



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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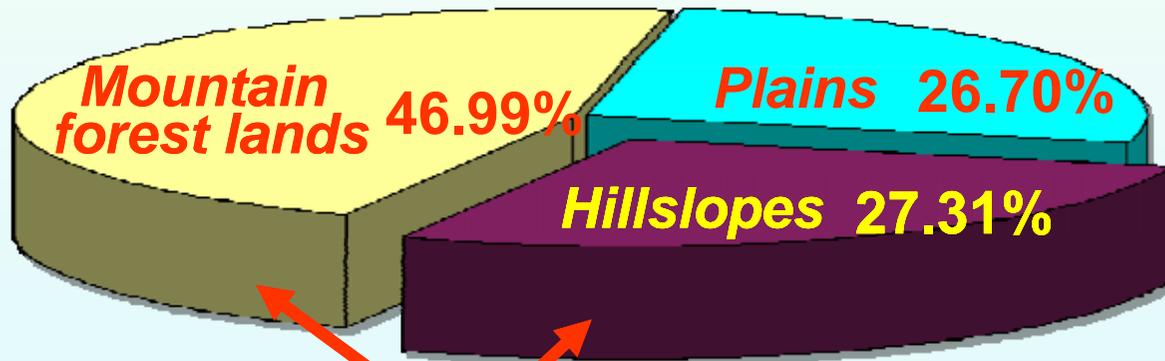
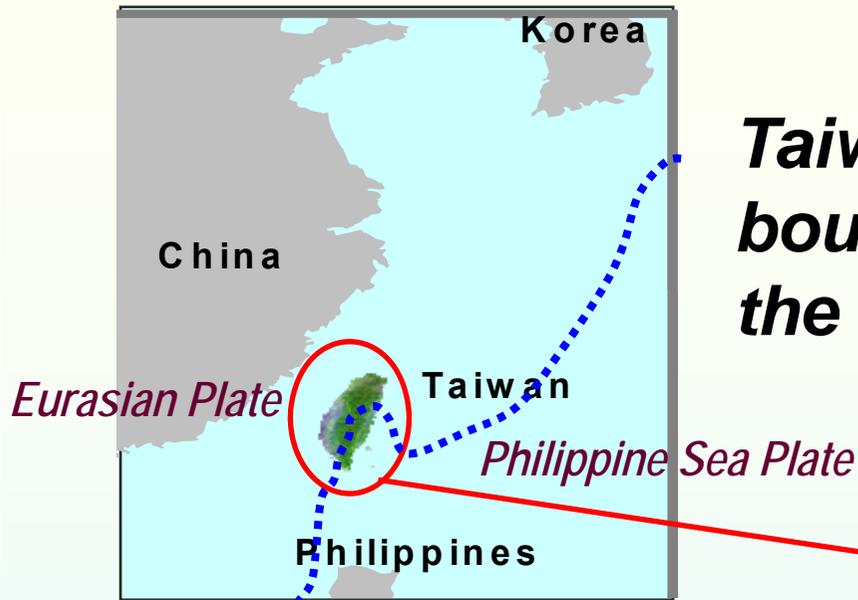
Outline

- 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





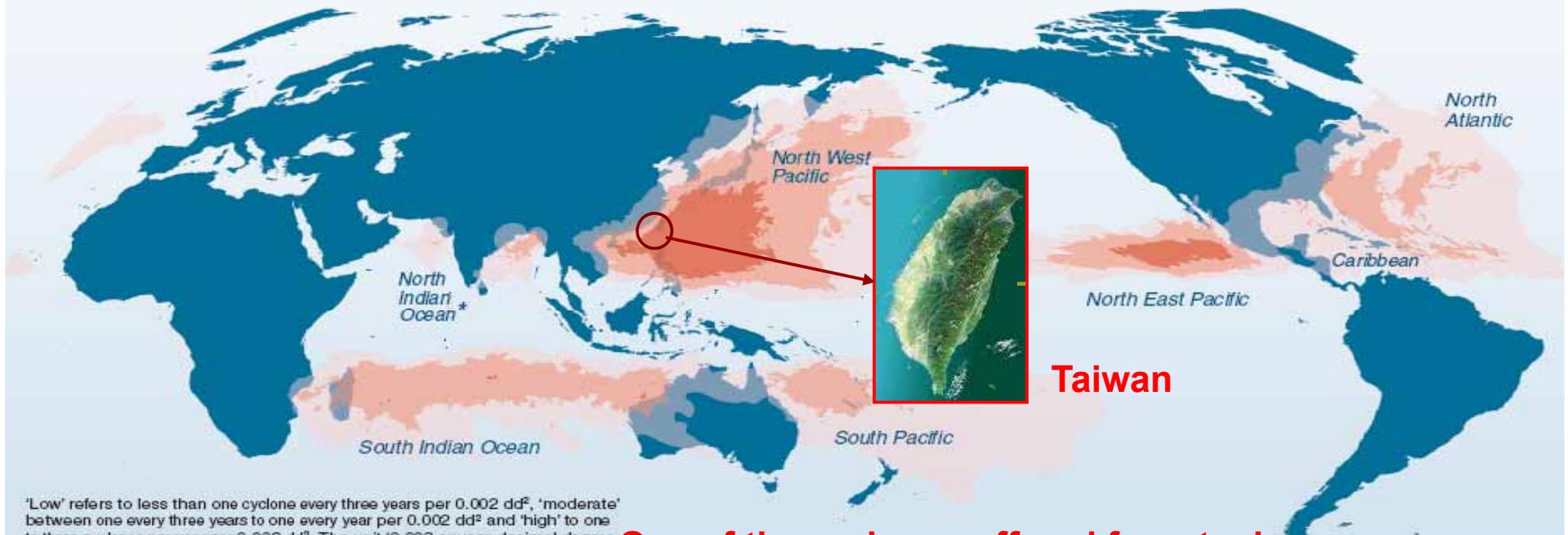
Climate Change Impact

- ◆ 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



Taiwan

'Low' refers to less than one cyclone every three years per 0.002 dd², 'moderate' between one every three years to one every year per 0.002 dd² and 'high' to one to three cyclones per year per 0.002 dd². The unit '0.002 square decimal degree (dd²)' is equivalent to 25 km² on the equator, diminishing as latitude gets higher.

* average based on eight years only.

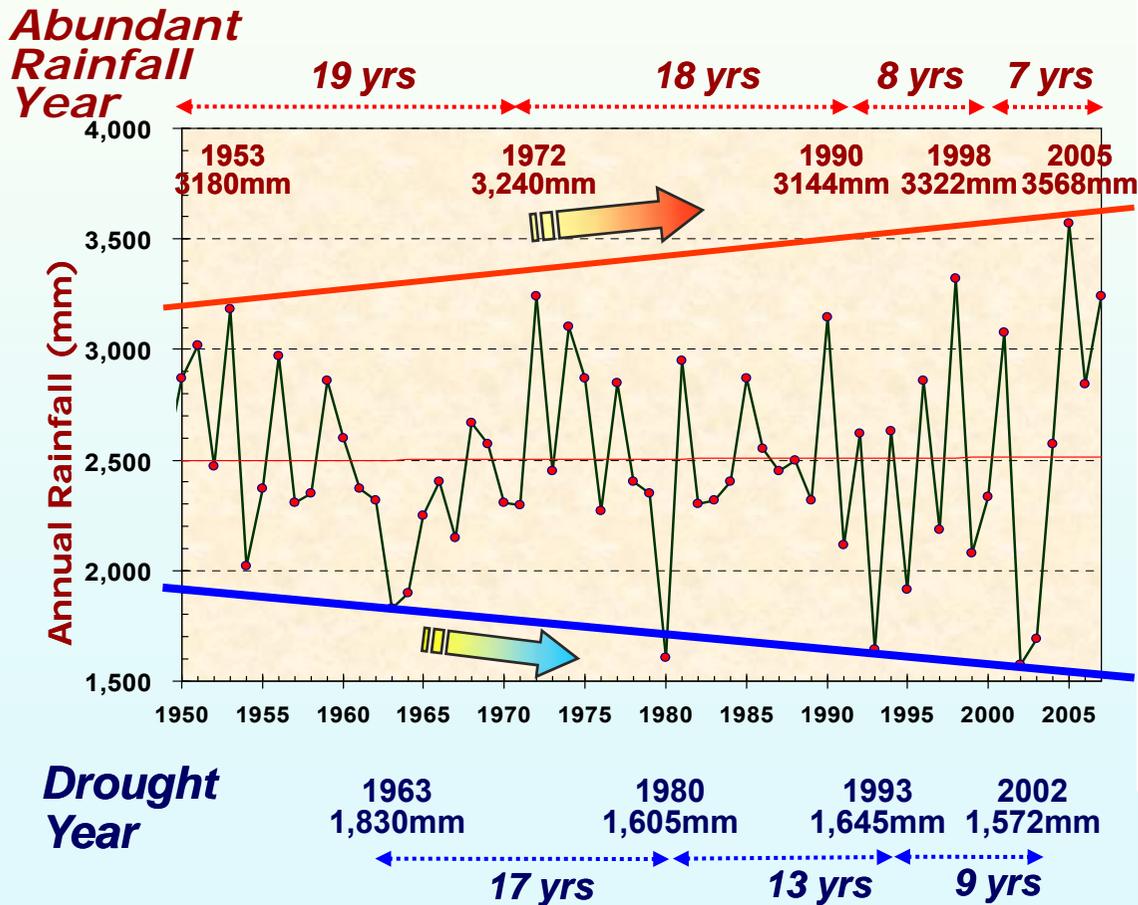
One of the regions suffered from typhoons

