

# 2020 International Smart Cities e-Forum

## ***Nationwide Decision Support System for Debris Flow Disaster Management in Taiwan***

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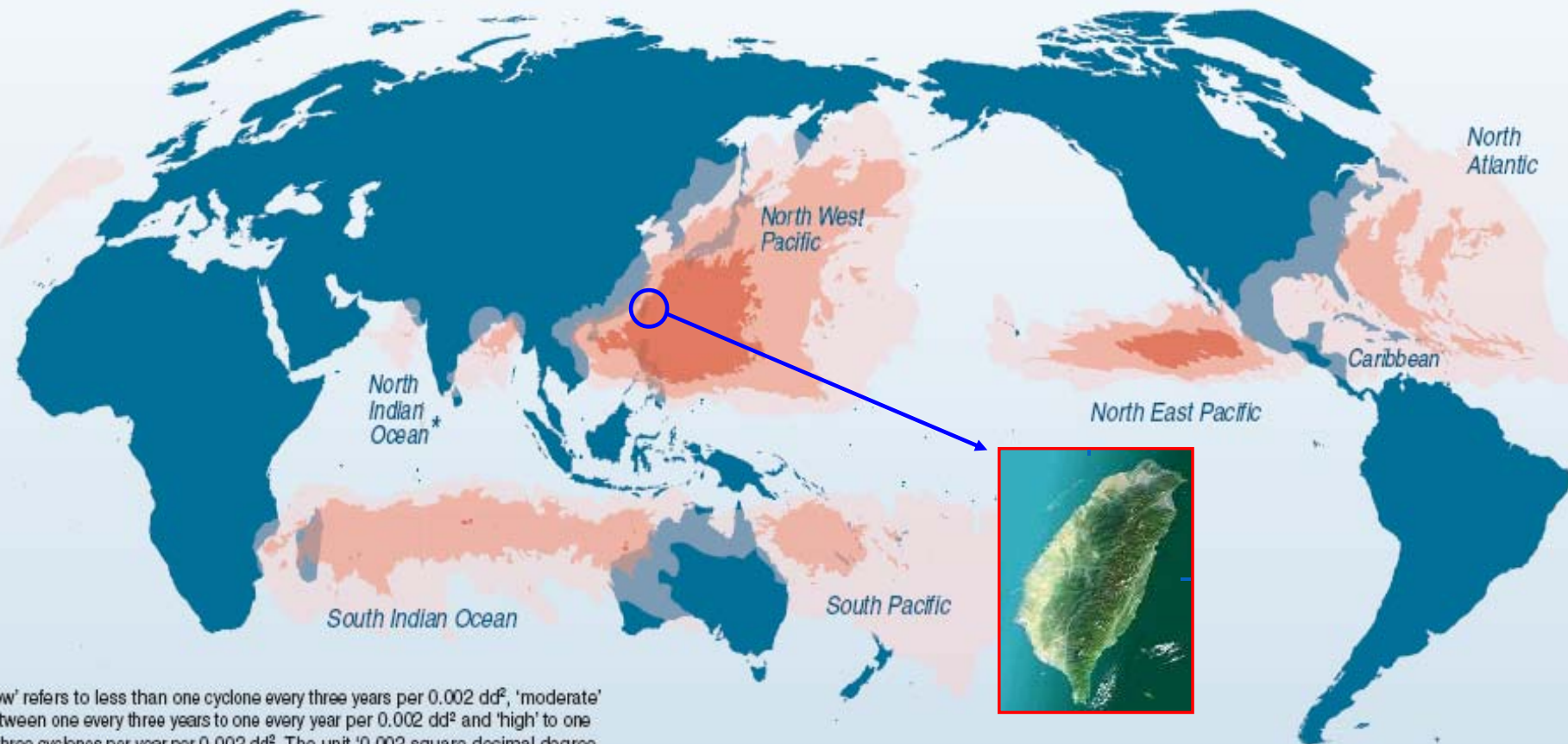
***Soil and Water Conservation Bureau  
Council of Agriculture, Taiwan***



## Tropical cyclone frequency

Average number of cyclones:  
(1980-2000)

low moderate high



'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.

