

Development of Safe Taiwan Inf. System(SATIS)

A Decision Support System for Natural hazard in Taiwan



Prof. Feng-Tyan Lin

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

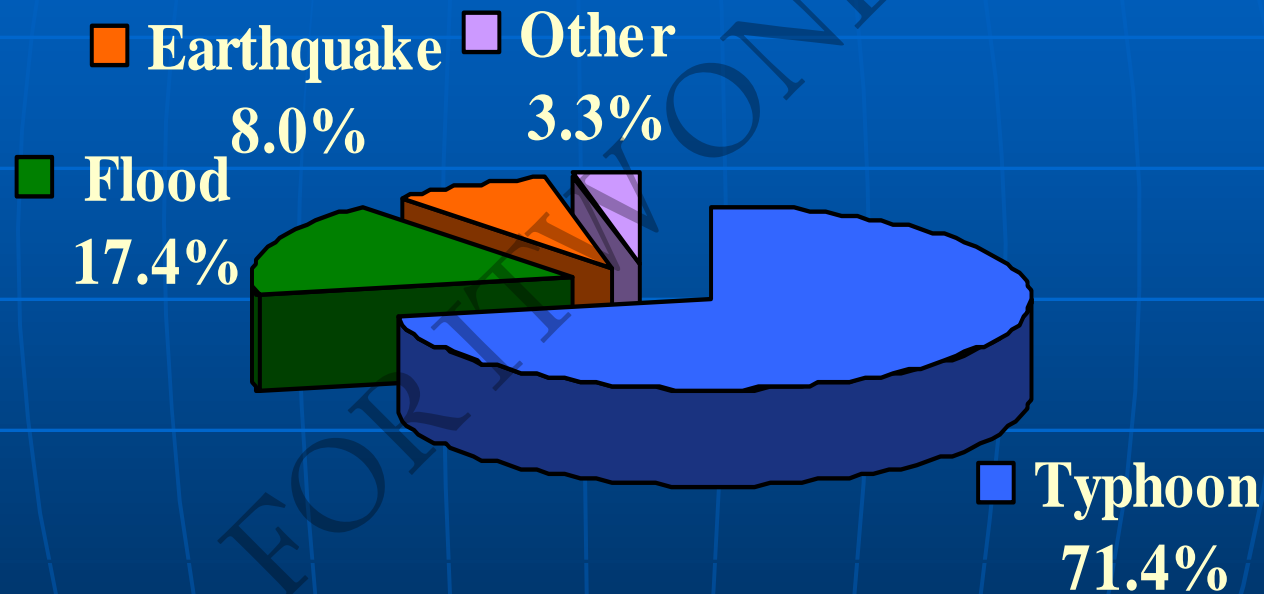
Surroundings

- 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

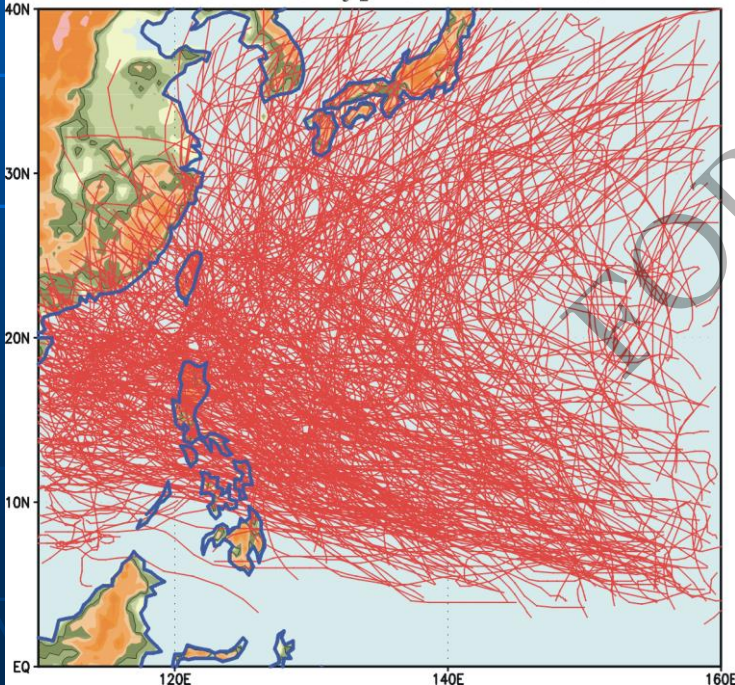