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

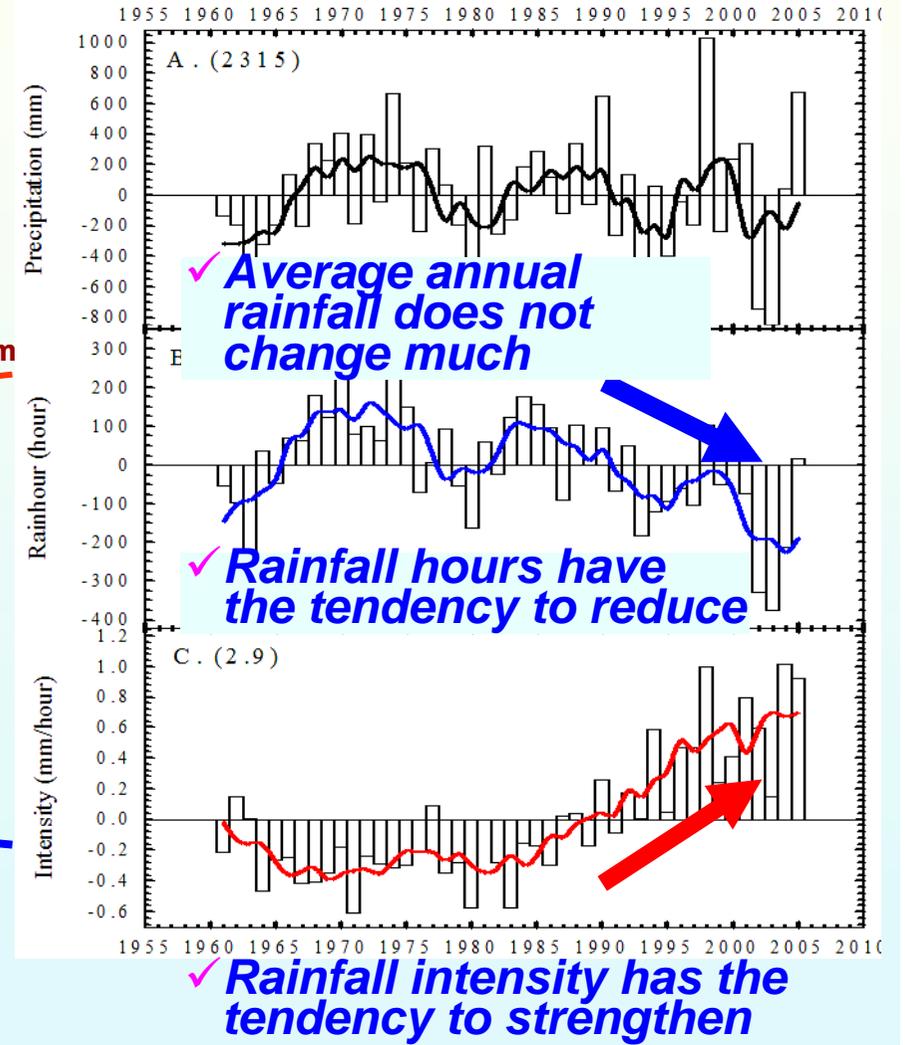


Variation of rainfall pattern of Taiwan in the past 50 years

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

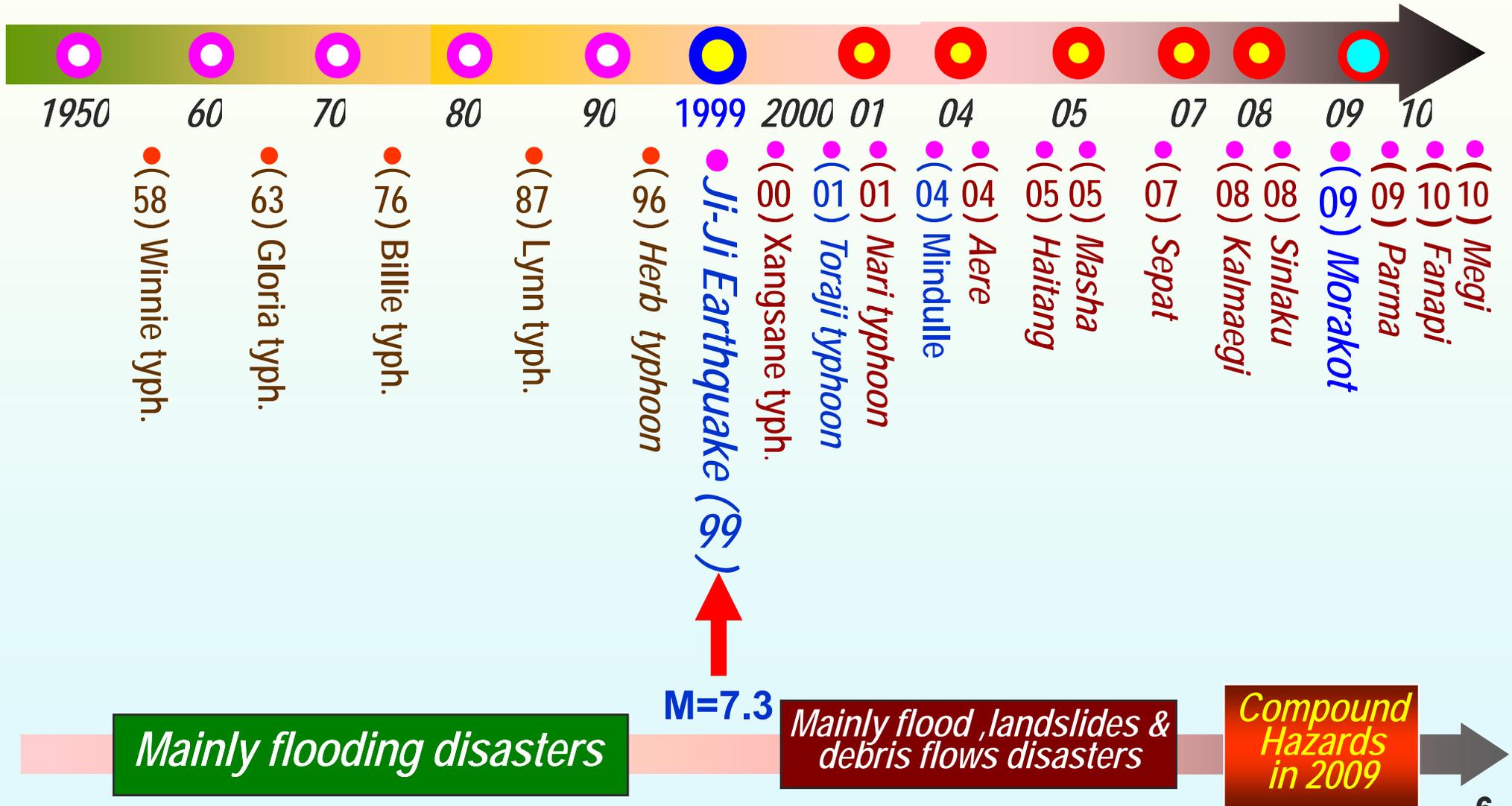


Average annual rainfall in the past 50 years





Historic Typhoon Disasters in Taiwan





Soil and Water Conservation Bureau (SWCB)

Debris Flow Disasters in Taiwan

1996-Herb



2001-Toraji



2004-Mindulle



2009-Morakot





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**





Debris Flow Disaster Management Framework

1,671
Torrents

Potential debris flow torrents

Where?

