

Development of Safe Taiwan Info. System(SATIS)

A Decision Support System for Natural hazard in Taiwan



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Natural Hazards in Taiwan

- Due to the particular geographical location and geological condition, Taiwan suffers from many natural hazards, such as typhoons, flooding, landslides, debris flows, and earthquakes, which often cause serious property damages and even life losses.

Earthquakes



Flooding



Typhoon



Landslide & Debris flow



Summary of Disaster Events and Potential Risks recent year in Taiwan

Disaster

- Large-Scale
- Higher-Reoccurrence
- Diversity
- Complexity

Vulnerability



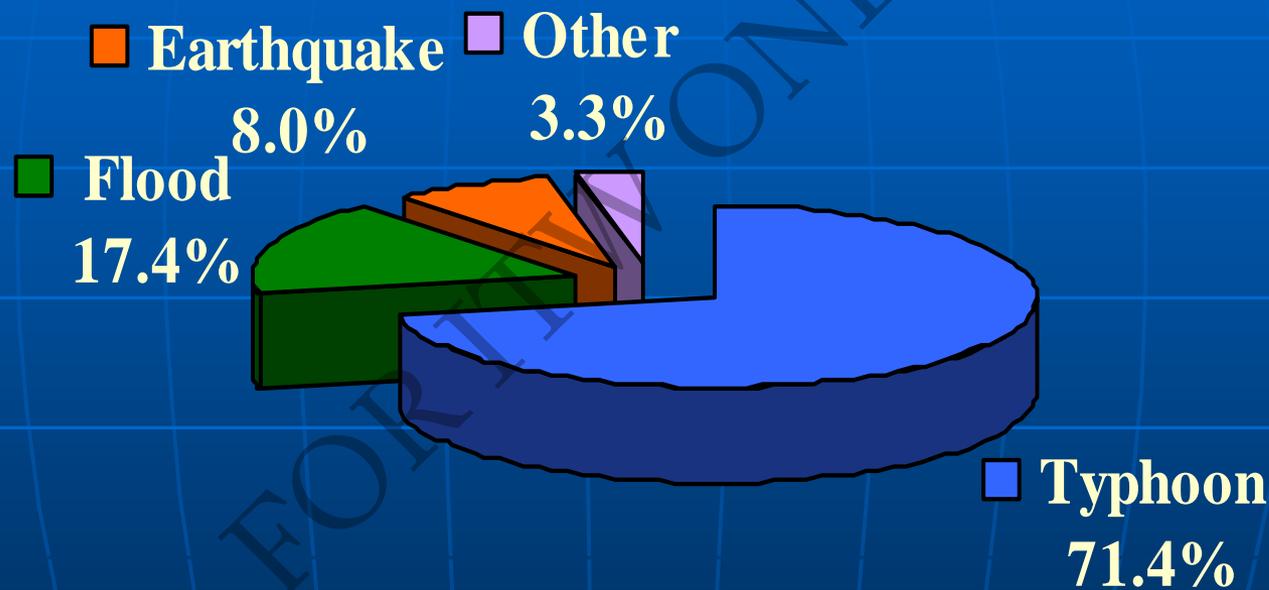
Surroundings

- Urbanization
- Social Development
- Environmental Degradation
- Global Change

- In 2005, the report entitled *“Natural Disaster Hotspots – A Global Risk Analysis”* issued by World Bank indicated: **“Taiwan might be the most vulnerable to natural hazards on Earth, with 73 % of land and population exposed to three or more hazards”**

Typhoon Disasters in Taiwan

Total loss due to natural disasters

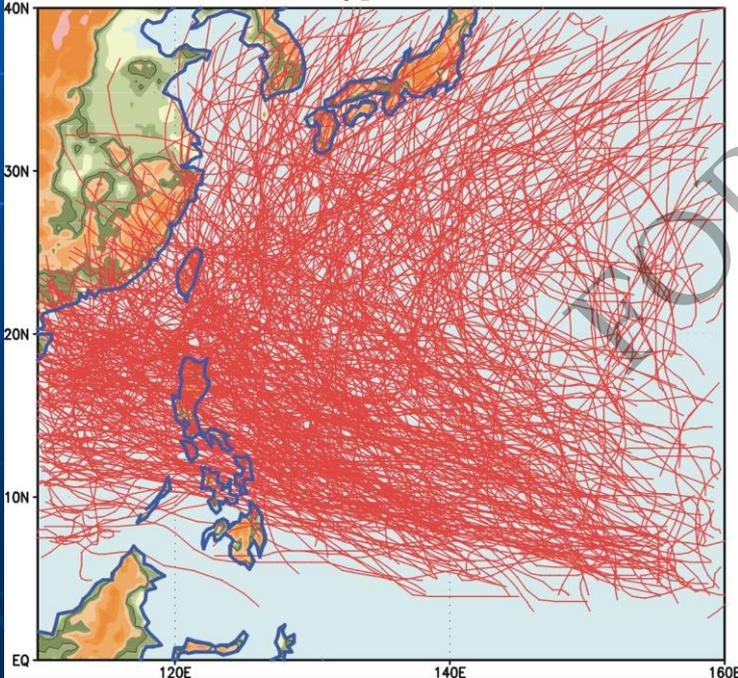


72% natural hazard damage is caused by typhoon in Taiwan area

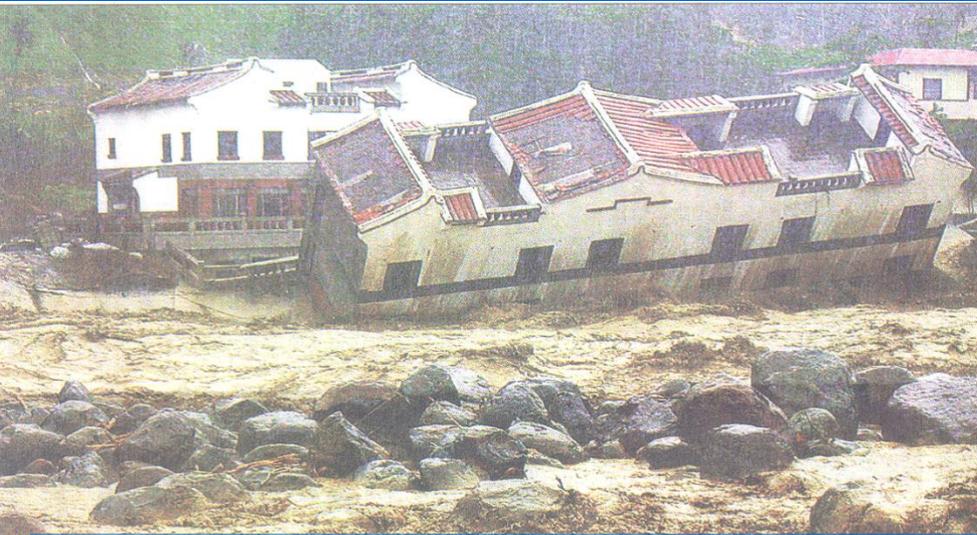
Economic Losses of Typhoon in Taiwan

- In average, there are 3.6 typhoons touched down in Taiwan every year
 - In 2001, 8 typhoons attacked Taiwan
 - In 2004, 6 typhoons swept Taiwan
 - In 2005, 3 category-4 typhoons hit Taiwan
 - In 2006, 7 typhoons swept
 - In 2007, 5 typhoons swept
 - In 2008, 6 typhoons attacked Taiwan

1980~2003 Typhoon Best Track



Typhoon	Death	Injure	Agri. Loss (\$US M) (A)	Constr. Loss (\$US M) (B)	Total (\$US M) (A+B)
Chebi	30	124	22.3	0.7	23.0
Trami	5	-	2.2	4.9	7.1
Toraji	214	188	235.7	170.6	406.4
Nari	104	265	126.5	56.7	183.1
Utor	1	6	2.9	7.6	10.5
Total	354	583	389.6	240.5	630.1



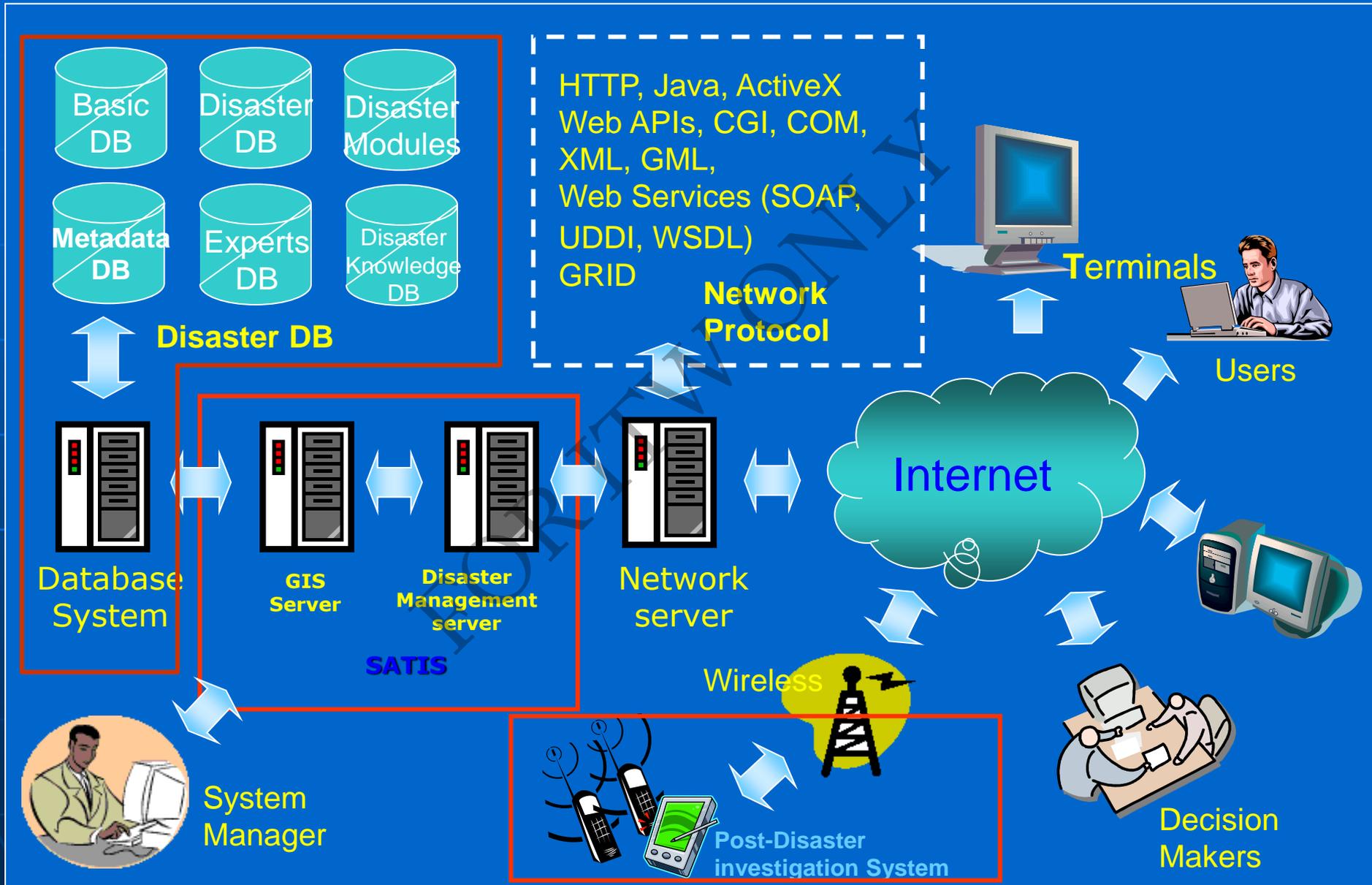
Debris flows and urban flooding have become the most severe hazards in Taiwan area during typhoon season.