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



# *Debris Flow Disasters in Taiwan by typhoons*

1996-Herb



2001-Toraji



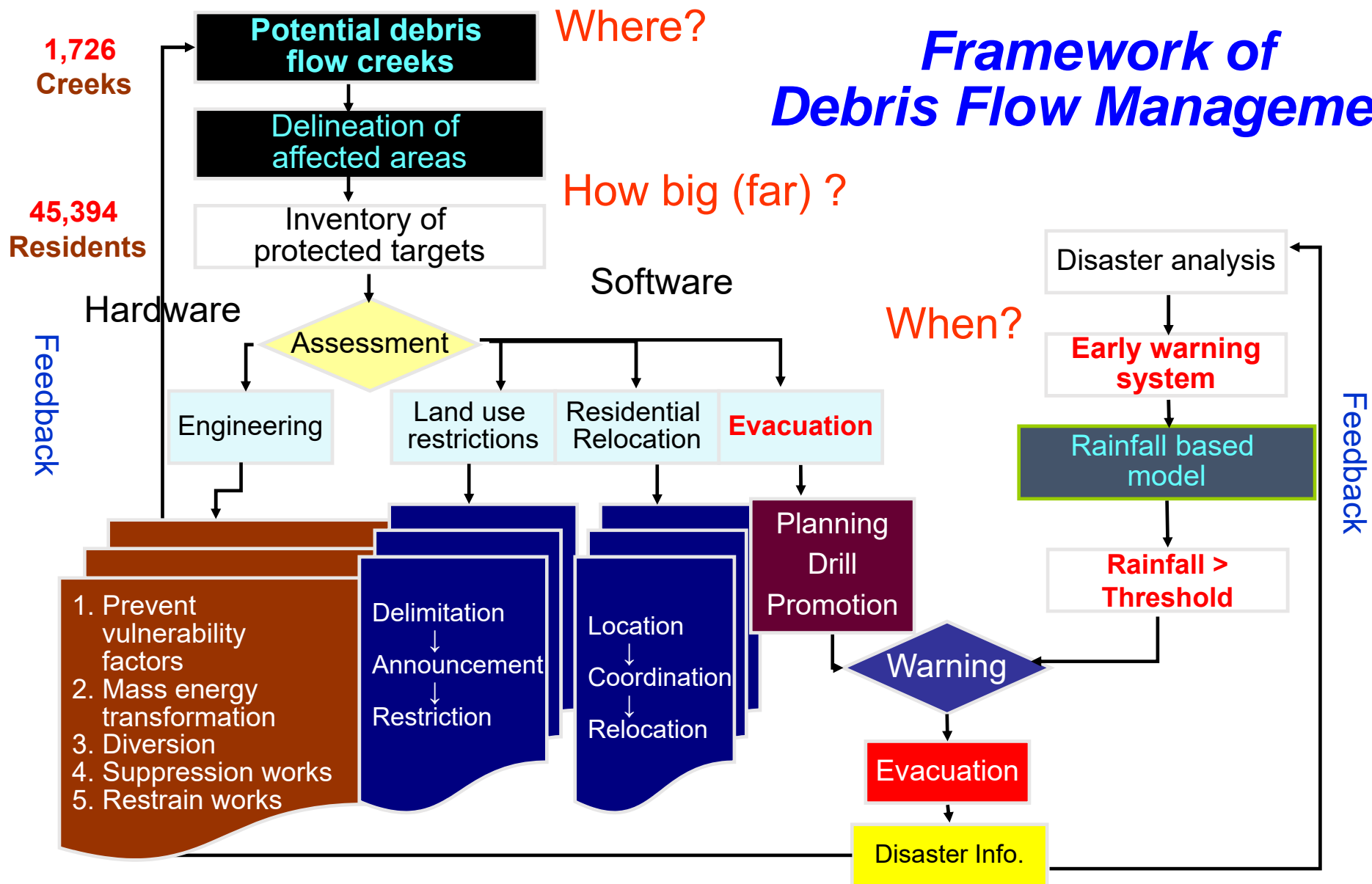
2004-Mindulle



2009-Morakot



# Framework of Debris Flow Management





# Debris-flow Disaster Management & Information(DDMI) System

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

## Preparedness



Potential debris flow creeks  
Evacuation plans  
Knowledge and education

## Emergency response



Weather information  
Early warning and monitoring

## Post-disaster survey

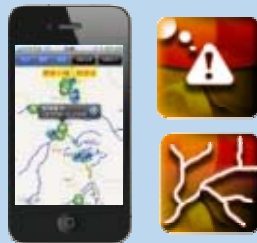


Events investigation  
Remote sensing methods

External website <http://246.swcb.gov.tw>



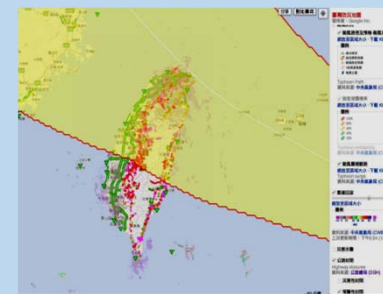
Website



APP



FaceBook



Google earth

# Identification of 1,726 Potential Debris Flow Creeks

**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

# Debris-flow Disaster Management & Information(DDMI) System

<http://246.swcb.gov.tw/>



土石流防災資訊網

防災監測

土石流資訊

防災應用

防災成果

下載與服務

重要公告

2019/04/22 因應108年0418花蓮地震，緊急調降花蓮縣（秀林鄉）等1縣1鄉鎮共25條土石流潛勢溪流之

2018/10/24 107年土石流潛勢溪流說明會開始報名，詳情請點連結至報名網頁

+ 更多公告

## Potential debris flow creek inquiry



土石流資訊便利搜

1.選擇縣市

土石流基準值

分布

土石流潛勢溪流共

1725條

分布159鄉鎮、689村里

2.選擇鄉鎮

3.選擇村里

列表

## Evacuation map

縣市政府疏散避難圖

連結

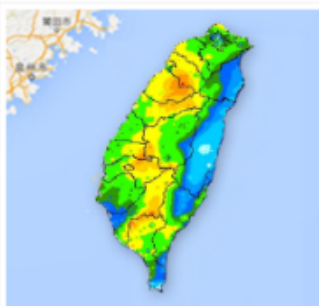
(連結至縣市政府網頁)

簡表

下載

## Rainfall criteria

## 掌握土石流資訊



即時雨量

Real-time rainfall



觀測站展示平台

Debris flow monitoring

## Debris flow knowledge



土石流介紹



防災任務

## 防災線上課程



107年度防災社區...