Delineation of affected areas

How big (far)?

48,496
People

Inventory of protected targets

Software

Hardware

Assessment

Engineering

Land use restrictions

Residential Relocation

Evacuation

When?

Disaster analysis

Monitoring system

Rainfall warning model

Rainfall > Threshold

Feedback

Feedback

1. Prevent vulnerability factors
2. Mass energy transformation
3. Diversion
4. Suppression works
5. Restrain works

Delimitation
↓
Announcement
↓
Restriction

Location
↓
Coordination
↓
Relocation

Planning
Drill
Promotion

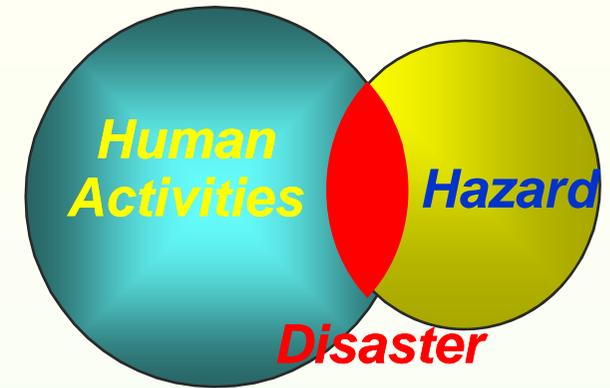
Warning

Evacuation

Disaster Info.



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

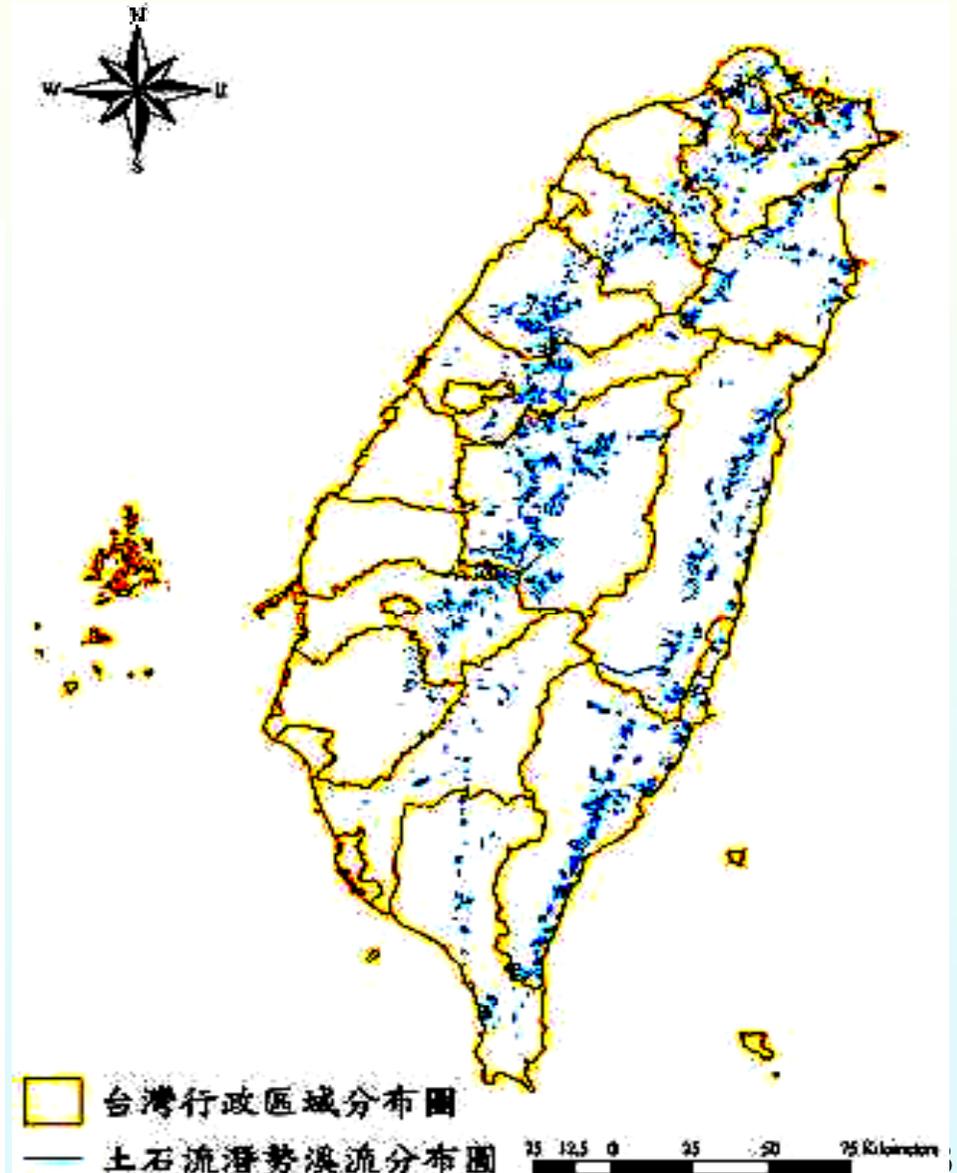
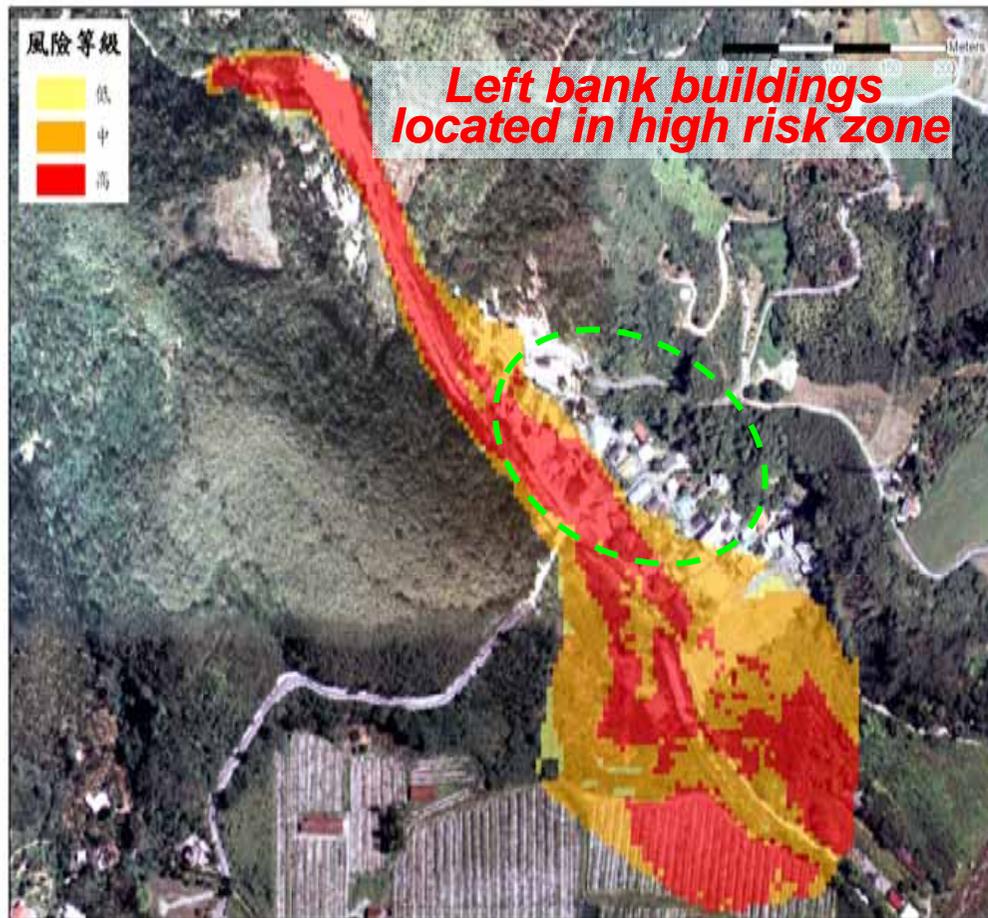
Risk Degree		Occurrence		
		Low	Mid	High
Protected Targets	Low	Low	Low	Mid
	Mid	Low	Mid	High
	High	Mid	High	High