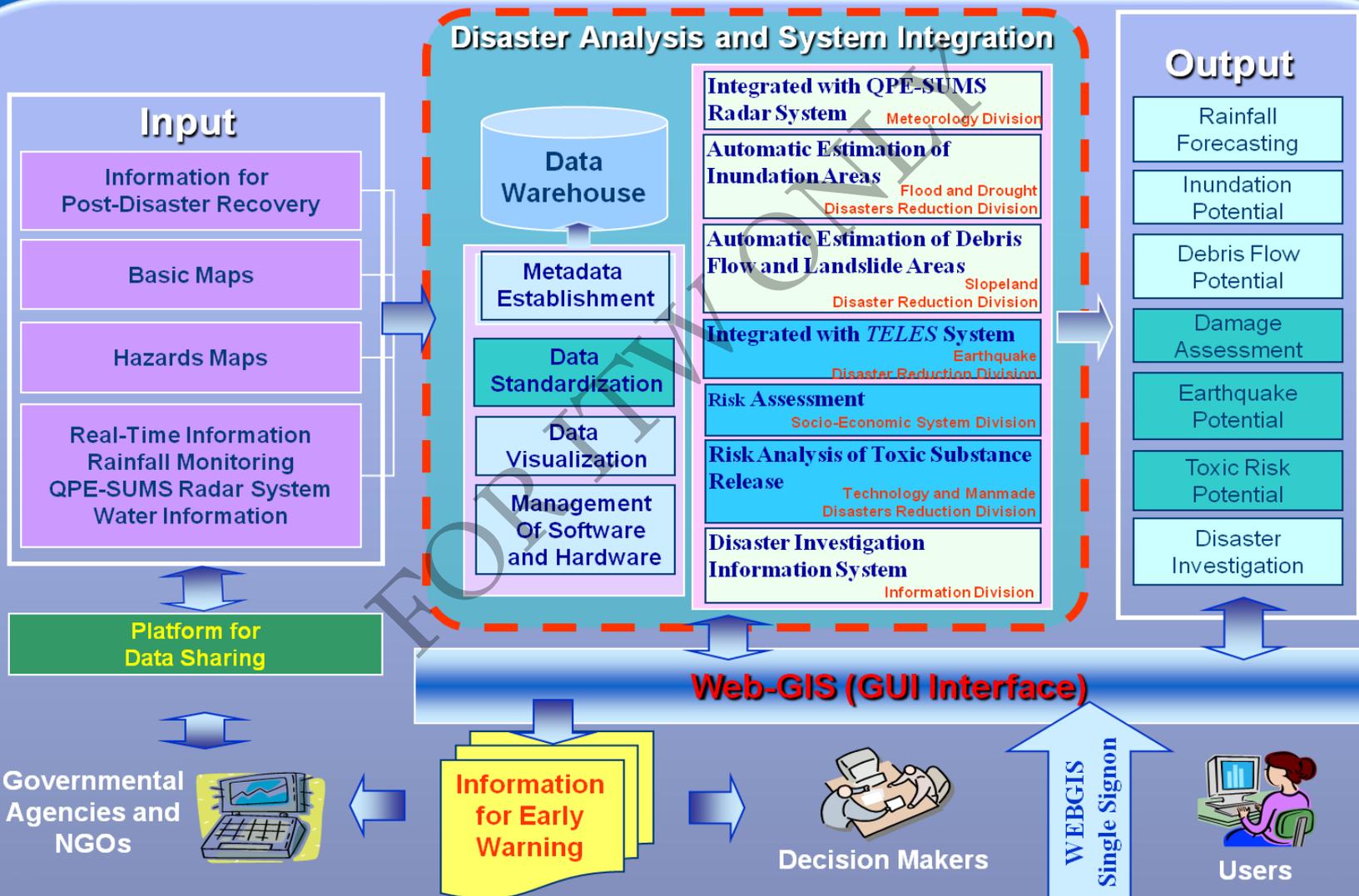
Safe Taiwan Information System(SATIS)

- **Safe Taiwan Information System(SATIS)** was developed by NCDR for natural hazards.
- The SATIS is designed to integrate the real-time monitoring data, the dynamic hazard models and Web-GIS technology to provide disaster management **decision support** tools for early warning.
- The input data of this system includes:
 - the basic maps
 - the real-time information of typhoon and rainfall issued by the Central Weather Bureau
 - the real-time water information from the Water Resources Agency
 - the hazard maps indicating areas of potential landslide, debris flow and flooding made by NCDR herself
- The results of analysis and **warning messages** are finally delivered to the Central Emergency Operations Center (CEOC) and help the commander to make the right decisions in disaster preparedness and response phases.