防災社區輔導團推動經驗分享

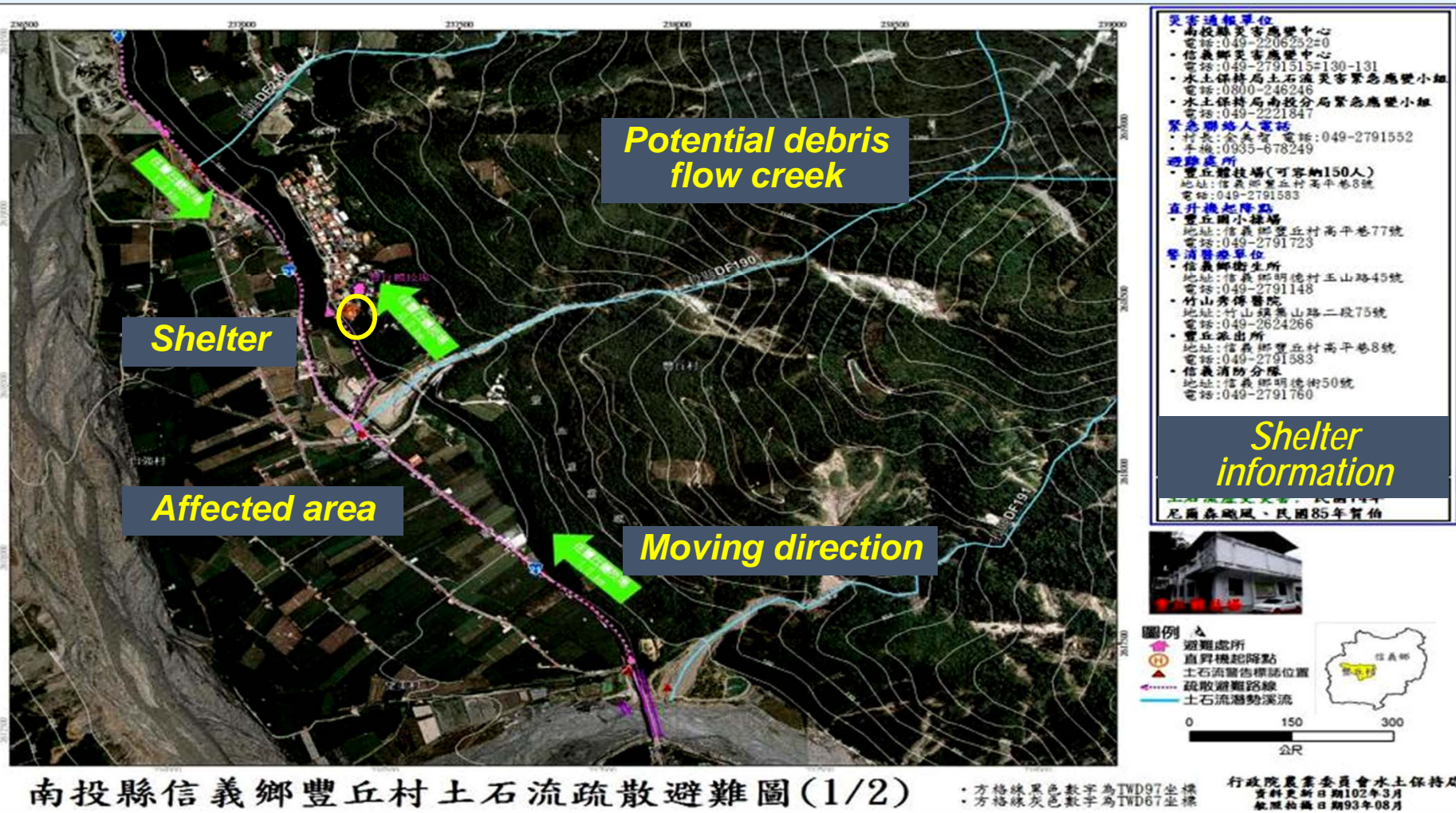
臺灣大學氣候天氣災害研究中心 柯凱元副組長

+ 更多課程



# Evacuation Rout Map in DDML System

<http://246.swcb.gov.tw/>





# Localized Rainfall-based Debris-flow Warning Model

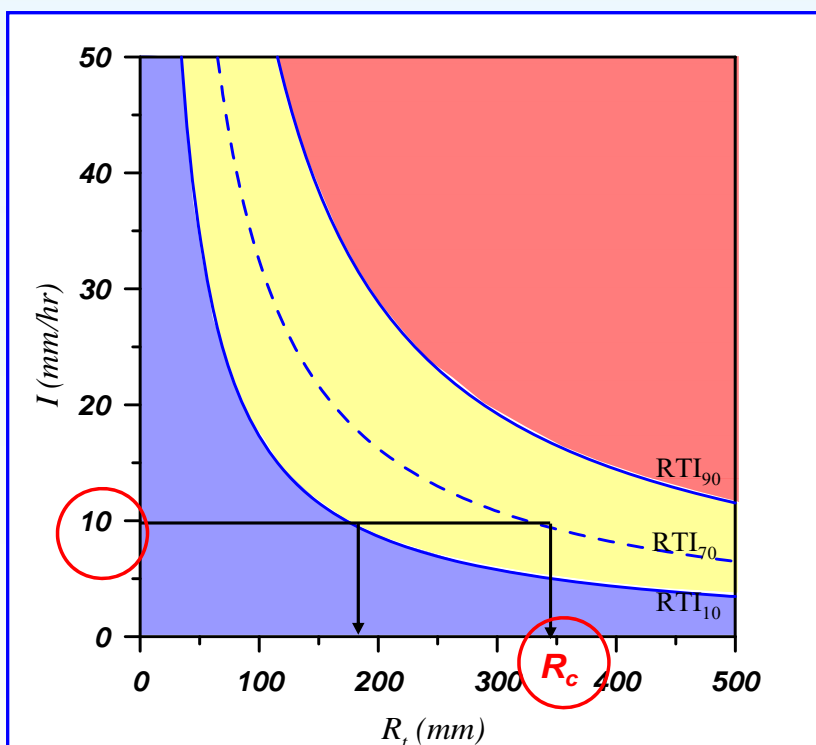
- **Rainfall Triggering Index (RTI)**  