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**

$$RTI = I \times R_t$$

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

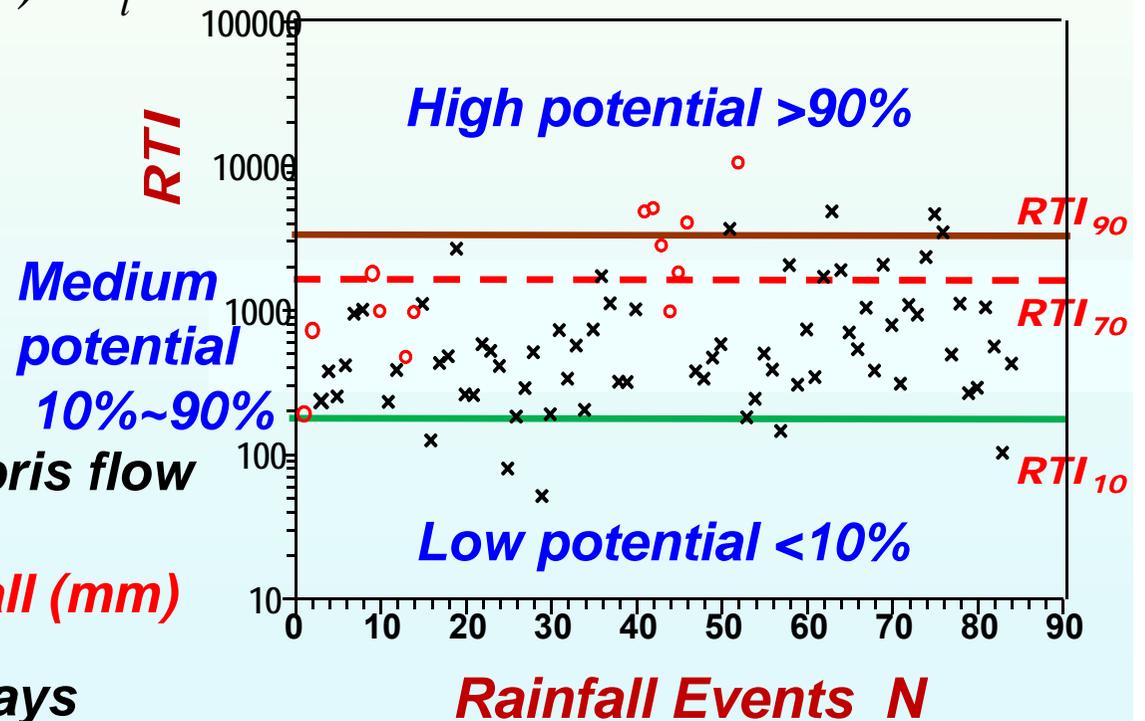
α is the decaying weighting factor = 0.7

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

X : debris flow do not occurred
O : debris flow occurred





Announcement of Debris Flow Warning in Taiwan

■ **Rainfall Threshold for Debris Flow Warning : 200 600mm**

Predict rainfall > Threshold

Real rainfall > Threshold

-30hr.

-18hr.

-12hr.

Accumulated rainfall



Rainfall forecast

Persuasive Evacuation

Enforced Evacuation

Local government should **Advise** the inhabitants to evacuate.

Local government should **Force** the inhabitants to evacuate.