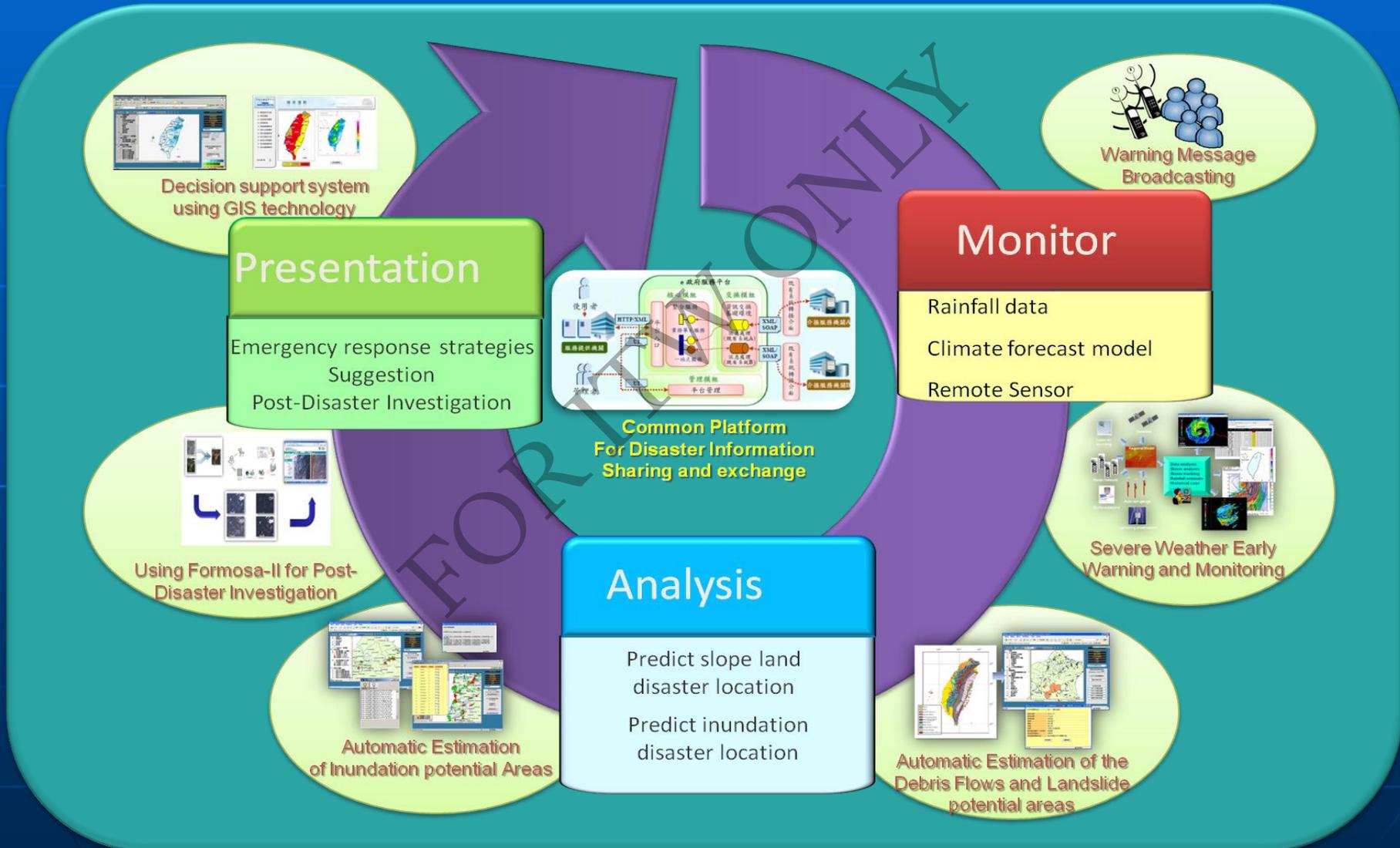
The Framework of SATIS



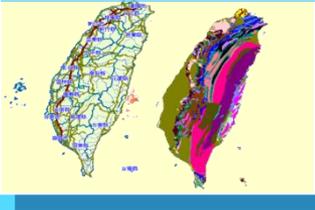
Information flow of SATIS



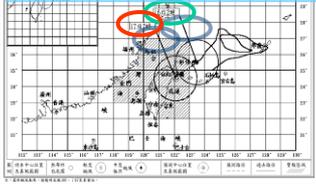
SATIS for Natural Hazards



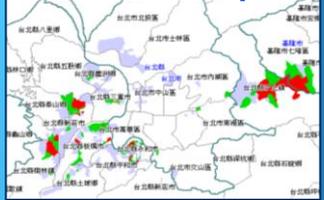
Basic Maps



Typhoon Path Prediction



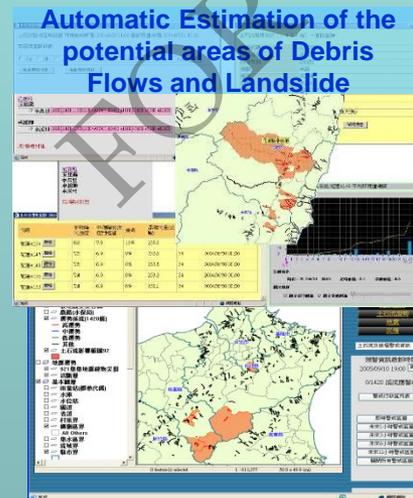
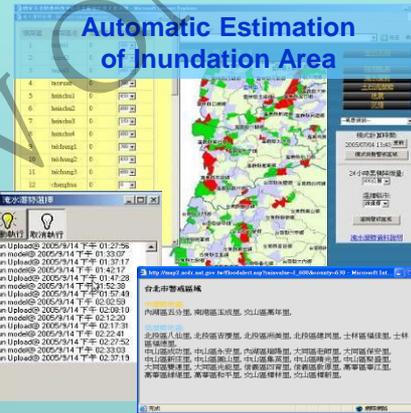
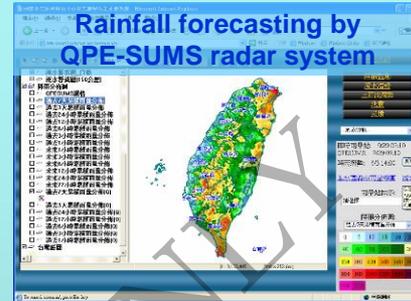
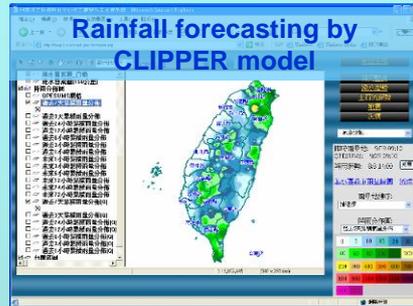
Inundation Potential Maps



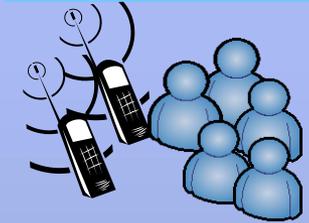
Debris Flow and landslide information



Safe Taiwan Information System



Warning Message Broadcasting



Analysis and Decision Making

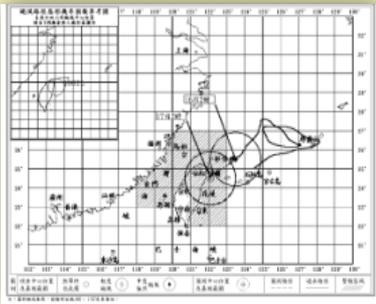


Central Warning Declaration



Monitor

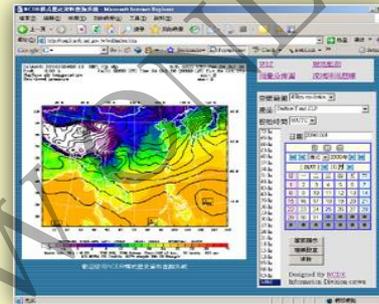
Monitor Real time data



Typhoon forecast data



Rain gauge data



Climate forecast model



River and reservoir status



Radar estimate rainfall

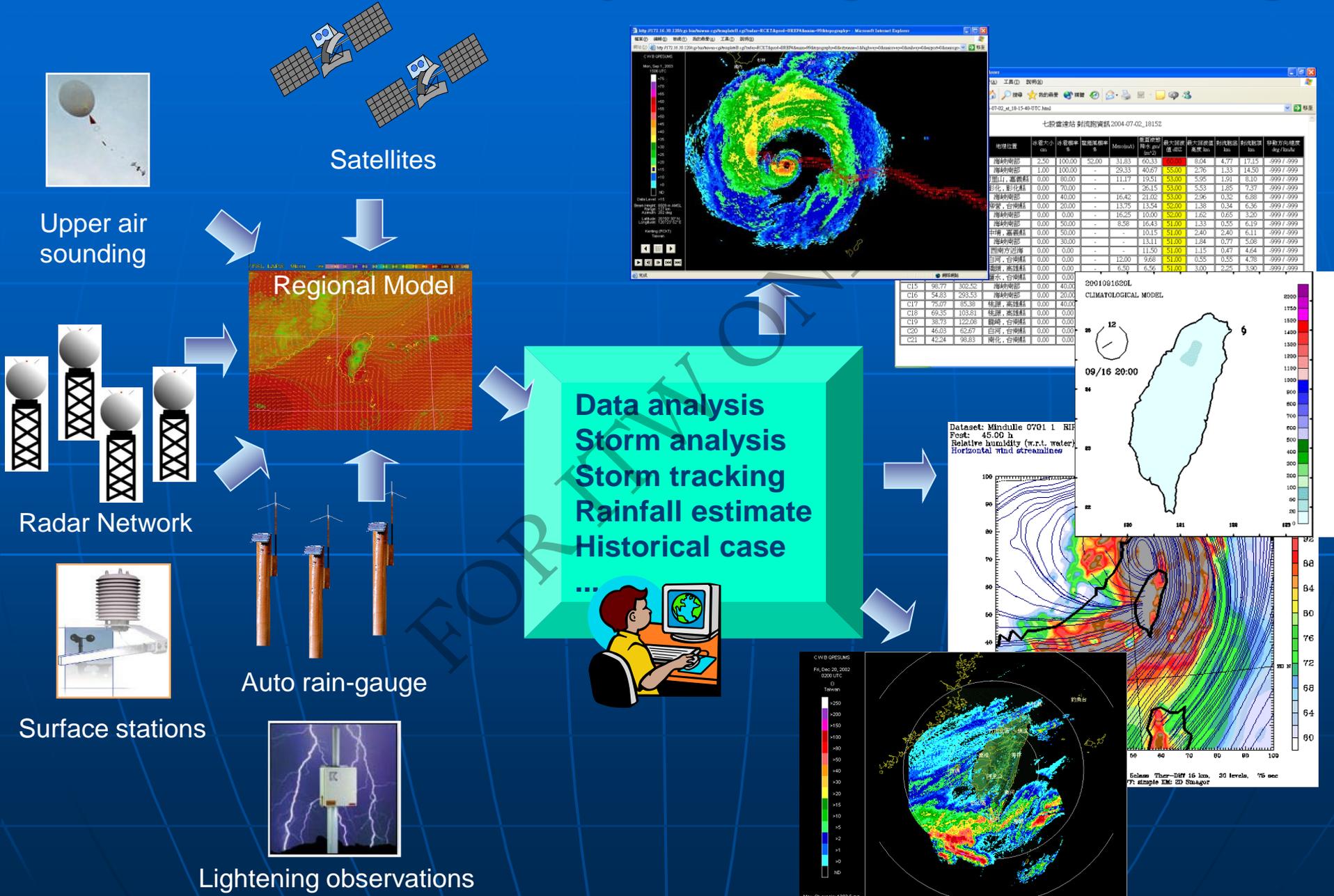
- collects the typhoon information
- estimate of its future track