= Rainfall intensity  $\times$  Effective accumulated rainfall

$$RTI = I \times R_t$$

**$I$  : 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



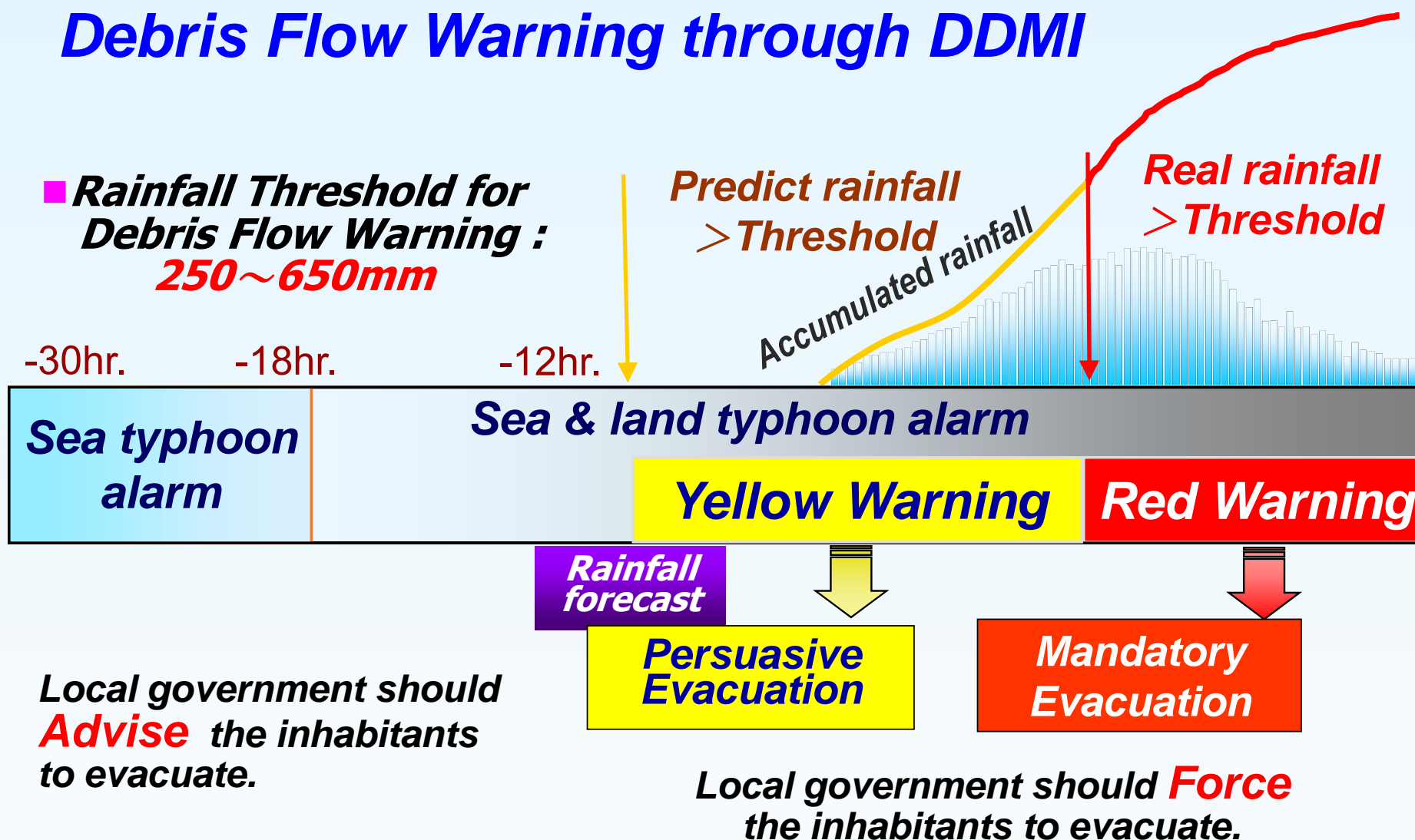
With **50mm** as an interval, **RTI** can be classified into 9 categories in different regions. They are **250 mm to 650 mm**.