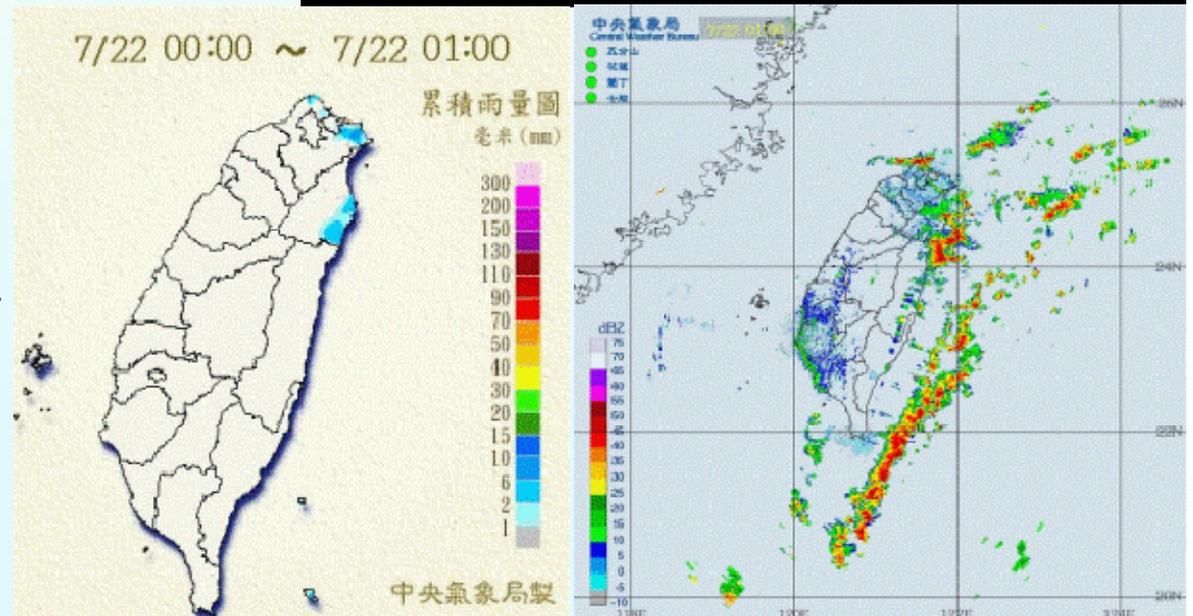


Debris Flow Emergency Operation Task Force of SWCB

<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



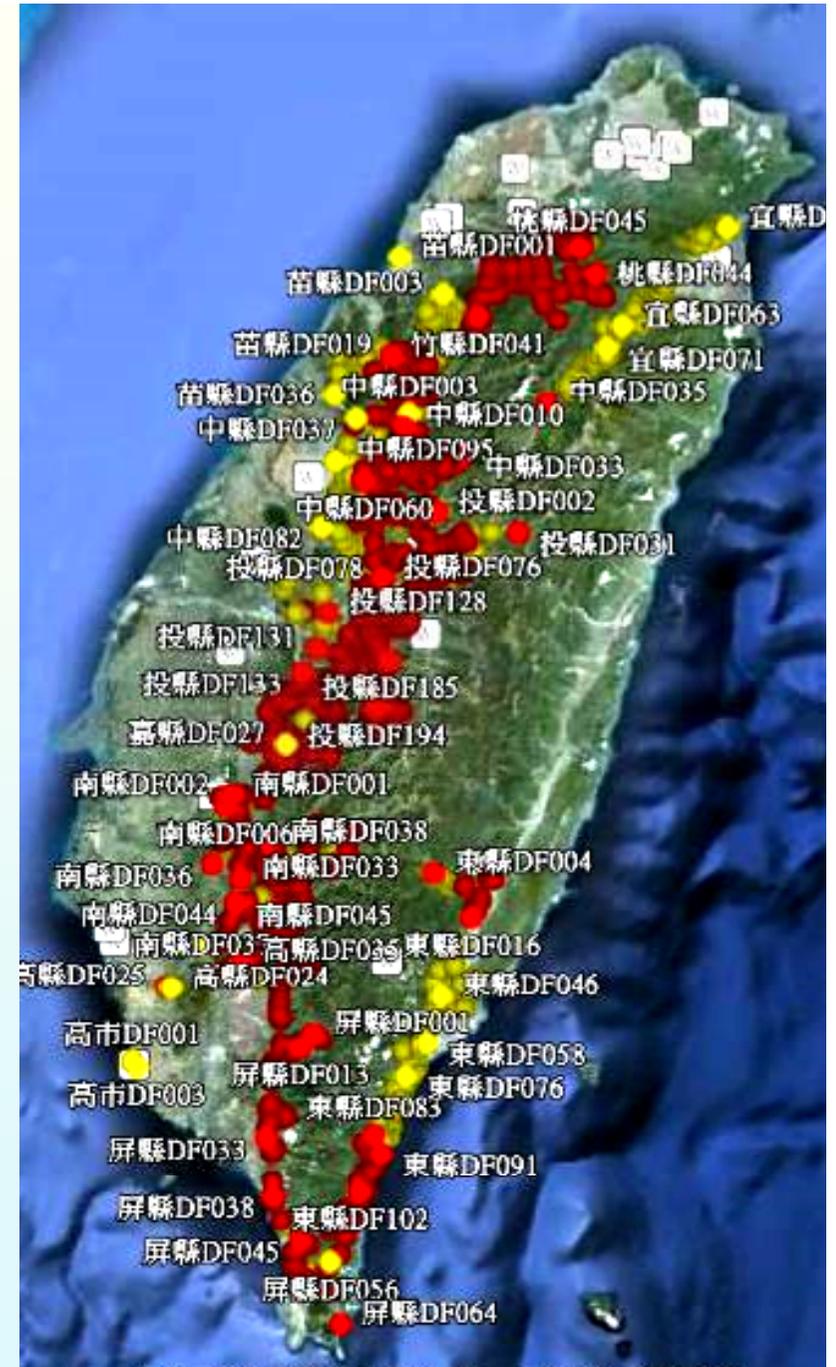


Debris Flow Warning and Evacuation

◆ 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.

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

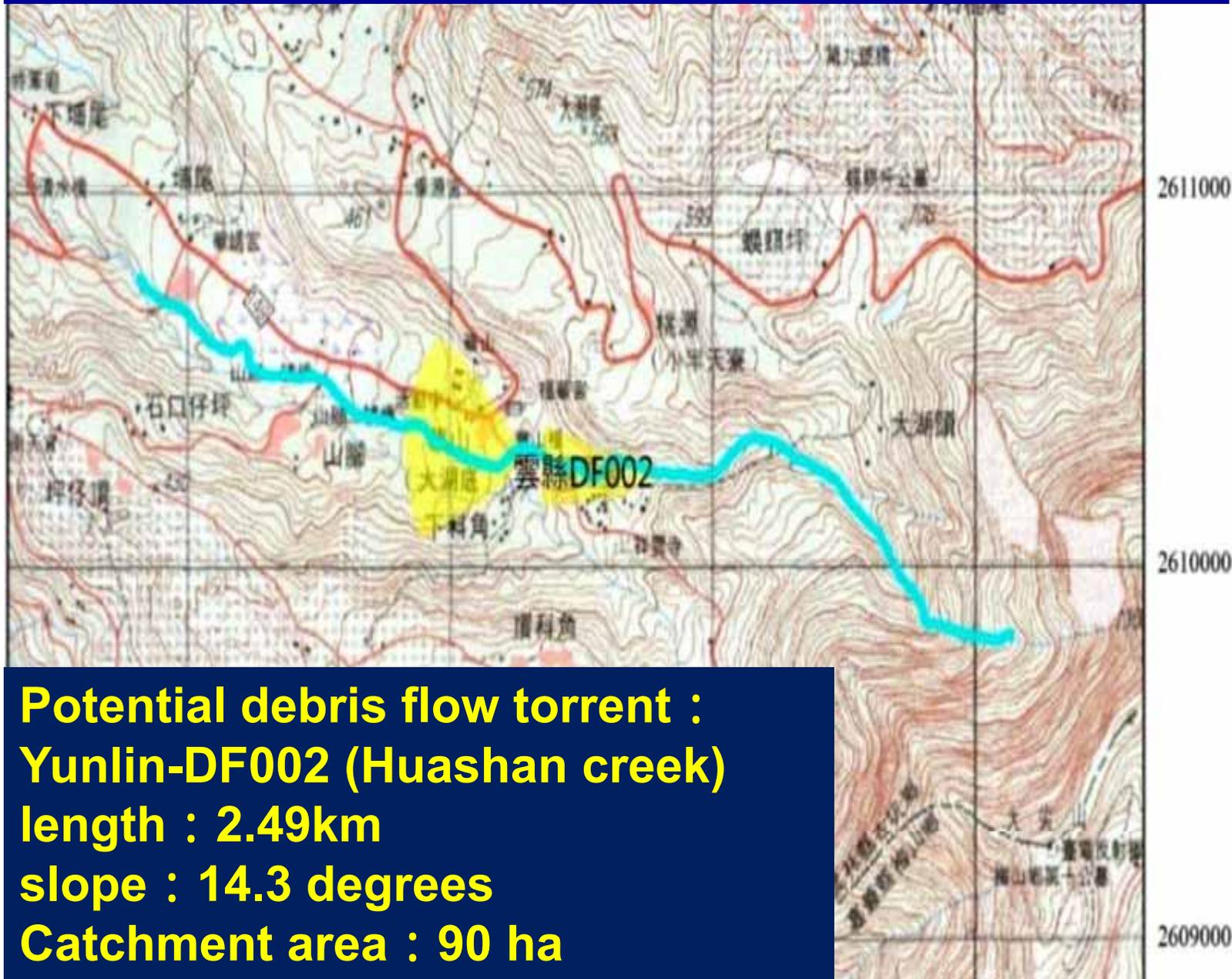
9,100 people were evacuated by local governments according to the warning. Among them, **1,046 people** escaped from the possible casualties.



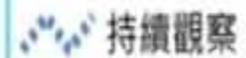


3. Debris Flow Control Works in Hwashan Village after Disasters

Hwashan village, Gukeng township, Yunlin County



土石流潛勢溪流自然潛勢



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

2609000



Protected Targets in Hwashan Village

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





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 m³ 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





Soil and Water Conservation Bureau (SWCB)

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





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 .