Warn instantly



Send Warning message

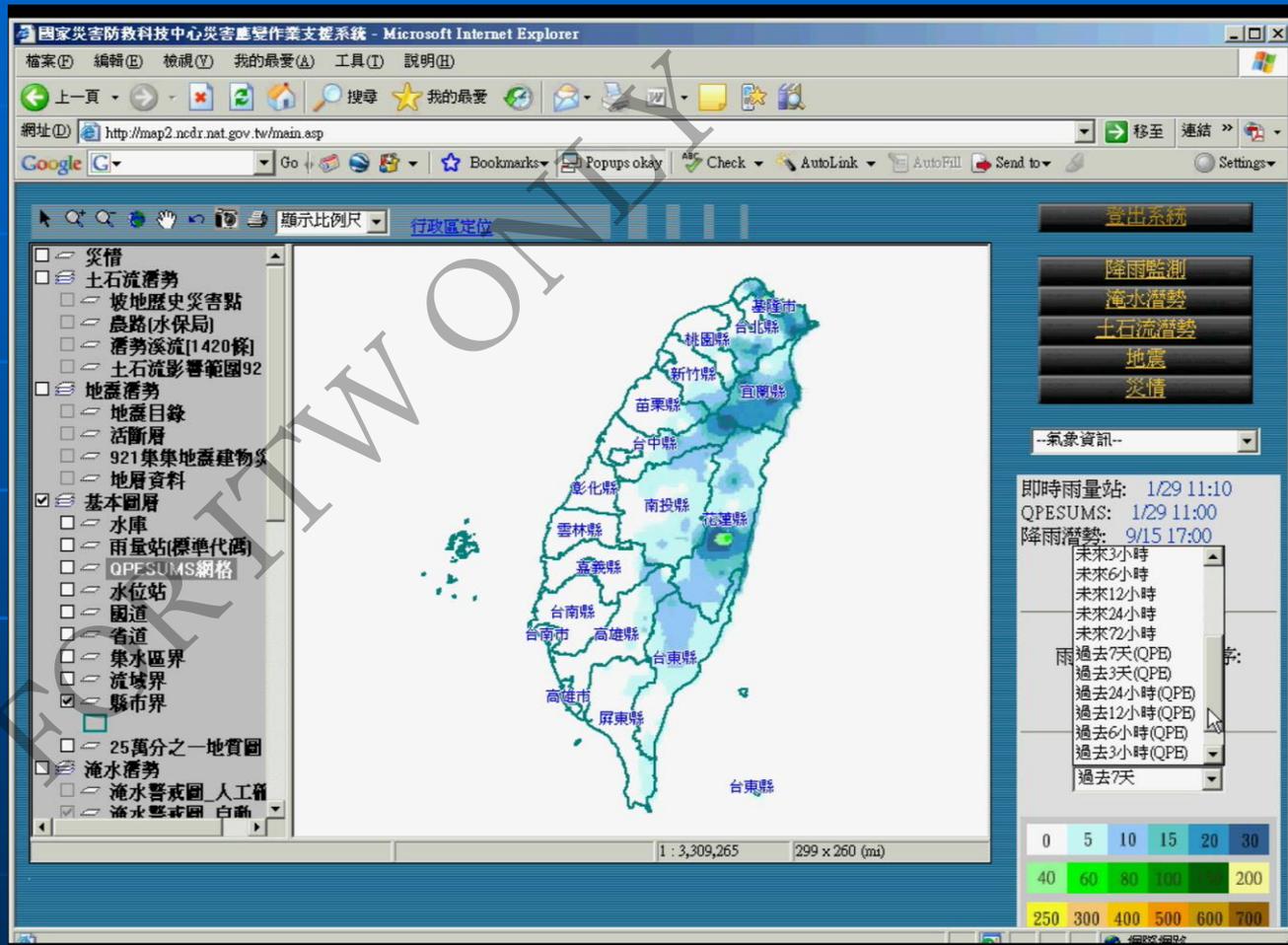
Severe Weather Early Warning and Monitoring



The User Interface for the Rainfall Distribution

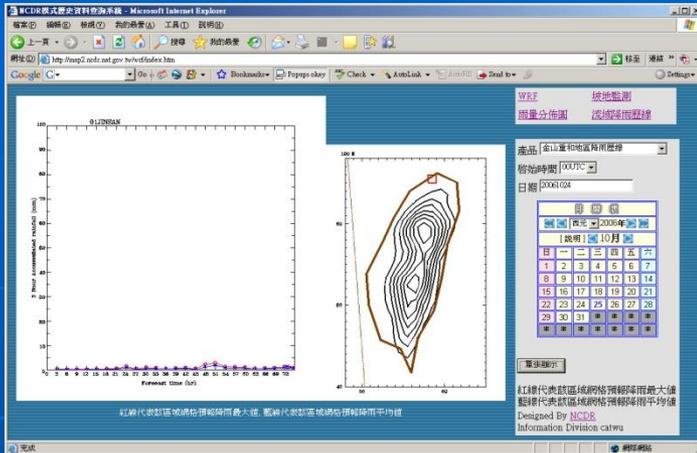
自2001/09/16 02:00起
累計未來24小時降雨量

站碼	站名	累積雨量	行政區
21D16	白石	535.54	新竹縣尖石鄉
C1U61	大礁溪	513.08	宜蘭縣宜蘭市
C1D40	鳥嘴山	502.77	新竹縣尖石鄉
21D15	玉峰	480.39	新竹縣尖石鄉
C0A89	雙溪	470.24	台北縣雙溪鄉
C1E48	鳳美	464.99	苗栗縣南庄鄉
C1E47	馬達拉	430.53	苗栗縣泰安鄉
C0A9C	天母	429.07	台北市士林區
C1D41	白蘭	411.83	新竹縣五峰鄉
01A43	福山	407.85	台北縣烏來鄉
C0A9G	南港	390.52	台北市南港區
C1D42	太閣南	385.8	新竹縣五峰鄉
C0A86	大坪	383.15	台北縣萬里鄉
C0D36	梅花	381	新竹縣尖石鄉
C0A9F	內湖	357.13	台北市內湖區
C1I14	卡奈托灣	356.43	南投縣信義鄉
C1F89	稍來	352.07	台中縣和平鄉
C0A9B	石碑	351.69	台北市北投區
21C08	高義	347.35	桃園縣復興鄉
21C14	霞雲	345.95	桃園縣復興鄉
21D17	鎮西堡	341.11	新竹縣尖石鄉
C1U70	土場	331.88	宜蘭縣三星鄉
21U11	池端	317.06	宜蘭縣大同鄉
C1U59	頭城	315.59	宜蘭縣頭城鎮

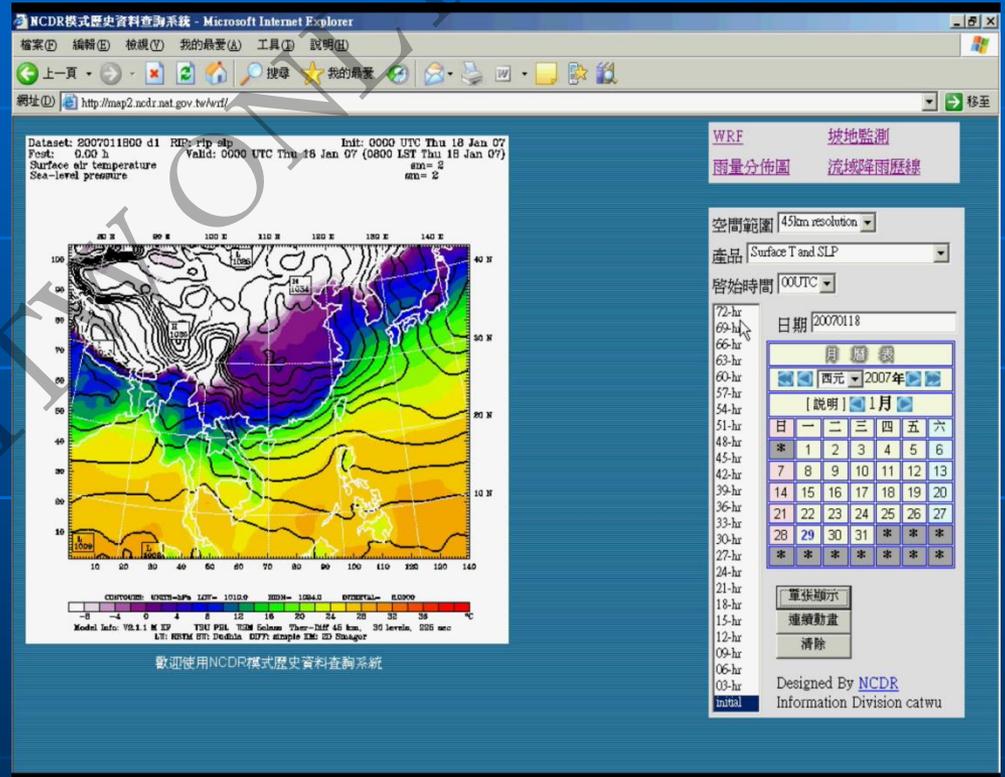


Rain gauge rainfall order The accumulated rainfall is calculated as the GIS layer

Climate forecast model



Forecast slope land area rainfall by WRF(Weather Research&Forecasting model)