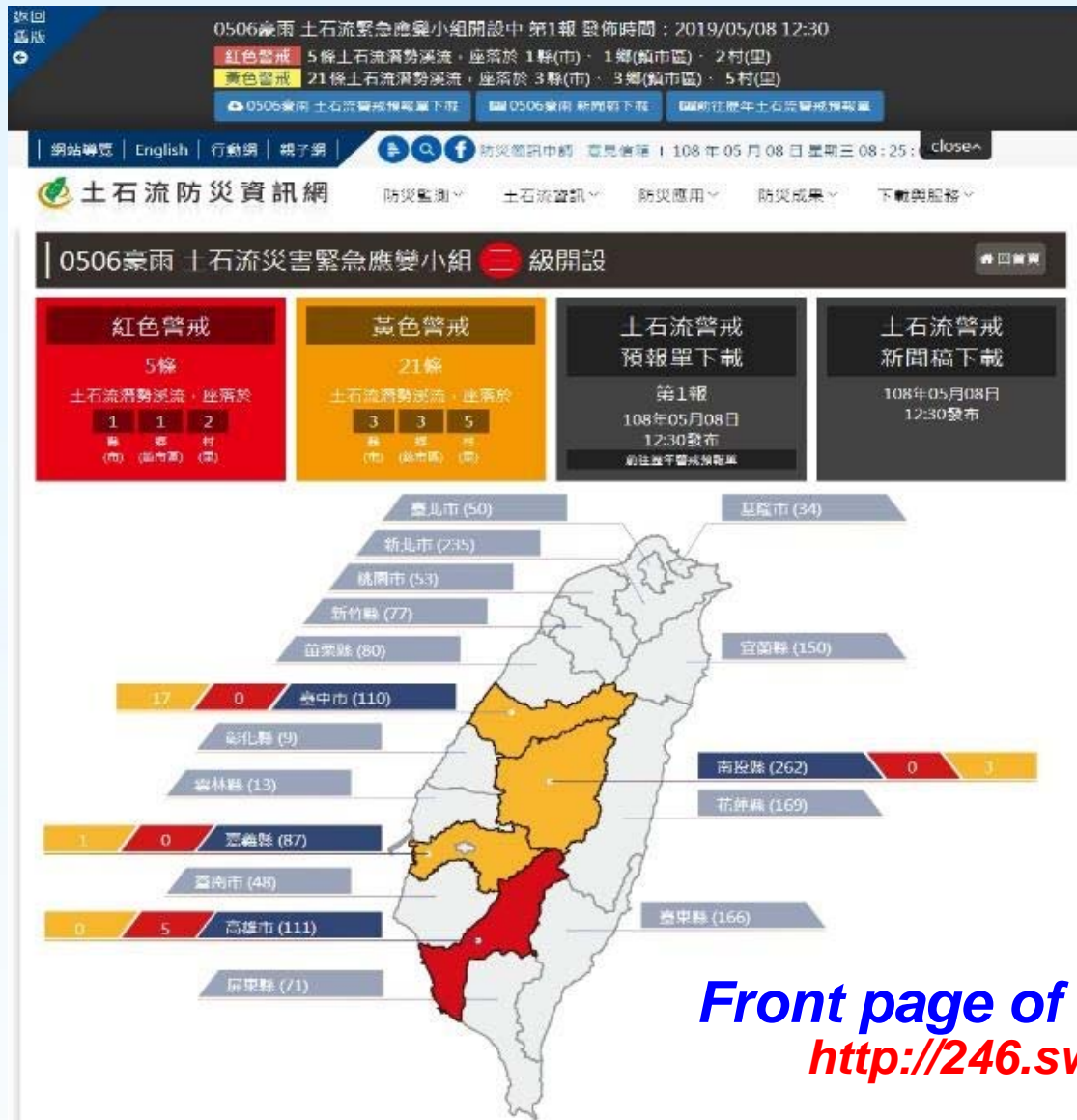
# Debris Flow Warning through DDMI

■ **Rainfall Threshold for Debris Flow Warning : 250~650mm**

**Predict rainfall > Threshold**

**Real rainfall > Threshold**





## Emergency Operation Task Force of SWCB during typhoon period



**Debris flow warnings were issuing through DDMI system**  
<http://fema.swcb.gov.tw/>



# On-site Debris Flow Monitoring

**17 Grid stations**

**3 Mobile stations**

<http://246.swcb.gov.tw/>