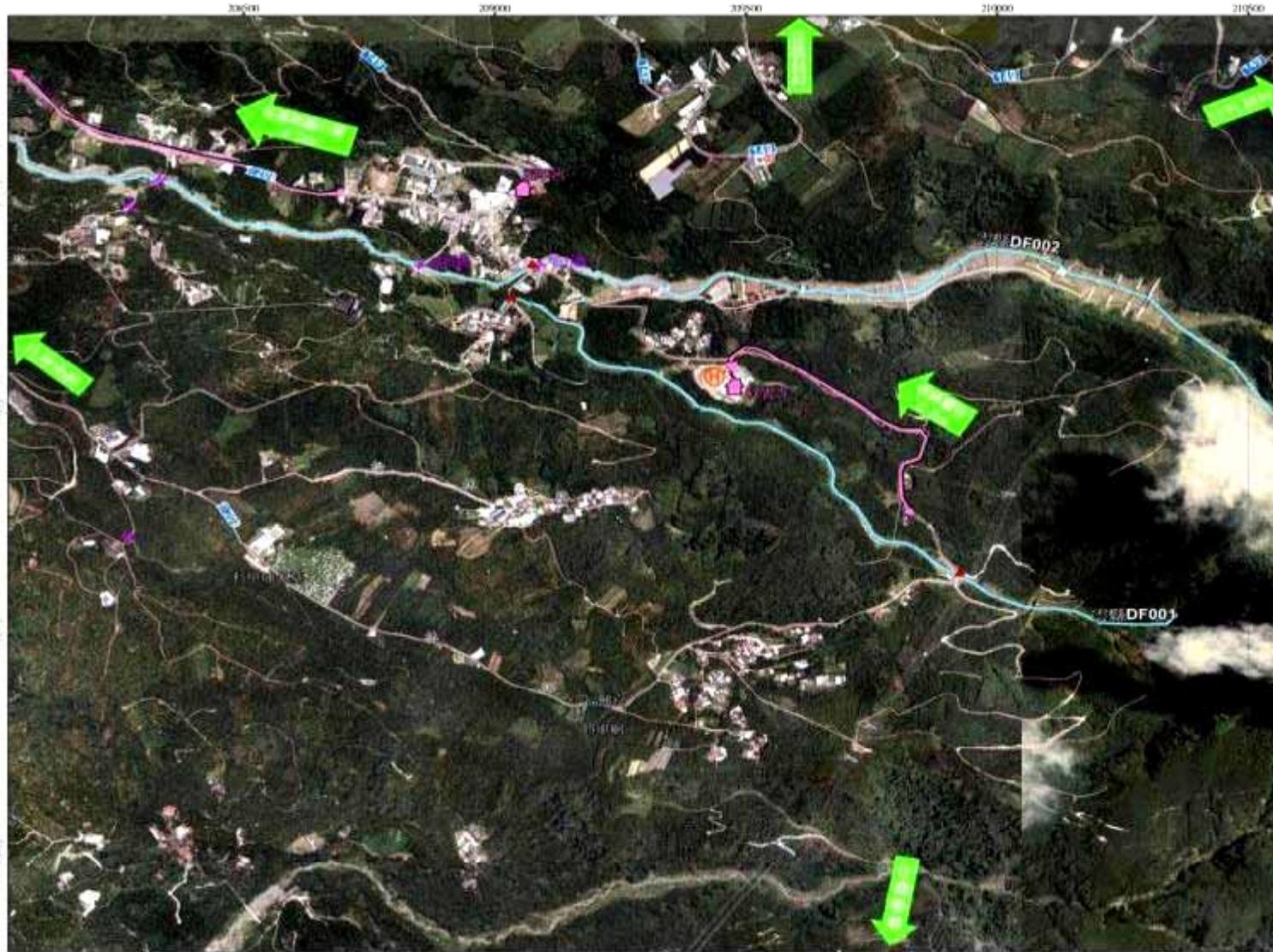


Deployment of debris flow control works





Evacuation Route Maps of Hwashan village



- 災害通報單位**
- 林縣災害應變中心
地址: 古坑鄉華山村華山6號
電話: 05-5901907
 - 古坑鄉災害應變中心
地址: 古坑鄉華山村華山34-1號
電話: 05-5901841
 - 水土保持局土石流災害緊急應變小組
電話: 0800-246246
 - 水土保持局南投分局緊急應變小組
電話: 049-8321841
 - 緊急聯絡人電話
林文和 電話: 05-5901255
李錦輝 電話: 0923-252626
- 避難處所**
- 林雲寺(可容納200人)
地址: 古坑鄉華山村華山6號
電話: 05-5901907
 - 福善宮(可容納40人)
地址: 古坑鄉華山村華山34-1號
電話: 05-5901841
 - 南天宮(可容納50人)
地址: 古坑鄉華山村10-1號
電話: 05-5901833
 - 華南國小(可容納200人)
地址: 古坑鄉華山村28號
電話: 05-5901529
- 直昇機起降點**
- 華南國小操場
地址: 古坑鄉華山村華山6號
電話: 05-5901907
 - 華南國小操場
地址: 古坑鄉華山村28號
電話: 05-5901529
- 醫療單位**
- 古坑鄉西平村中山路391號
地址: 古坑鄉西平村中山路391號
電話: 05-5821132
 - 斗六市雲林分院斗六院區
地址: 斗六市雲林路二號579號
電話: 05-8323911
 - 古坑消防分隊
地址: 古坑鄉西平村中山路393號
電話: 05-5821537
 - 華山派出所
地址: 古坑鄉華山村華山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
二月豪雨、民國89年六月豪



圖例

- ◆ 避難處所
- ⊕ 直昇機起降點
- ▲ 土石流警告標誌位置
- 疏散避難路線
- 土石流潛勢溪流

0 250 500
公尺

雲林縣古坑鄉華山村土石流疏散避難圖



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 m³ debris flow sediments flushed to the downstream area and piled in the main channel.