72% natural hazard damage is caused by typhoon in Taiwan area

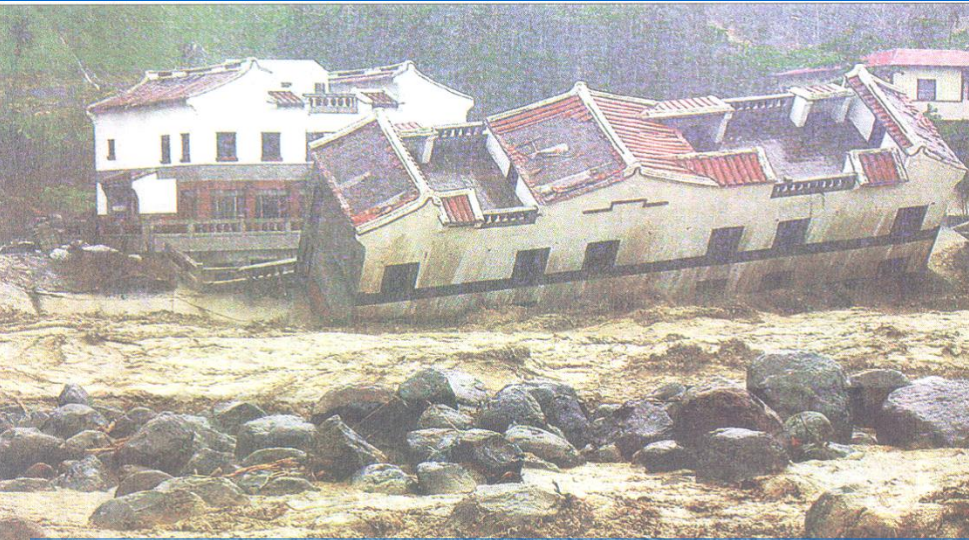
Economic Losses of Typhoon in Taiwan

- 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

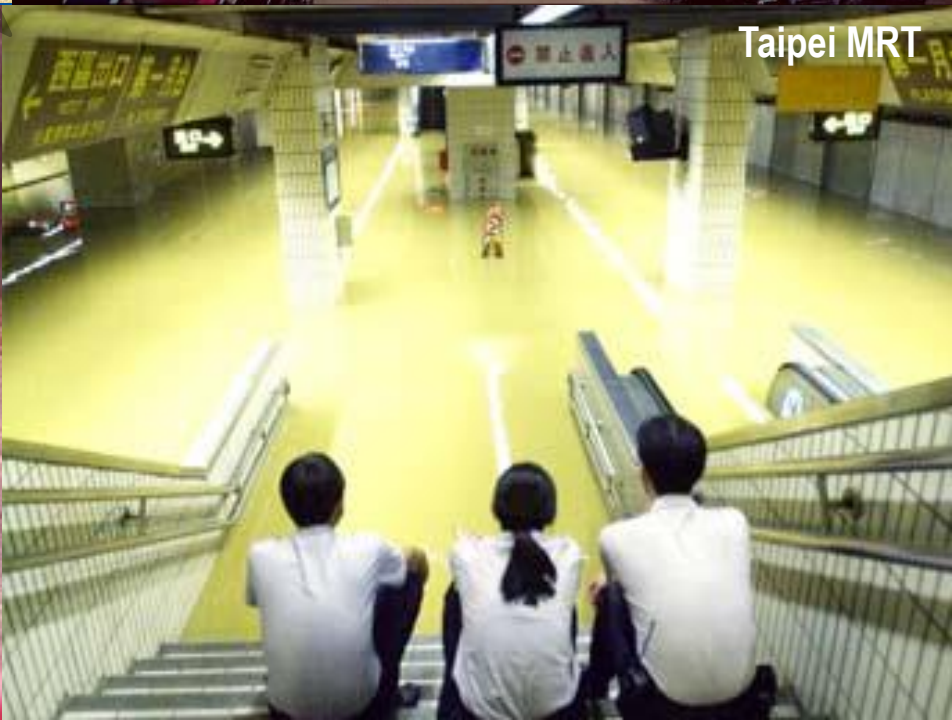
1980~2003 Typhoon Best Track



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.