Forecast Basin rainfall by WRF

Send warning message to cell phone



(May) 27 04:10

Taitung county DaRan town NanTian
accumulate 1 hour rainfall 43mm

Taitung county DaRan town Shouka
accumulate 1 hour rainfall 45mm



Analysis

Static basic data



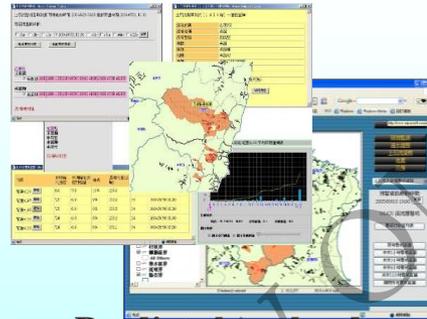
Basic map data



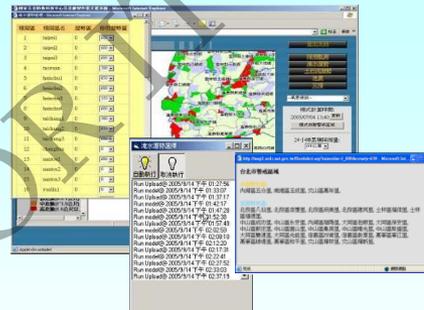
Potential inundation data



Potential debris flow data

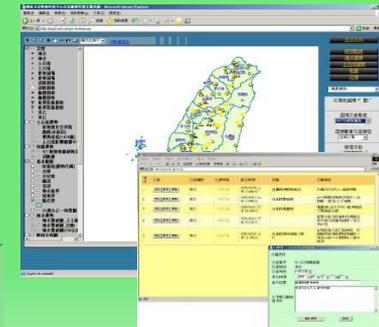


Predict slope land disaster location



Predict inundation disaster location

Real time hazard data

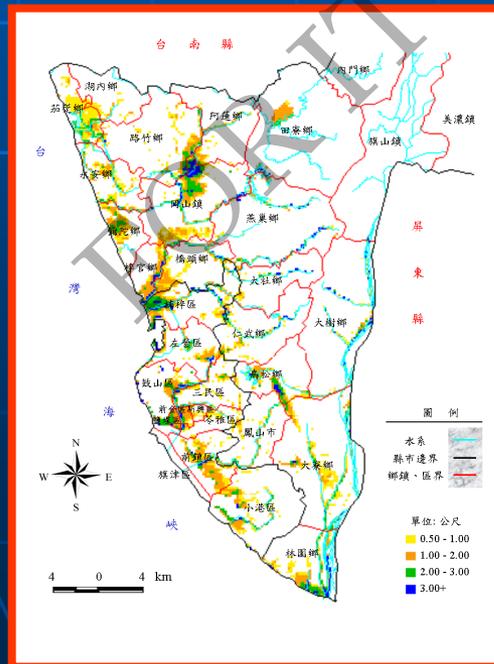
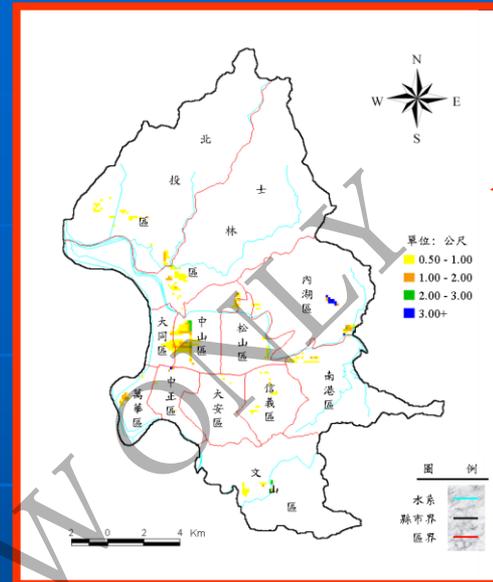


Reveal hazard location

The Inundation Potential Maps in Taiwan

The flood and drought mitigation research group had finished the island-wide inundation potential maps in 2001.

- For floodplain managements
- For flood mitigations
- Incorporation with social-economic information

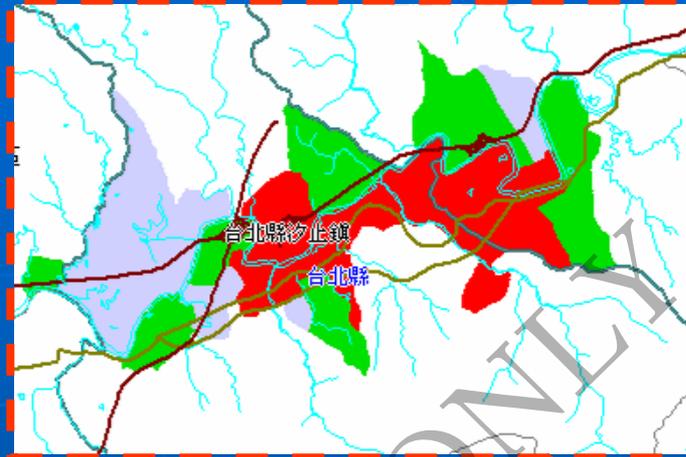


Depth : m

- 0.50 - 1.50
- 1.50 - 2.50
- 2.50 - 3.50
- 3.50+

20 0 20 40 Kilometers

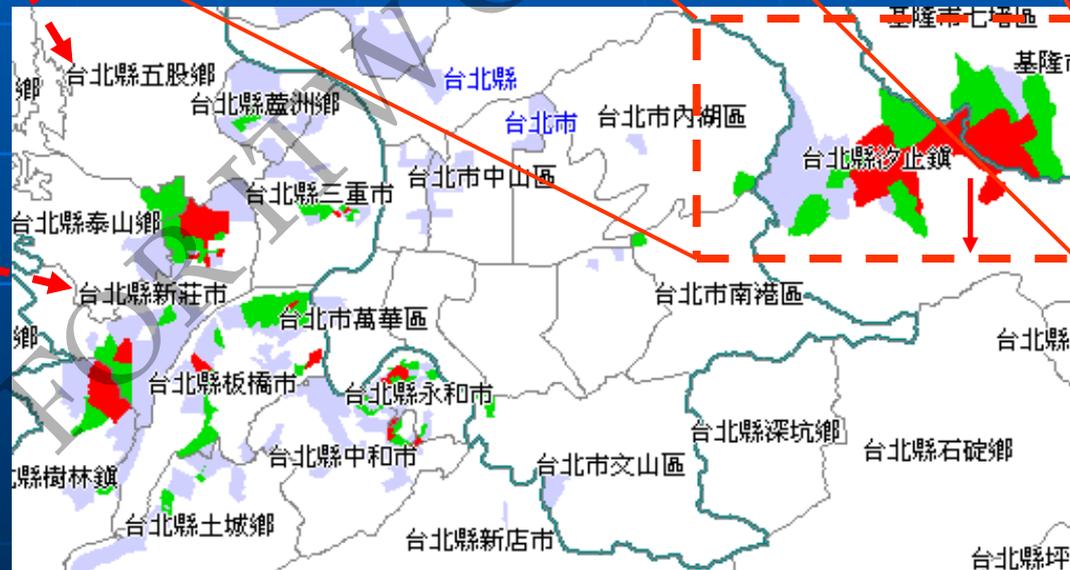
Estimation of Inundation and Warning Issue



-  River
-  County boundary
-  Township boundary
-  Highway
-  Major road

Real-time Rainfall Records

+



Flood Potential

-  Highest (avg. depth > 1.5 m)
-  Higher (avg. depth 1.0m – 1.5m)
-  High (avg. depth 0.5m – 1.0 m)

Rainfall Forecasting

Automatically selects the inundation potential layers every 10 minutes

Potential Streams of Debris Flow



國家災害防救科技中心災害應變作業支援系統 - Microsoft Internet Explorer

網址: http://map2.ncdr.nat.gov.tw/main.asp

Legend:

- 災情
- 土石流潛勢
- 坡地歷史災害點
- 農路(水保局)
- 潛勢溪流(1420條)
- 高潛勢
- 中潛勢
- 低潛勢
- 其他
- 土石流影響範圍92
- 地震潛勢
- 921集集地震建物災類
- 活斷層
- 基本圖層
- 雨量站(標準代碼)
- 水庫
- 水位站
- 隧道
- 省道
- 村里界
- 鄉鎮區界
- All Others
- 集水區界
- 流域界
- 縣市界

0 feature(s) selected 1:60,357 508 x 499 (m)

Right Panel:

- 降雨監測
- 淹水潛勢
- 土石流潛勢
- 地震
- 災情
- 土石流及崩塌警戒資訊
- 預警資訊最新時間: 2005/09/10 19:00 [更新]
- 0/1420 溪流應警戒
- 警戒行政區列表
- 即時警戒區圖
- 未來1小時警戒區圖
- 未來3小時警戒區圖
- 未來6小時警戒區圖
- 未來12小時警戒區圖
- 關閉所有警戒區圖

http://map2.ncdr.nat.gov.tw - 土石流潛勢溪流 (1420條) 一屬性查詢 - Microsoft L...

土石流潛勢溪流 (1420條) 一屬性查詢

溪流代碼	台北A137
溪流名稱	扎孔溪
溪流型態	溪流型
地標	福山國小
鄉鎮	烏來鄉
村里	福山村
地質	古第三紀亞變質
優先整治順序(水保局)	高潛勢
保全對象聯絡人	高美林
保全對象聯絡住址	烏來鄉福山村大羅蘭25號

降雨歷程 關閉視窗

Automatically identifies the potential areas of debris flow and landslide every one

Issues the Warning and Security for the Counties of the Slope Land Disaster Vulnerability

