://246.swcb.gov.tw

## 土石流防災大富翁



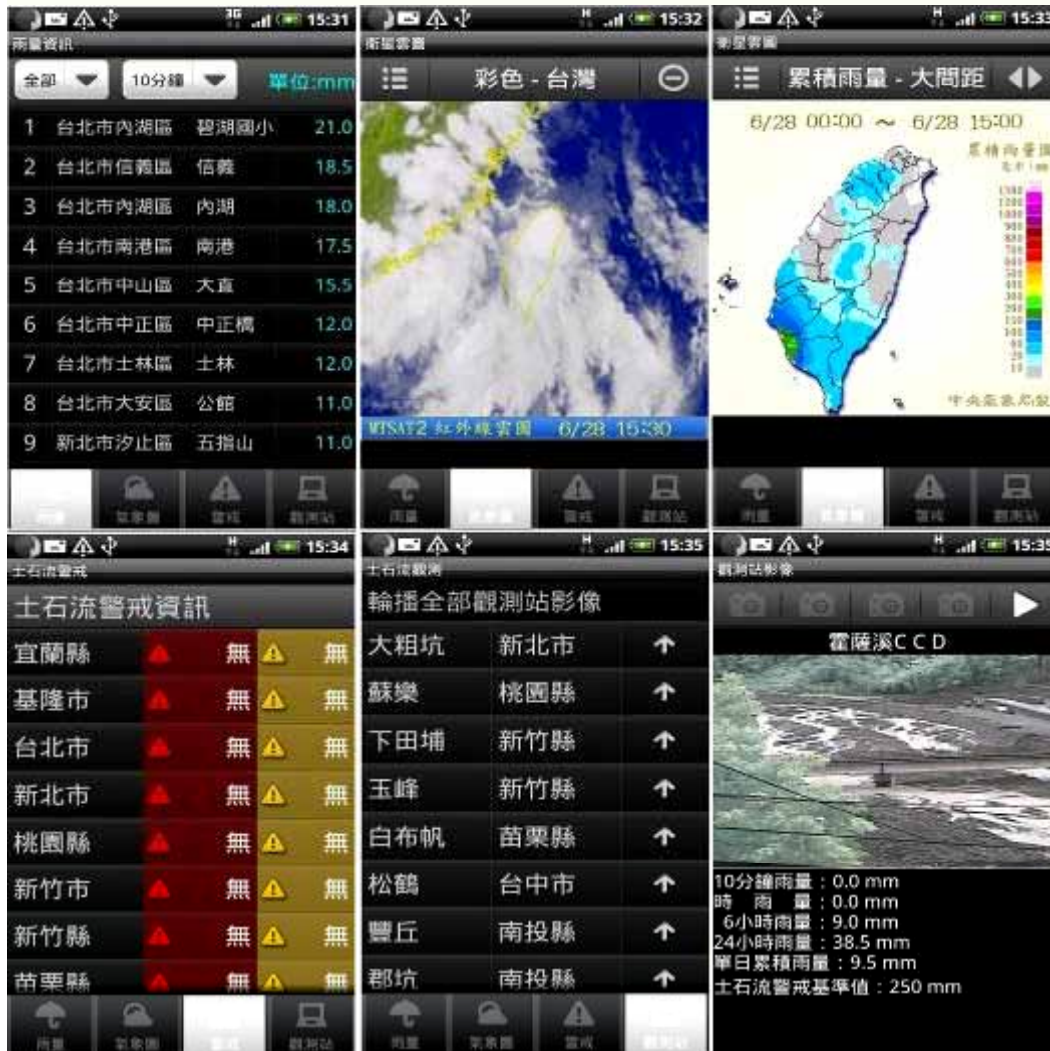
On-line monopoly game for disaster prevention