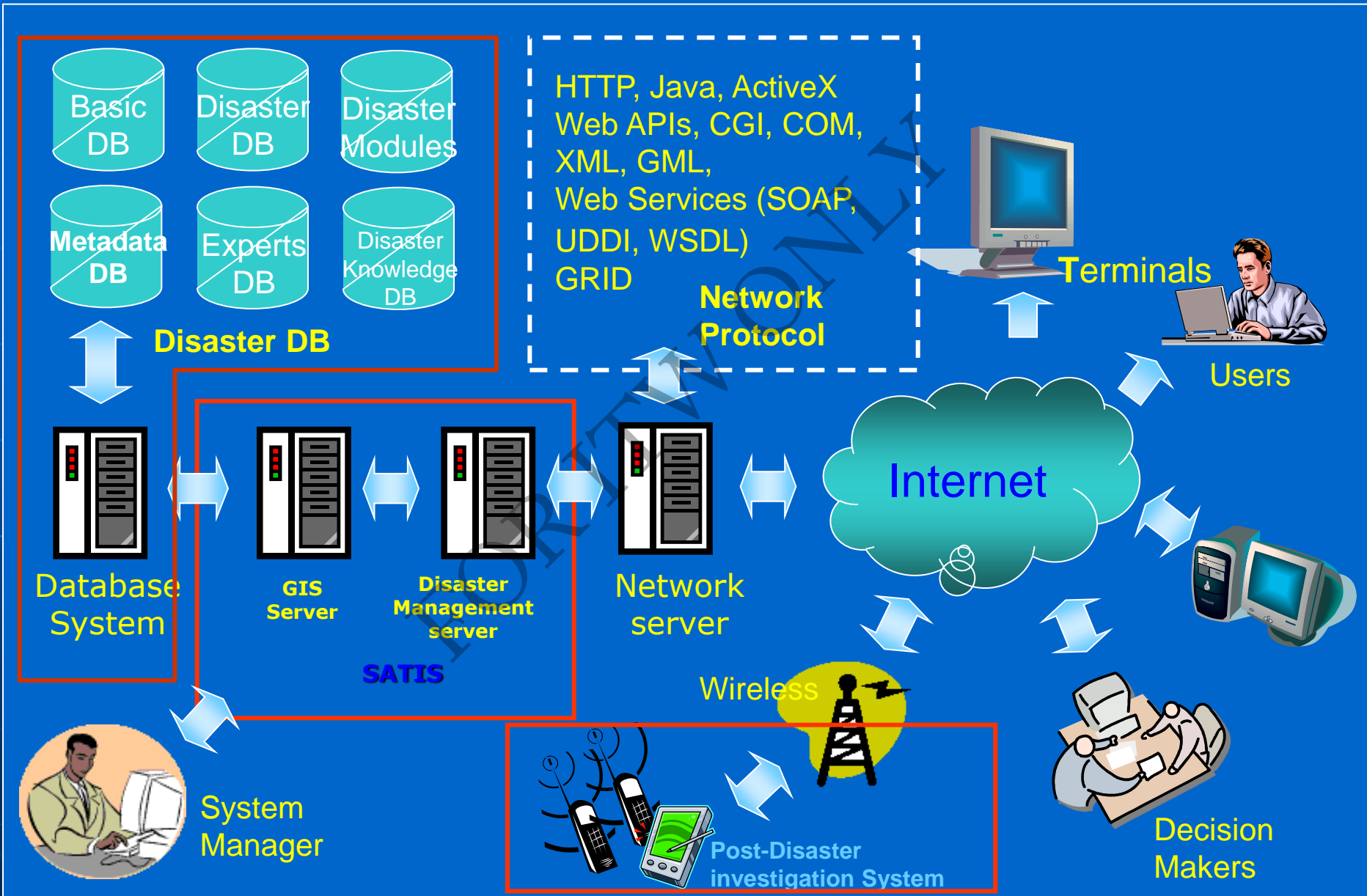


Taipei MRT

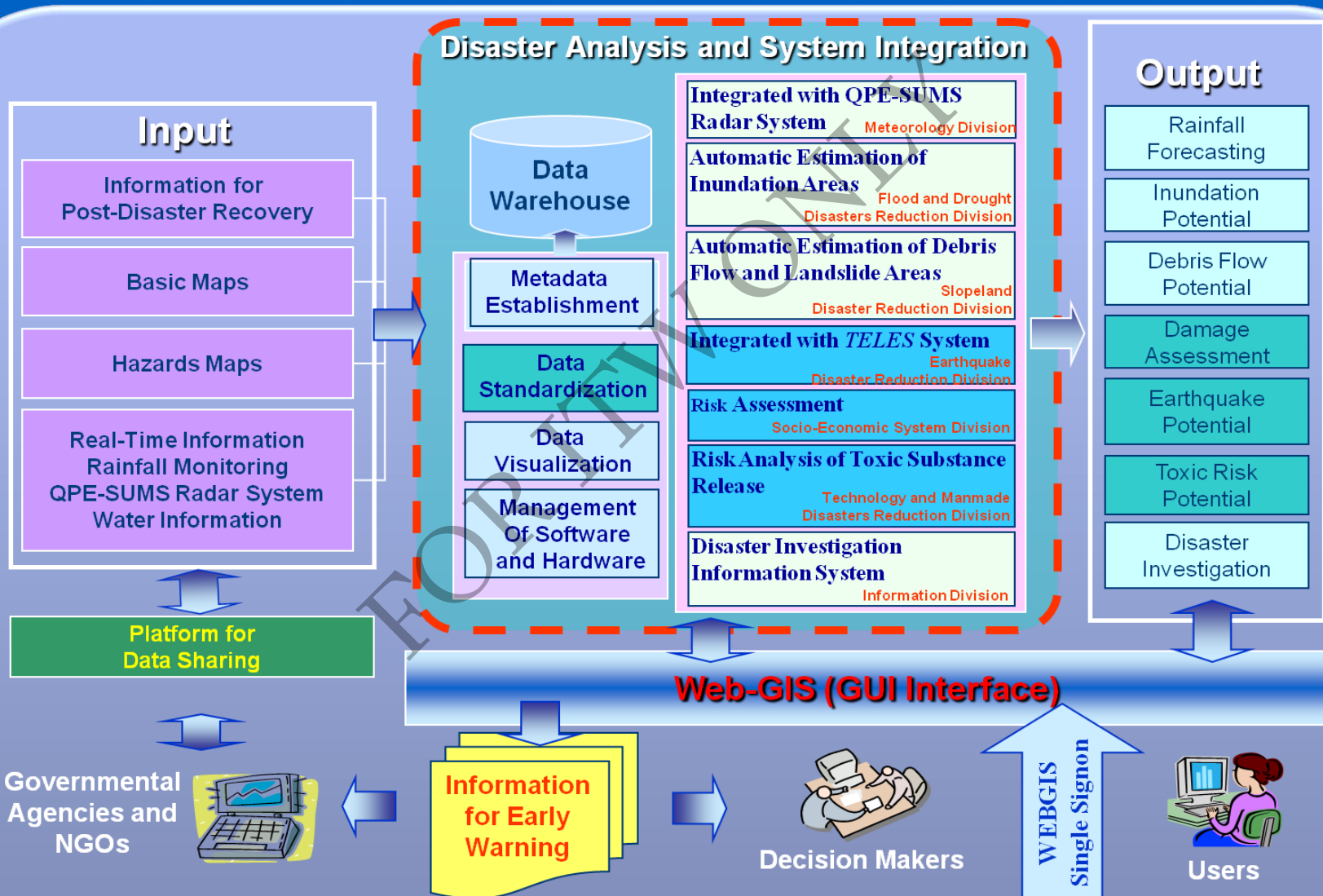
Safe Taiwan Information System(SATIS)

- 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.