**Display through  
DDMI system and APPs**

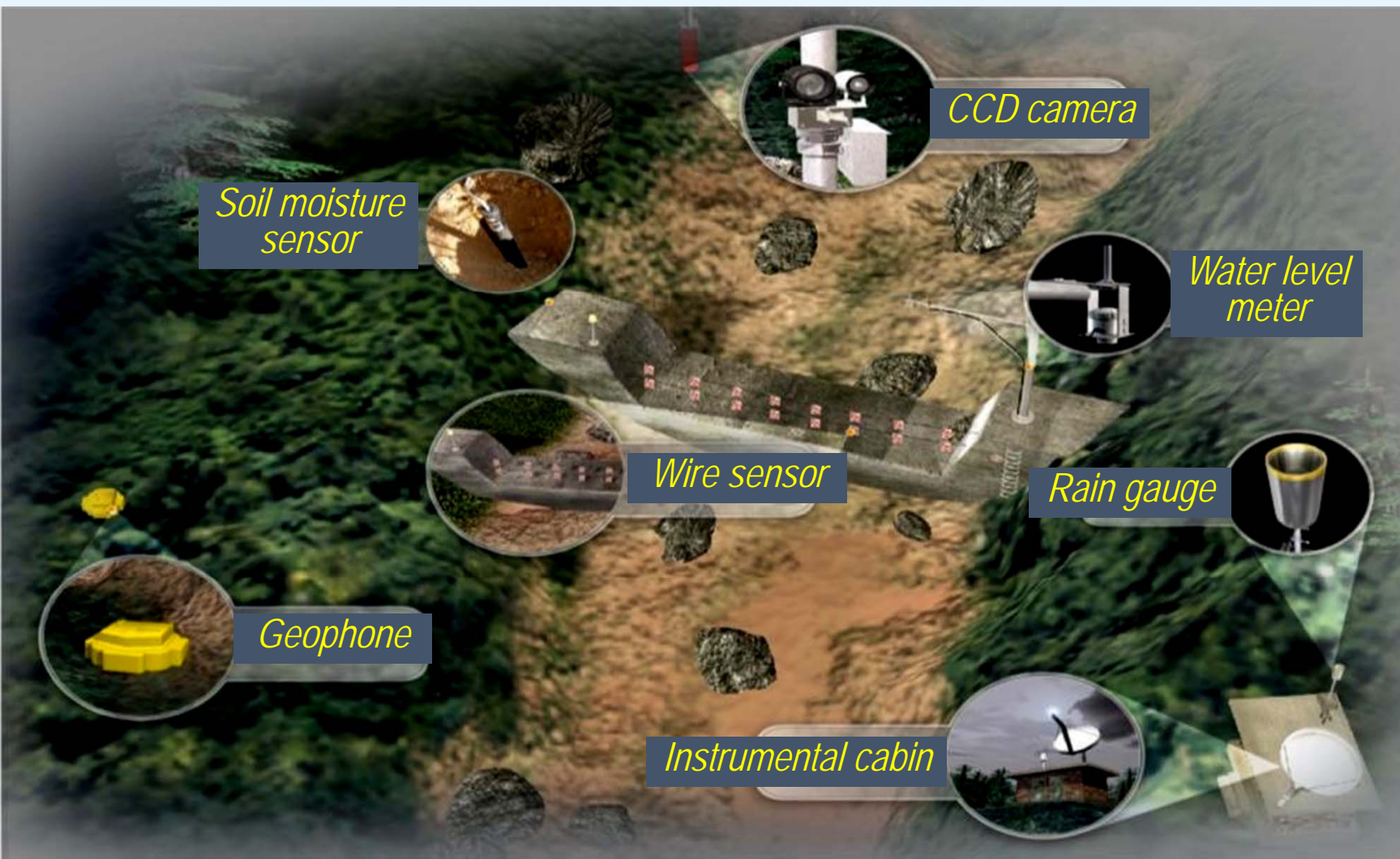


**Communication**



**21 Fixed stations**

# ***Different On-site Monitoring Sensors***



# Real-time on-line Debris Flows Observation Data

*Torrential rain in Shenmu monitoring station, 20 May, 2014*

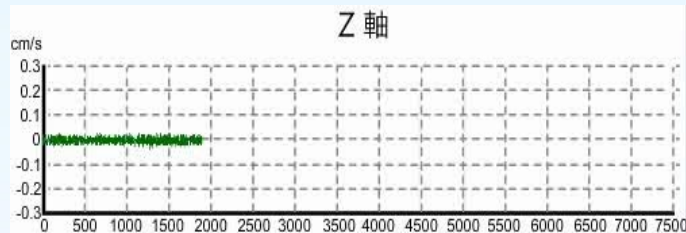
*Upstream,  $I=54$  mm/hr,  $R=58.5$  mm*