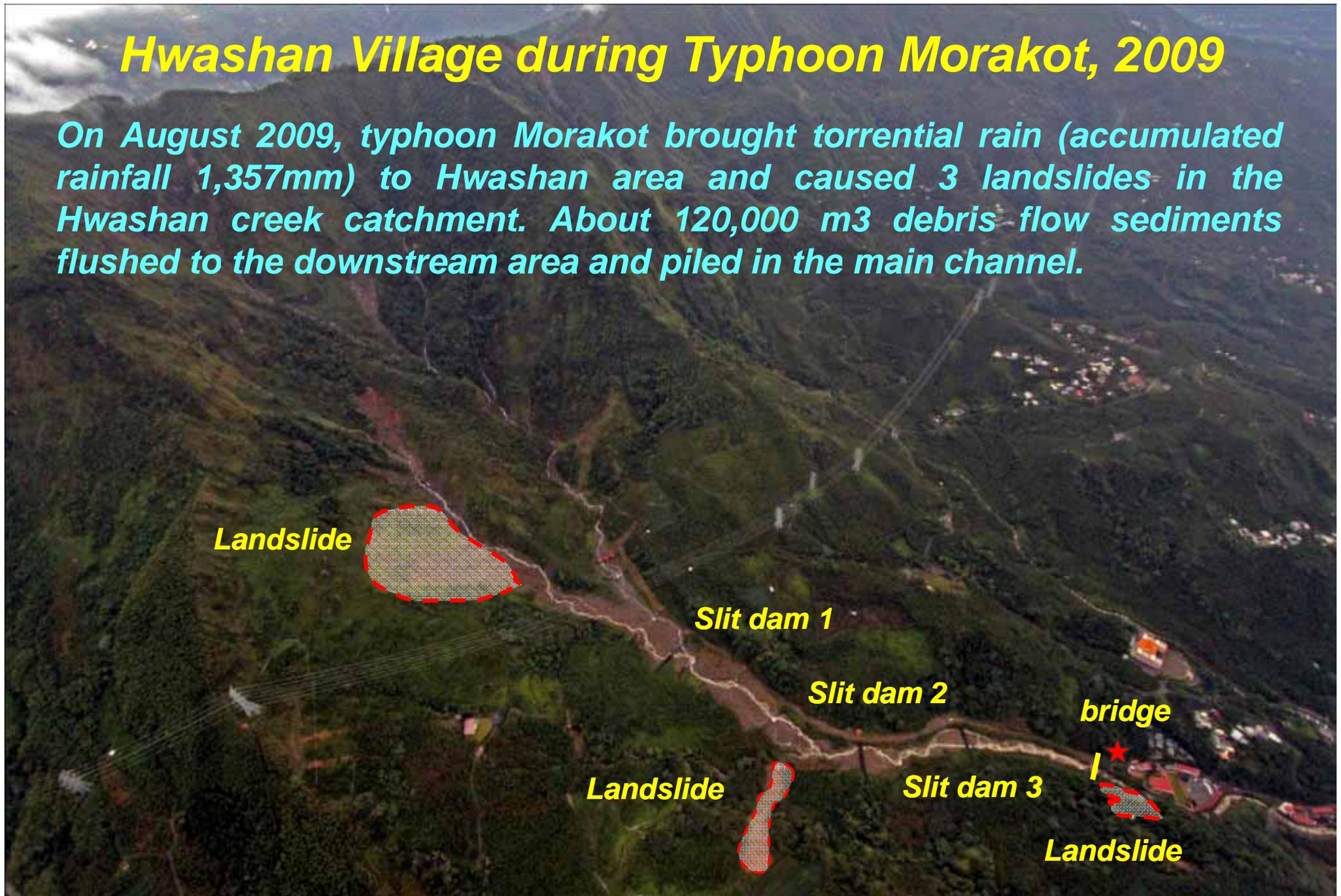




Photo of UAV Aug. 12

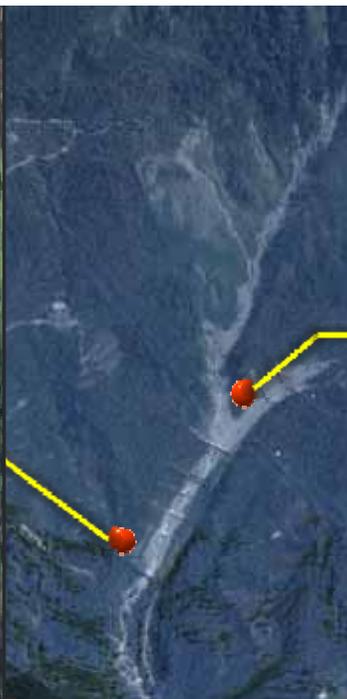
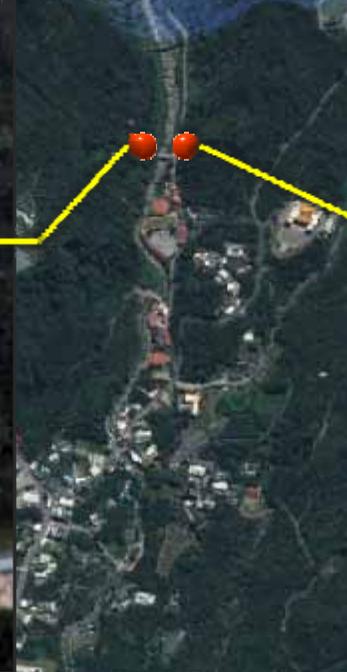


Photo of UAV Aug. 12



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.



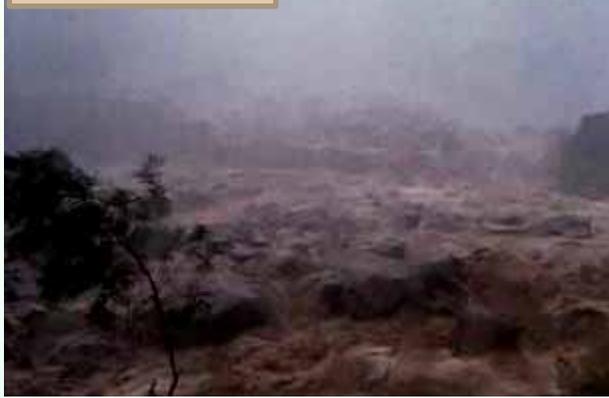
Debris Flow Monitoring during Typhoon Morakot

Upstream CCD camera

7:30 Aug. 9



9:30 Aug. 9

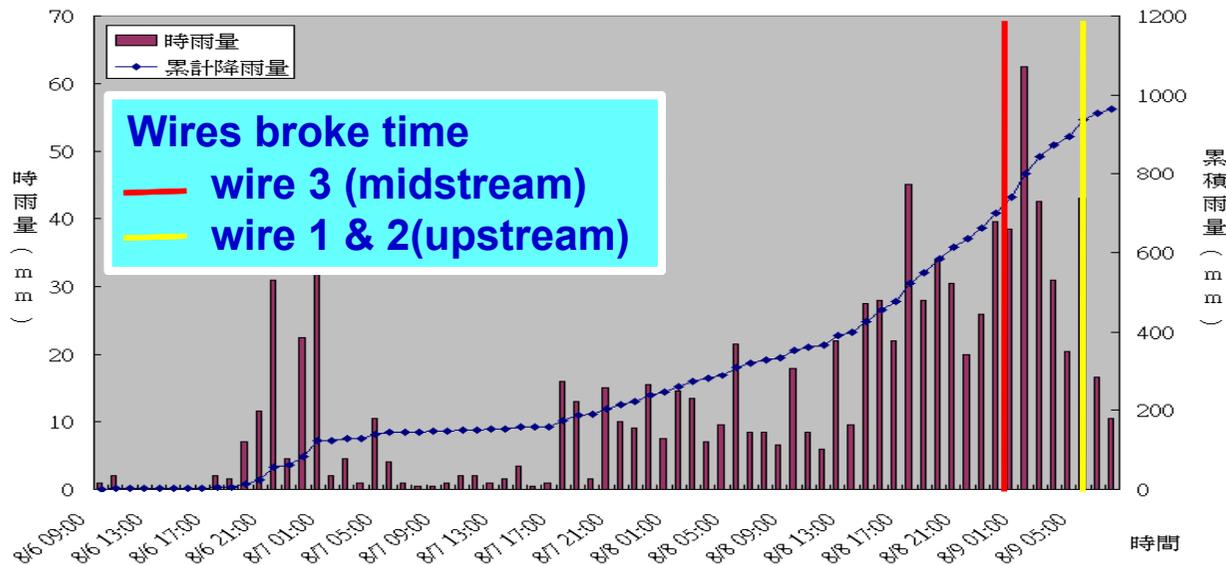


Midstream CCD camera

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

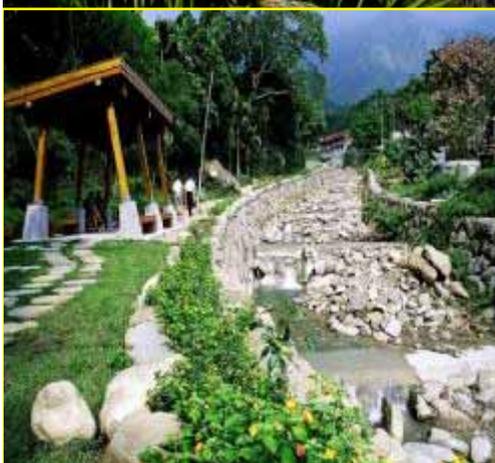


4. Community Development and Rural Regeneration Project

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



華山經典農村

Awarded the Top 10 Rural Villages





5. Future Perspective



On-line Education of Debris Flow Knowledge

Education videos uploaded on Youtube



防災利器 防災背包介紹



Disaster prevention knowledge



Parent-child interactive website



On-line monopoly game for disaster prevention



Apps for DDMI System

iOS
Android

Google map application



雨量資訊

全部 10分鐘 單位:mm

1	台北市內湖區	碧湖國小	21.0
2	台北市信義區	信義	18.5
3	台北市內湖區	內湖	18.0
4	台北市南港區	南港	17.5
5	台北市中山區	大直	15.5
6	台北市中正區	中正橋	12.0
7	台北市士林區	士林	12.0
8	台北市大安區	公館	11.0
9	新北市汐止區	五指山	11.0

彩色 - 台灣

累積雨量 - 大間距

6/28 00:00 ~ 6/28 15:00

WISAT2 紅外線雲圖 6/28 15:30

土石流警戒資訊

宜蘭縣	▲	無	▲	無	大粗坑	新北市	▲
基隆市	▲	無	▲	無	蘇澳	桃園縣	▲
台北市	▲	無	▲	無	下田埔	新竹縣	▲
新北市	▲	無	▲	無	玉峰	新竹縣	▲
桃園縣	▲	無	▲	無	白布帆	苗栗縣	▲
新竹市	▲	無	▲	無	松鶴	台中市	▲
新竹縣	▲	無	▲	無	豐丘	南投縣	▲
苗栗縣	▲	無	▲	無	郡坑	南投縣	▲

輪播全部觀測站影像

霍薩溪 CCD

10分鐘雨量: 0.0 mm
時雨量: 0.0 mm
6小時雨量: 9.0 mm
24小時雨量: 38.5 mm
單日累積雨量: 9.5 mm
土石流警戒基準值: 250 mm

士石流防災資訊-民眾版

北屯區

大坑

田寮湖

番仔寮

半天嶺

笨箕湖

橫坑巷

北坑巷

三路

太平區

雨量站站名: 大坑
地區: 台中市北屯區
十分鐘雨量: 0.0 mm
一小時雨量: 0.0 mm
三小時雨量: 0.0 mm
六小時雨量: 0.0 mm
12小時雨量: 0.0 mm
24小時雨量: 0.0 mm
本日雨量: 0.0 mm
預測一小時雨量: nm 1
預測二小時雨量: nm 0
預測三小時雨量: nm 0

座標: 24.1936,120.813
地址: 新社鄉協成村興義街219號
電話: 04-25813437
容納人數: 200
目前定位點: 24.181664,120.648541
直線距離: 約 16762 公尺

Does the slit dam work?