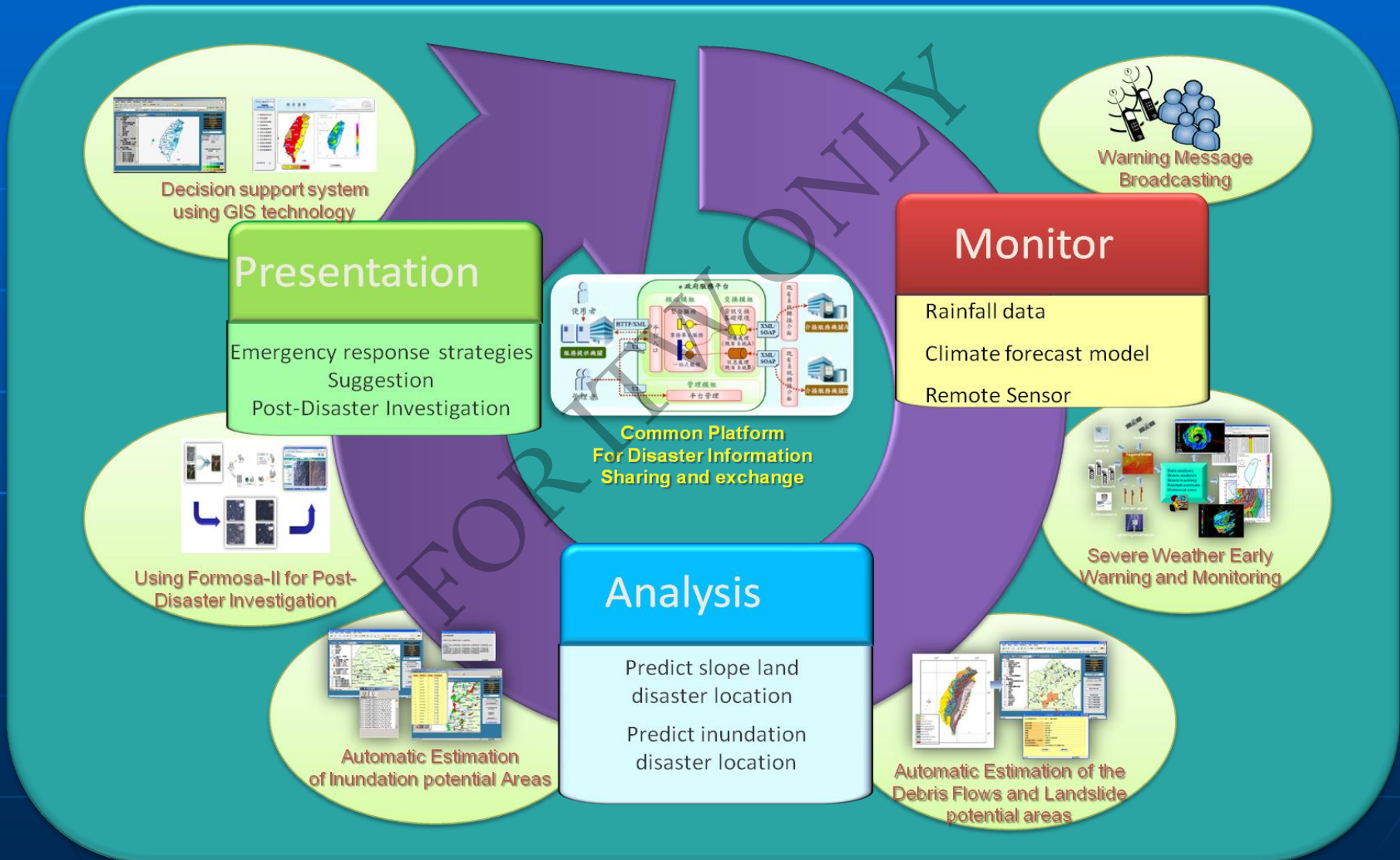
The Framework of SATIS



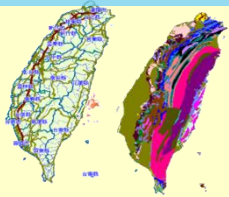
Information flow of SATIS



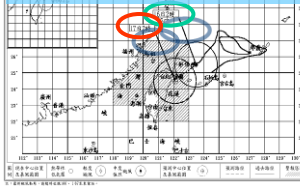
SATIS for Natural Hazards



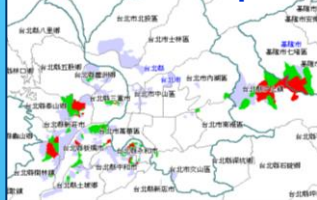
Basic Maps



Typhoon Path Prediction



Inundation Potential Maps

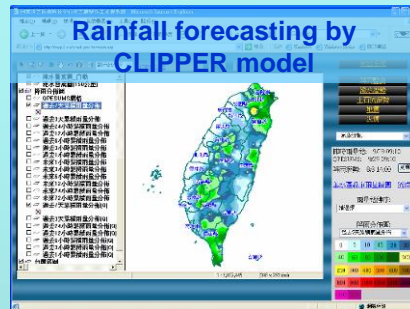


Debris Flow and landslide information

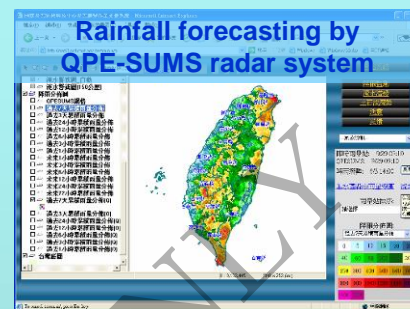