*Downstream,  $I=24.5$  mm/hr,  $R=26$  mm*

*Wires broke at 12:53:44*

*Front surge velocity =  $4.9$  m/s*

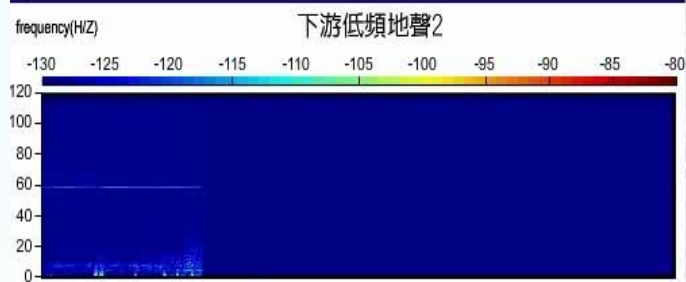
geophone



seismometer



spectrum







# 102年蘇力颱風重大土砂災例最速報

**102年蘇力颱風**

**台中市—和平區天輪里**

參考雨量站：和平國小(C119C) 土石流警戒基準值：300mm

## 102年蘇力颱風、台中和平-001

- ☆災害性質：土石流小
- ☆災害發生時間：7月13日07時
- ☆災害類型：土石流
- ☆有危害範圍量：320.23 mm

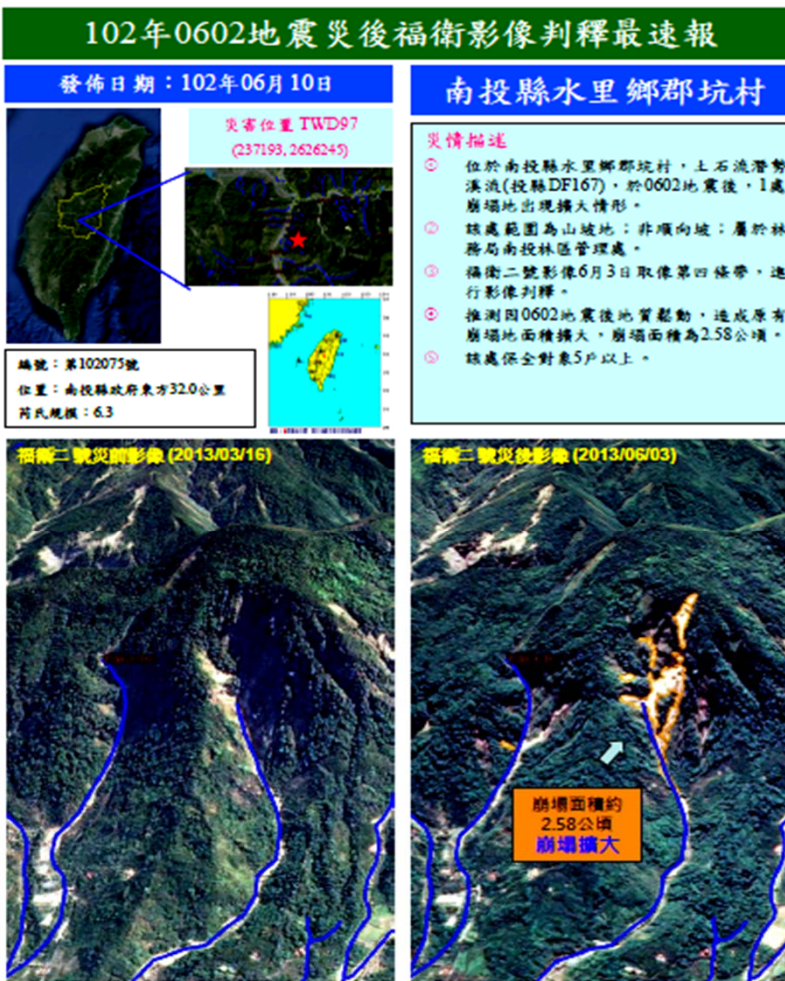
註1：查該地「TWID97」為坡，  
 註2：降雨地區屬山崩潛勢一次土砂特異  
 土流及土石流變態者。  
 註3：該處附近為舊山崩先方口壩埤將  
 對方向側呈垂直線之水平角。

## 今天與過去統計：

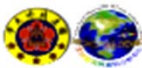
- ✓災害情形：受蘇力颱風侵襲之際影響，白冷國有野溪崩塌土石流災情；上方聯結道路崩落斷橋，崩塌土砂自白冷國小旁野溪滾下，大量土石明顯堆積白冷國小校內。
- ✓災害損傷：土砂堆積面積約900平方公尺，堆積土方量約650立方公尺，半段及天輪巷道路崩落長度約100公尺。
- ✓災害估計：土石流冲塌白冷國小門口設施，整入庫部分掩蓋；天輪巷4戶民宅連土砂入牆；上方聯結道路斷橋流失路寬約20公尺。

優質、效率、團隊

行政院農業委員會水土保持局



ter



行政院農業委員會水土保持局  
Soil and Water Conservation Bureau  
Council of Agriculture, Executive Yuan



# On-line Education of Debris Flow Knowledge <http://246.swcb.gov.tw/>



# Free **APP** for Debris Flow Disaster Prevention

Google map application

iOS  
Android



Rain gauge

Potential  
Debris flow  
Creek

Shleter



# Google Crisis Response-Taiwan Disaster Prevention Map

<http://www.google.org/crisismap/taiwan>



分享 對比模式

**臺灣防災地圖**  
發佈者：Google Inc.

圖例  
-10 0 10 25 35 45 60 70

資料來源：中央氣象局 (CWB)  
上次更新時間：下午4:05 (20 分鐘前)

☒ 災害示警  
資料來源：中央氣象局、水土保持局、及水利署，並透過Google.org的災害示警發佈

☒ 公路封閉  
Highway closures  
資料來源：公路總局 (DGH)

☐ 災害性封閉

☒ 預警性封閉  
縮放至區域大小 · 下載 KML 檔

圖例  
 道路預警性封閉

☐ 土石流警戒(含疏散避難路線圖&避難處所)

☒ 雲層  
資料來源：Google 地圖

☒ 交通路況  
資料來源：Google 地圖

☒ 土石流潛勢溪流  
圖例  
● 潛勢度高  
● 潛勢度中  
● 潛勢度低  
● 持續觀察

Google Crisis Response

HOME RESPONSE EFFORTS FOR RESPONDERS FAC

Making critical information more accessible in times of disaster

When disaster strikes, people turn to the internet for information. We help ensure the right information is there in these times of need by building tools to collect and share emergency information, and by supporting first responders in using technology to help improve and save lives.