Meteorological data

Rainfall distribution

Forecast rainfall distribution

Threshold

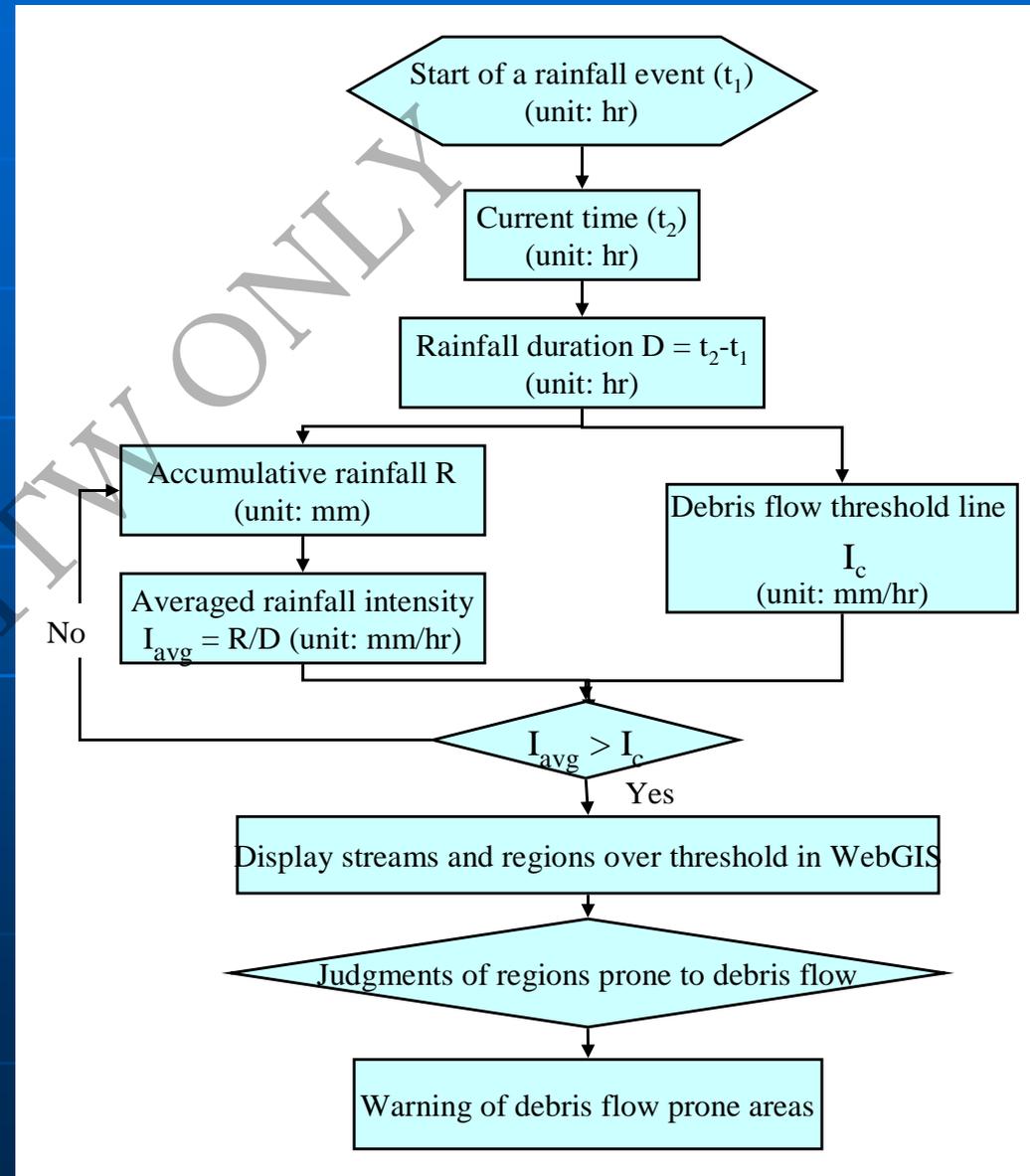
Slope land disaster threshold

Forecast disaster locations

Disaster location of the same typhoon tracking before vs. rainfall distribution

Slope land disaster Vulnerability

Forecast traffic interruption location



The User Interface for the Forecasting of the Slopeland Disaster Locations

土石流警戒區域計算 雨場起始時間: 2004/6/29 01:00 最新雨量時間: 2004/07/01 10:00

請選擇查詢條件:

-3hr
 -2hr
 -1hr
 2004/07/01 10:00
 +1hr
 +3hr
 +6hr
 +12hr

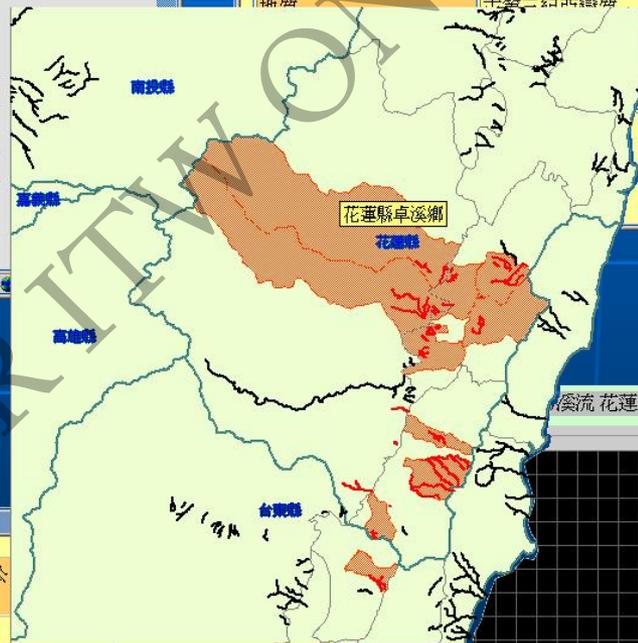
花蓮縣
 玉里鎮
 泰昌里 -3HR -2HR -1HR 2004/07/01 10:00 +1HR +3HR +6HR +12HR

卓溪鄉
 卓溪村 -3HR -2HR -1HR 2004/07/01 10:00 +1HR +3HR +6HR +12HR

共2警戒村里

土石流潛勢溪流 (1420 條) - 屬性查詢

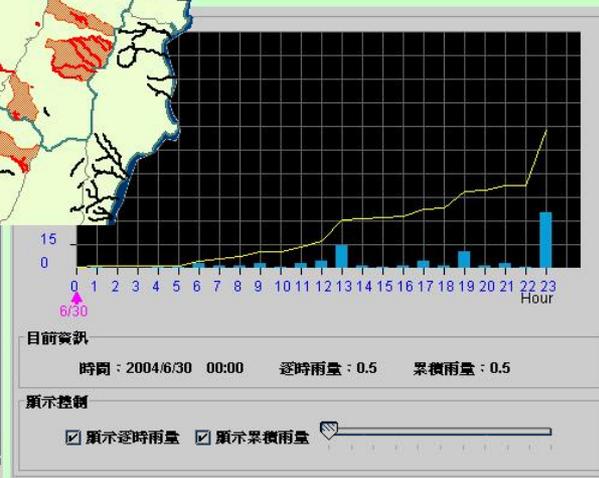
溪流代碼	花蓮050
溪流名稱	卓溪
溪流型態	溪流型
地標	卓溪
鄉鎮	卓溪鄉
村里	卓溪村
鄉別	花蓮縣卓溪鄉



花蓮縣
 玉里鎮
 泰昌里
 卓溪鄉
 卓溪村
 共2警戒村里

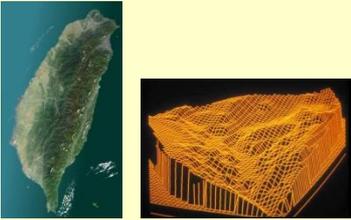
代碼	平均降雨強度	平均降雨強度門檻值	差異	累積雨量(公厘)
花蓮A154 <input type="button" value="歷史"/>	8.8	7.8	13%	256.0
花蓮A147 <input type="button" value="歷史"/>	7.5	6.9	9%	253.6
花蓮A148 <input type="button" value="歷史"/>	7.5	6.9	8%	253.5
花蓮A155 <input type="button" value="歷史"/>	7.4	6.9	8%	253.3
花蓮A153 <input type="button" value="歷史"/>	7.4	6.9	8%	252.1

溪流 花蓮A148 平均降雨量線圖



Presentation

Image and
3D land form data



Information
dashboard



3D demonstration

Decision making

Central
Emergency
Operations
Center



Response and
arrange resource

Presentation by Web GIS

國家災害防救科技中心災害應變作業支援系統 - Microsoft Internet Explorer

檔案(F) 編輯(E) 檢視(V) 我的最愛(A) 工具(T) 說明(H)

http://map2.ncdr.nat.gov.tw/main.asp

顯示比例尺 行政區定位

- 地層資料
- 基本圖層
 - 水庫
 - 雨量站(標準代碼)
 - QPESUMS網格
 - 水位站
 - 國道
 - 省道
 - 集水區界
 - 流域界
 - 縣市界
- 25萬分之一地質圖
- 淹水潛勢
 - 淹水警戒圖_人工修
 - 淹水警戒圖_自動
 - 淹水警戒圖[600公尺]
- 降雨分佈圖
 - 過去7天雨量
 - 過去3天雨量
 - 過去24小時雨量
 - 過去12小時雨量
 - 過去6小時雨量
 - 過去3小時雨量
 - 過去1小時雨量

1 : 3,309,265 299 x 260 (mi)

登出系統

降雨監測

淹水潛勢

土石流潛勢

地震

災情

--氣象資訊--

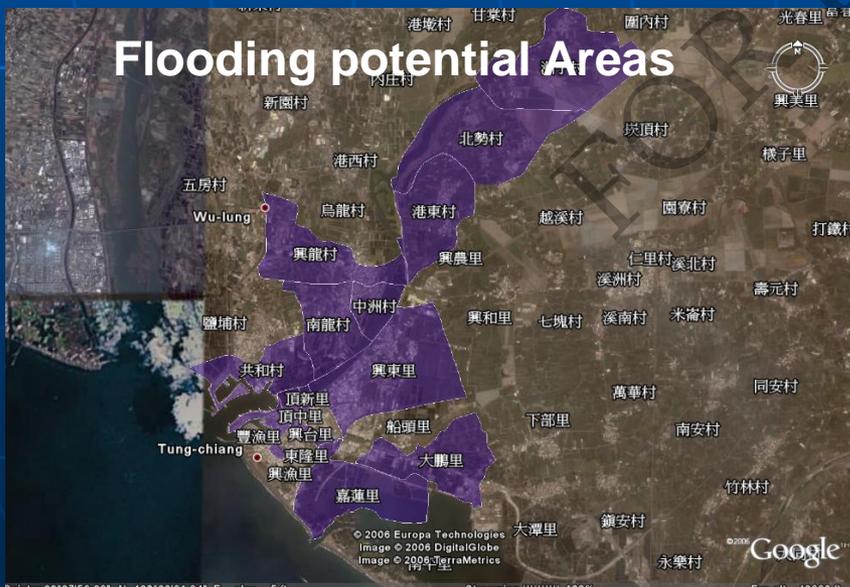
即時雨量站: 1/29 11:10
QPESUMS: 1/29 11:10
降雨潛勢: 9/15 17:00
更新

雨量站累積降雨排序:
請選擇

累積降雨分佈圖:
過去7天

0	5	10	15	20	30
40	60	80	100	150	200
250	300	400	500	600	700

Visualization of the disaster Information Using Google Earth / Map



災害應變儀表板 - Microsoft Internet Explorer

網址 http://www.ndrc.nat.gov.tw/chi/

20060809 桑美颱風災情

- 15 14:30 道路損毀於高雄縣六龜鄉
- 15 14:00 其它於高雄縣岡山鎮
- 15 12:00 坡地崩塌於嘉義縣梅山鄉
- 15 11:00 坡地崩塌於高雄縣杉林鄉
- 15 10:30 道路損毀於彰化縣芬園鄉
- 15 10:00 道路損毀於高雄縣桃源鄉
- 15 09:00 道路損毀於台中縣太平市
- 15 09:00 人員傷亡於嘉義縣

雨量站警戒

災情警戒

土石流警戒

- 屏東004-屏東縣三地門鄉口社村
- 屏東005-屏東縣霧台鄉霧台村
- 屏東006-屏東縣三地門鄉達來村
- 屏東007-屏東縣瑪家鄉北葉村
- 屏東A030-屏東縣高樹鄉新豐村
- 屏東A031-屏東縣三地門鄉青山村
- 屏東A032-屏東縣三地門鄉安坡村
- 屏東A033-屏東縣霧台鄉阿禮村

降雨警戒

- 06/09 14:00 旗德 3hr148mm
- 06/09 14:00 內埔 3hr117mm
- 06/09 14:00 大樹 3hr132mm
- 06/09 14:00 內埔 3hr117mm
- 06/09 14:00 旗德 3hr148mm
- 06/09 14:00 旗德 3hr103mm

POWERED BY UCMap

This screenshot shows a web browser window displaying disaster information from the National Disaster Relief Center (NDRC) website. The page is titled '20060809 桑美颱風災情' (20060809 San Mei Typhoon Disaster Information). It lists various disaster events, including road damage, landslides, and personnel casualties. The page also features a map of Taiwan with a grid of counties, and a detailed satellite view of a specific area. The browser interface shows the URL 'http://www.ndrc.nat.gov.tw/chi/' and the page title '災害應變儀表板 - Microsoft Internet Explorer'. The page is powered by UCMap.