Safe Taiwan Information System

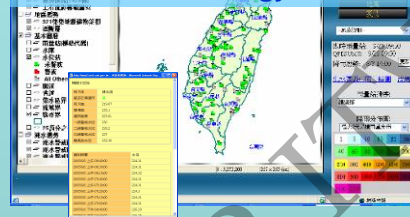
Rainfall forecasting by CLIPPER model



Rainfall forecasting by QPE-SUMS radar system



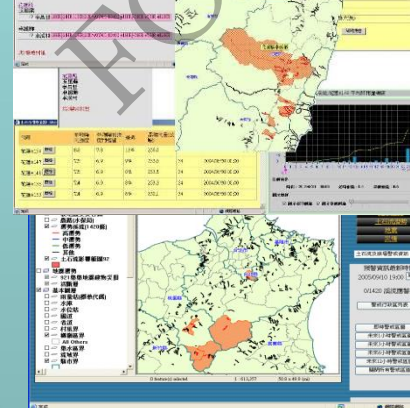
Real-Time Water Information of rivers by Web-Services Technology



Automatic Estimation of Inundation Area



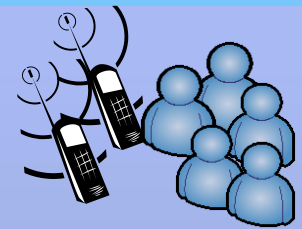
Automatic Estimation of the potential areas of Debris Flows and Landslide