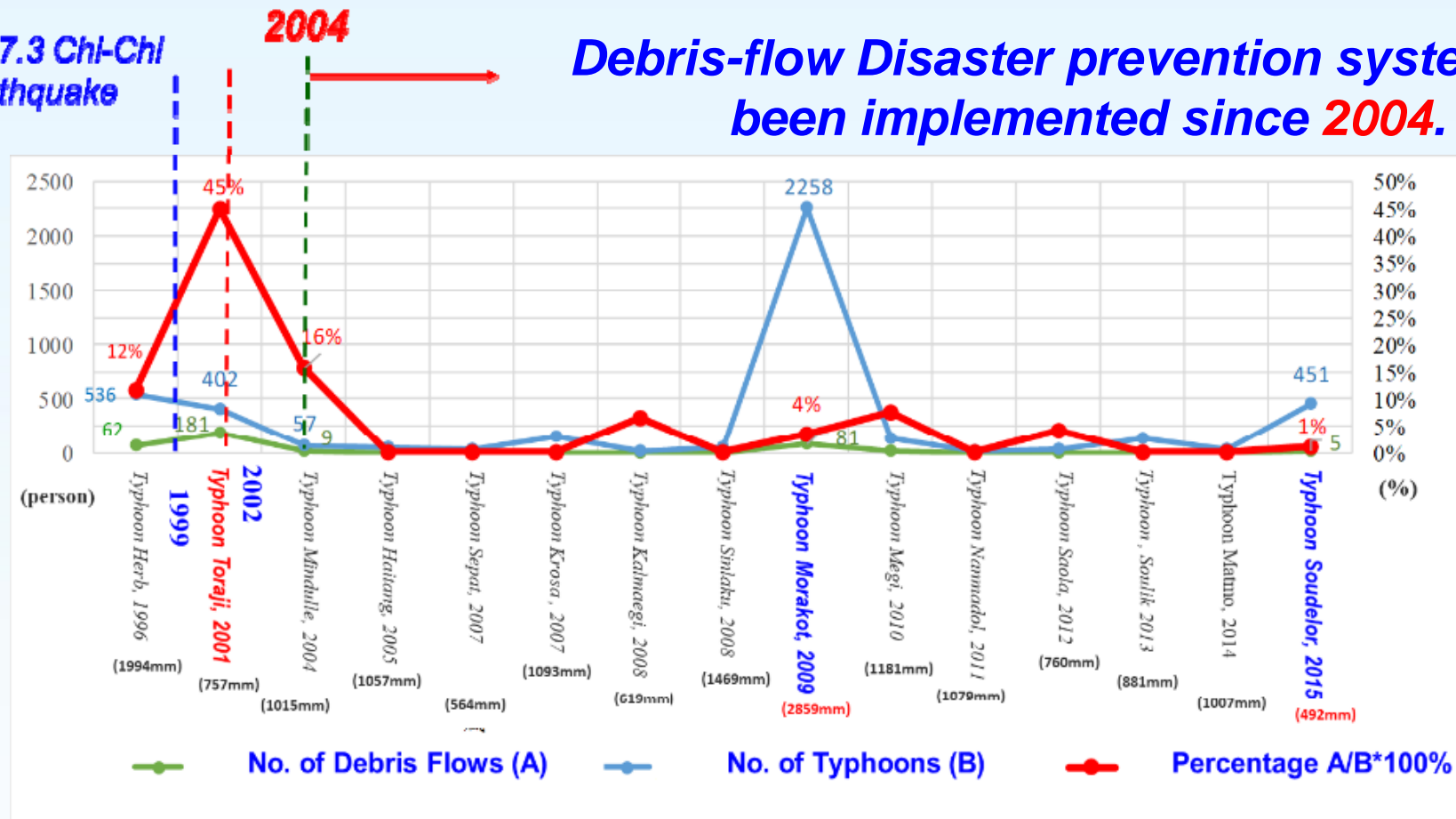
Photo courtesy of Bill & Melinda Gates Foundation



Response Efforts Tools for Responders Work with Us

## No. of Casualties and Wounded Debris Flows vs Typhoon

Debris-flow Disaster prevention system has been implemented since **2004**.



# Geospatial World Excellence Awards – Disaster Prevention

## Intelligent Disaster Prevention and Decision-making Network for Debris Flows

## Geospatial World Forum 2019

### 榮獲國際肯定 台土石流防災智慧新科技荷蘭獲獎

李鎮洋：結合硬體減災工程及軟體防災措施，建構土石流安全防護網，保護人民生命財產安全，期能達成坡地防減災的具體目標

By 林靜怡,台灣英文新聞 - 編輯  
2019/04/08 09:26



水土保持局長李鎮洋(左4)與國際開放空間資訊組織(OGC)主席 Bart Lathouwe 等人員合影。(照片由水土保持局提供)

(台灣英文新聞 / 林靜怡 綜合報導) 行政院農業委員會水土保持局開發的「土石流智慧防災決策網絡」新科技，日前在荷蘭阿姆斯特丹獲頒「世界空間地理資訊傑出獎—地理資訊技術創新獎」的殊榮。

水土保持局長李鎮洋表示，這次獲頒國際「2019世界空間地理資訊傑出獎」實屬不易，顯示台灣在土石流防災科技上已受到國內外的肯定，未來在全球氣候條件日趨極端多變的情形下，水土保持與坡地防災領域都將面臨全新的衝擊與挑戰。