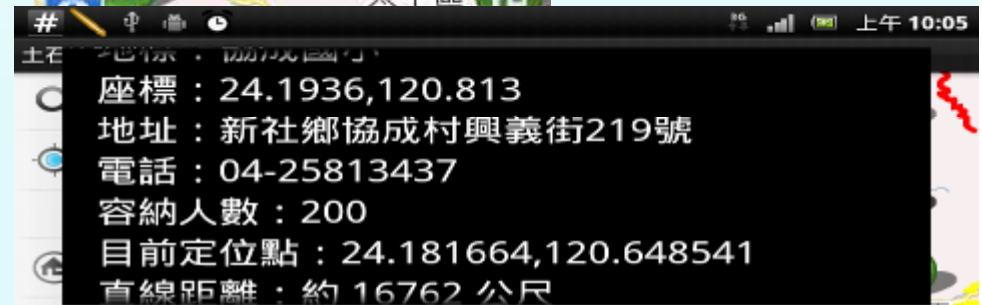
Soil and Water Conservation Bureau (SWCB)

# Apps for DDMI System



iOS  
Android

Google map application





***Does the slit dam work?***





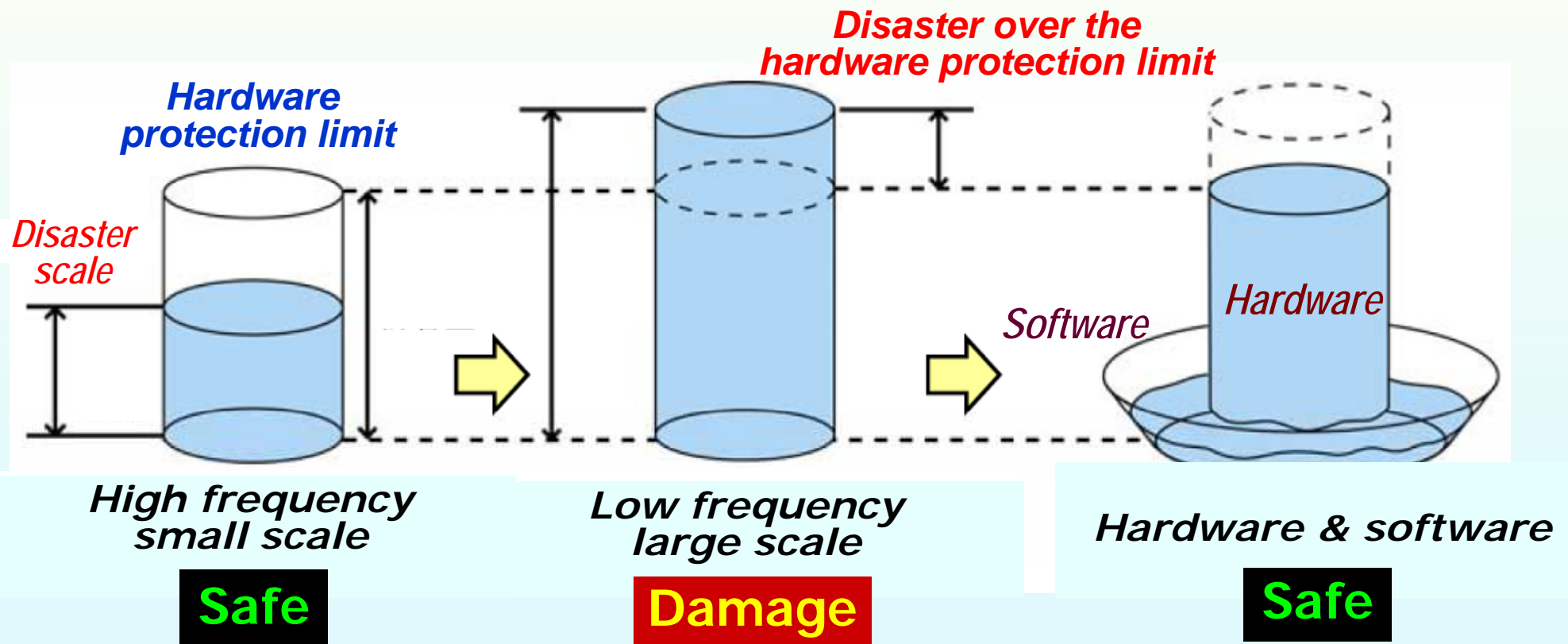
# *Grid-type steel dam*





# *Integration of Software and Hardware*

- *Under climate change impact, strategy of disaster precaution should be considered from hardware to software.*
- *Non-engineering measures should combine with mitigation works.*







***Thank You for  
Your Attention***

***Soil and Water Conservation Bureau  
Always Working with You***