Analysis result demonstrated by Google Map

Early Warning INFO. for Decision Maker

Early Warning System For Typhoon hazard

Typhoon Forecasting

Route

Distribution of Rainfall

Rainfall Period

Inundation

Potential areas

Landslide

Potential areas

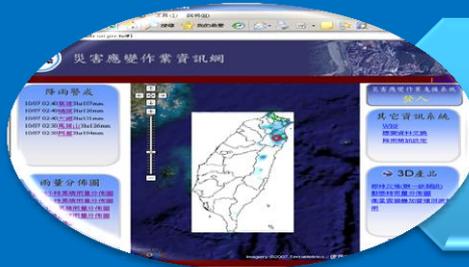
Suggestion

- 未來應加強淹水警戒區域包括**台北縣、宜蘭縣及基隆市**等沿海及低窪地區。
- 石門水庫、翡翠水庫及鯉魚潭水庫洩洪中，沿岸低窪地區民眾請加強防範淹水。
- 受颱風降雨影響，石門水庫水質濁度可能造成影響，應持續加以監測，並建議此區域居民儲水備用。
- 建請相關單位掌握抽水機、發電機、吊運車輛、操作人員、消波塊、沙包、機具設備等救災搶修資源及備置。
- 捷運及相關工程施工地區應加強整備，防範淹水情形。



National Science and Technology Center for Disaster Reduction

How SATIS operate for Typhoon Hazard in NCDR?



Response Operation Sub-System for Typhoon Hazard

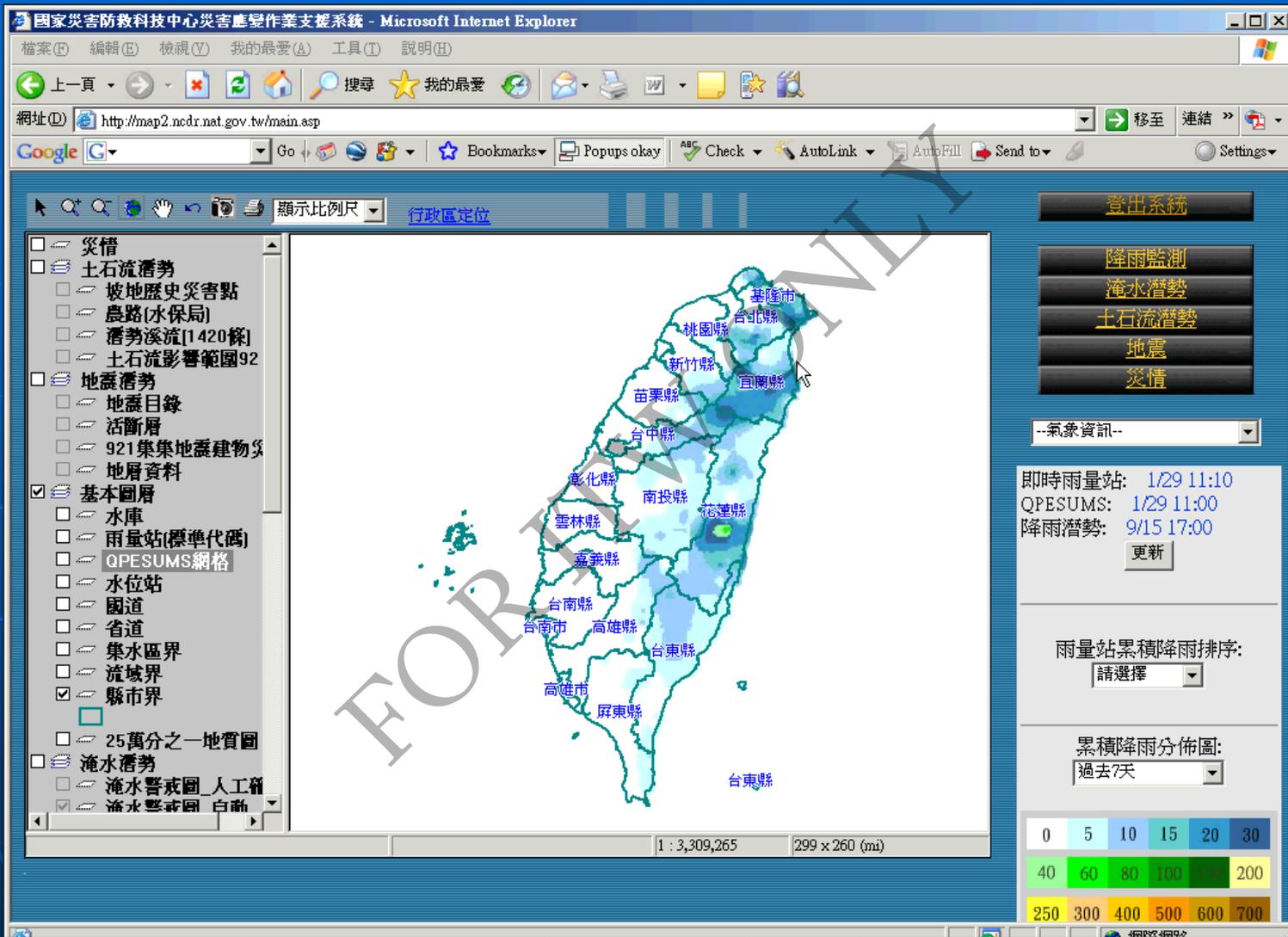


Decision Support Sub-System for Typhoon Hazard

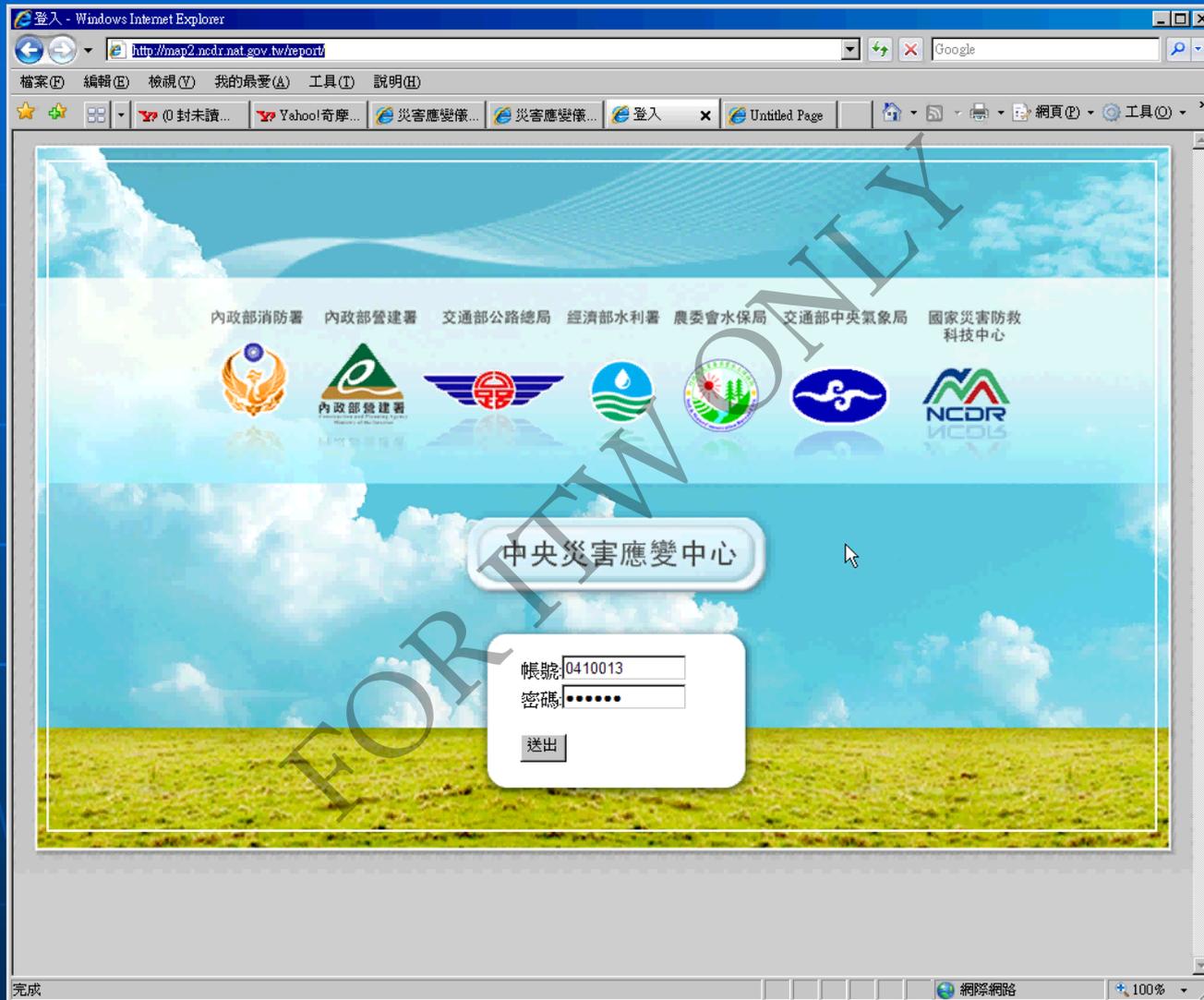


Remote Sensing Sub-System for Post-Disaster Investigation

Response Operation Sub-System for Typhoon Hazard



Decision Support Sub-System for Typhoon Hazard



Remote Sensing Sub-System for Post-Disaster Investigation

太空中心福衛二號影像查詢系統 - Windows Internet Explorer

http://61.56.4.46/kmg/

國家災害防救科技中心
National Science and Technology Center
for Disaster Reduction
國家太空中心福衛二號災後影像查詢系統