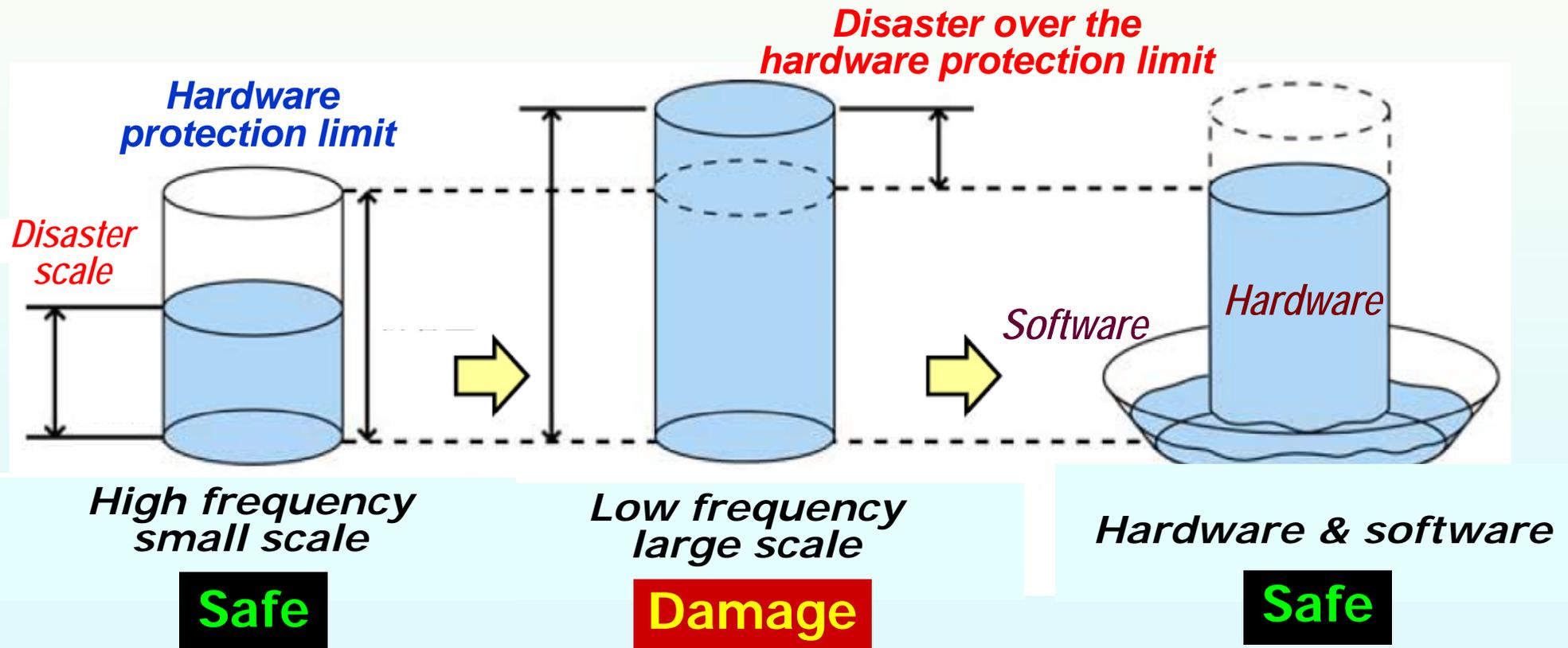
Grid-type steel dam

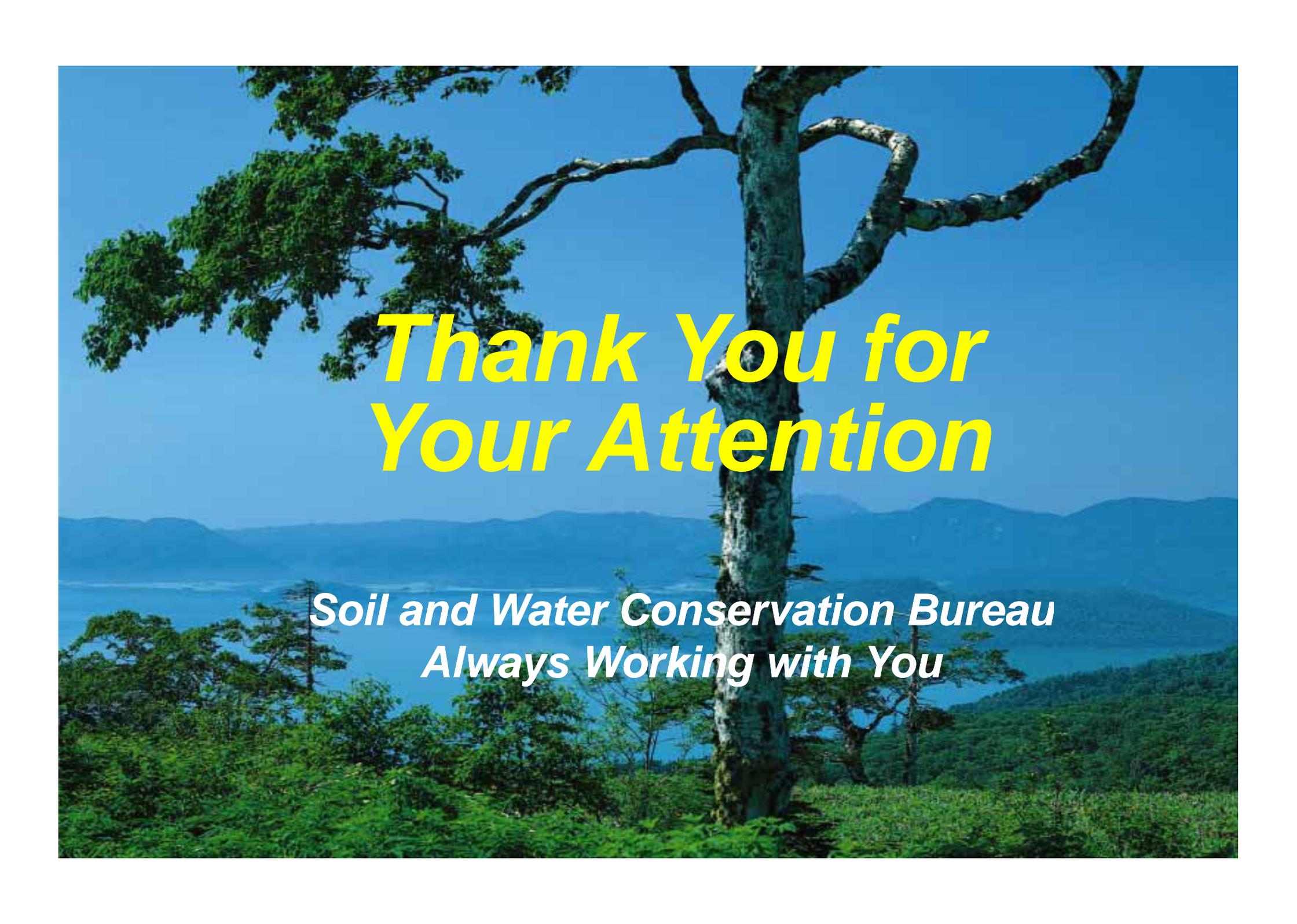




Integration of Software and Hardware

- 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***