NSPO
NCDR

災害區域查詢

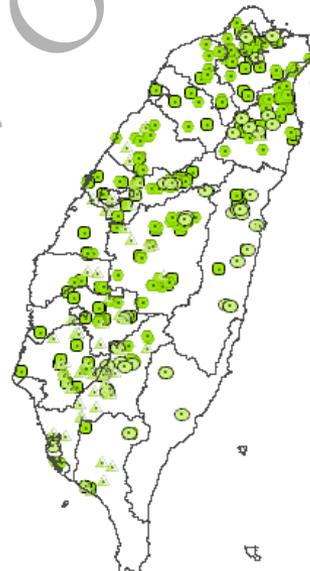
卡玫基颱風
鳳凰颱風
辛樂克颱風
薔密颱風

查詢結果

影像內容

- kmg
 - 基本圖資
 - City
 - town
 - Village
 - 受災區域
 - 卡玫基颱風
 - 鳳凰颱風
 - 辛樂克
 - 薔密
 - 災害初步判視
 - 0721_landslide
 - 0721_river
 - 災後衛星影像
 - 970721

災前影像



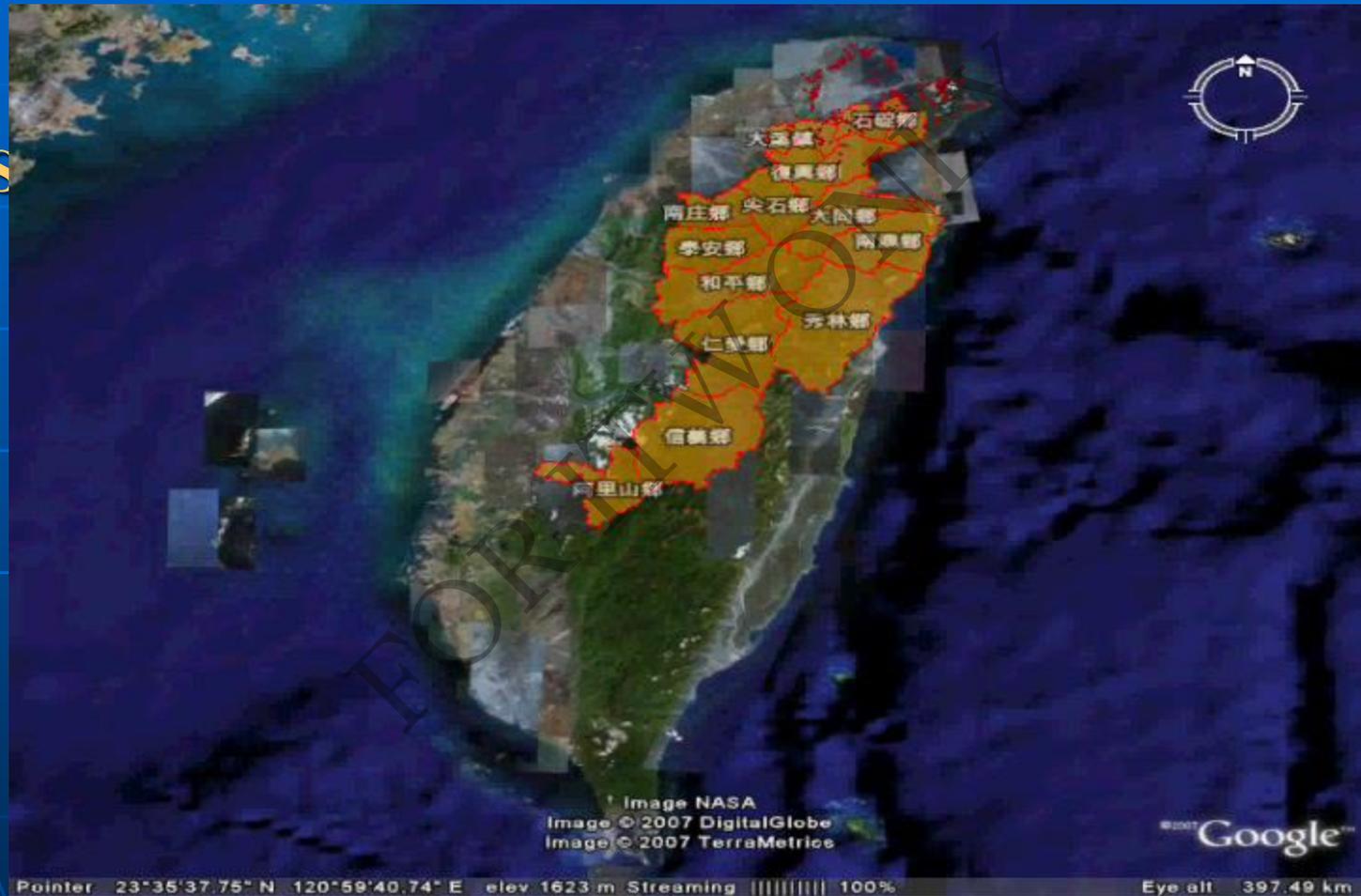
2010.0 20 Kilometers

98368.846, 2769653.903

網際網路 100%

FOR ITW ONLY

Display of Disaster Information in 3D Google Earth



Display of Disaster Information in 3D Google Earth



Slopeland Information

Shelter Information

第二分站

縣市 = 台北縣
鄉鎮 = 坪林鄉
站別 = 第二分站
設置地點 = 坪林國小 (坪林村坪林街一四號)
負責人 = 校長
收容人數 = 二百人
聯絡電話 = 26656213
備註 =

Directions: [To here](#) - [From here](#)

台北A113

坪林村

第一分站

第三分站

總站

第三分站

Image © 2007 DigitalGlobe

© 2007 Google

Pointer 24°55'52.31" N 121°42'39.83" E elev 278 m

Streaming 100%

Eye alt

Display of Flood Simulation in 3D Google Earth



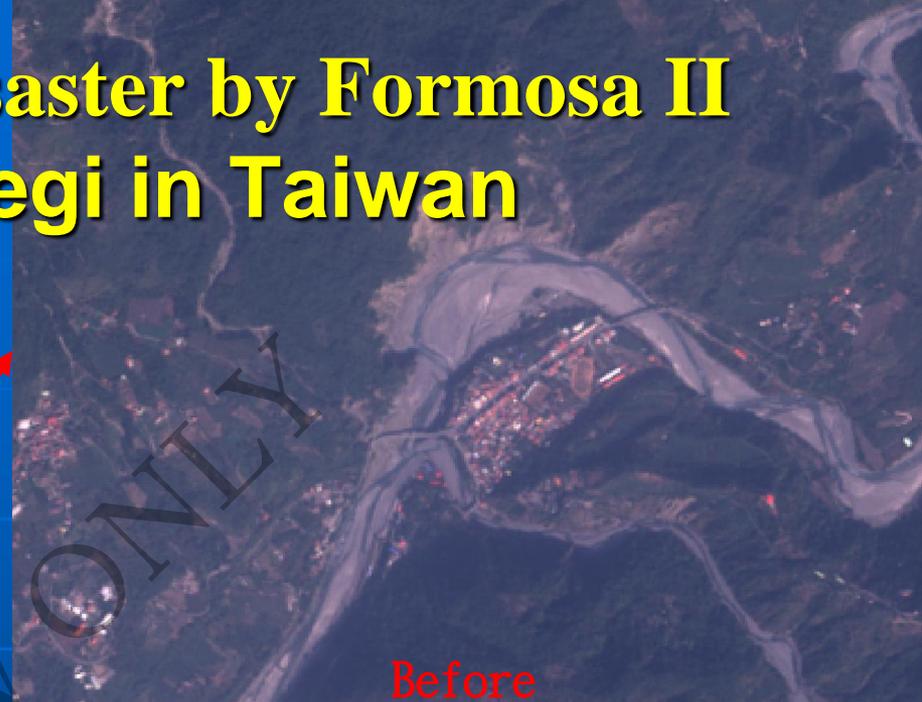
Interpretation of Disaster by Formosa II -Flooding in Myanmar 5/7/2008



Interpretation of Disaster by Formosa II -Typhoon Kalmaegi in Taiwan



高雄縣六龜鄉



Before



After

Interpretation of Disaster by Aerial Images

Typhoon Sinlaku in Taiwan



Landslide areas



Summaries

- Safe Taiwan Information System(SATIS) was developed for preparedness and response of Natural hazards.
- This system is base on the Web-GIS framework that the disaster information can be distributed via internet technology.
- When typhoon is coming, the SATIS is used to integrate real-time monitoring information, hazard models and graphical user interfaces to analyze and manage the disaster information such as the current position and possible path of typhoon, the spatial distribution of rainfalls, and potential areas of flooding, landslides and debris flows.
- The results of hazard analysis and warning messages are finally delivered to the Central Emergency Operations Center (CEOC) and help the commander to make the right decisions in disaster preparedness and response phases.
- The active assessment and evacuation for typhoon events using the DSSEW has proven effective for the reduction of property damages and life losses.

Future Works

- Taking the advantages of other GIS programs in Taiwan.
- Establishing data exchange standard and common platform for information sharing.
- Participating International Information Cooperation Projects.
- Integrating with the infrastructure of GEO GRID for more applications.

**Thank you
for your attention!!!**

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