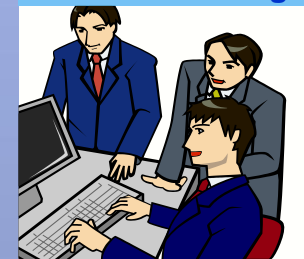
Management of Disaster Investigation



Warning Message Broadcasting



Analysis and Decision Making

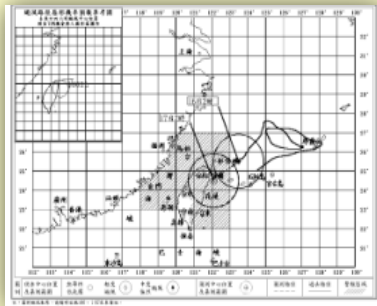


Central Warning Declaration



Monitor

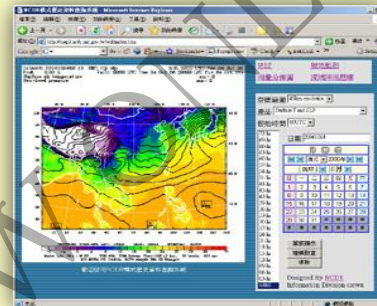
Monitor Real time data



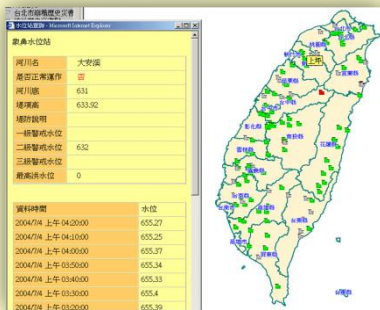
Typhoon forecast data



Rain gauge data



Climate forecast model



River and reservoir status



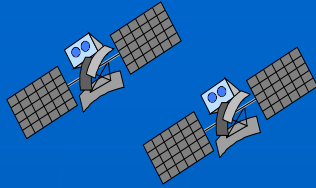
Radar estimate rainfall

- collects the typhoon information
- estimate of its future track

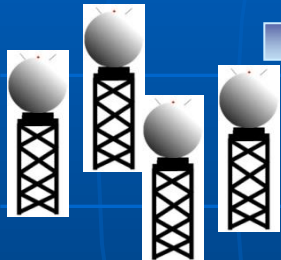
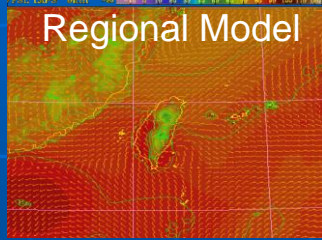
Warn instantly



Send Warning message



Upper air sounding



Radar Network



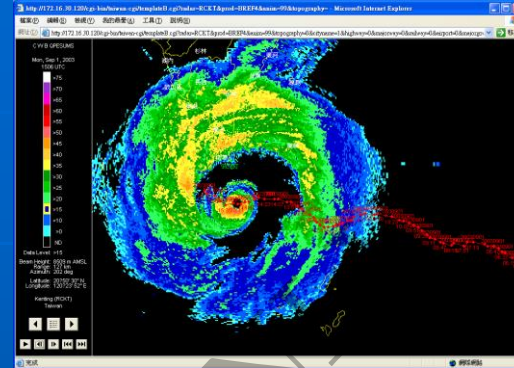
Surface stations



Auto rain-gauge



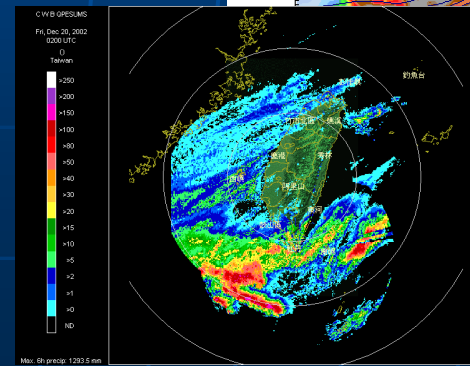
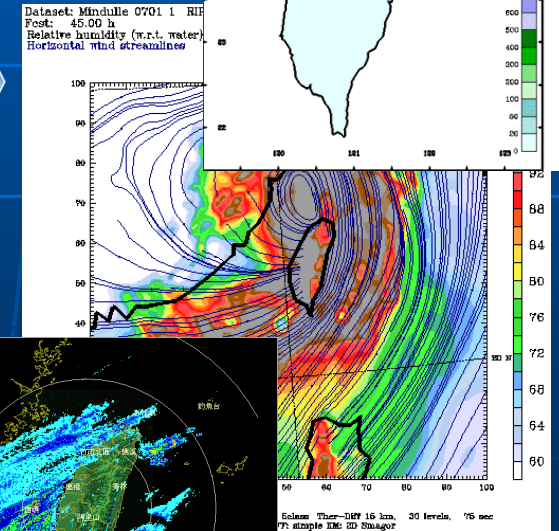
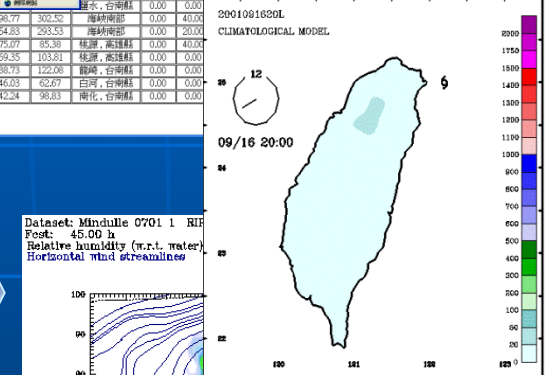
Lightening observations



七股雷達站 制鋼管資訊 2004.07.02_18152

地理位置	小管寬 1/4 吋	小管寬 3/8 吋	配管風速 呎/分 (M/min)	管內流速 呎/分 (M/min)	最小管徑 呎 (吋)	不銹鋼管 呎 (吋)	制鋼管 呎 (吋)	初步方向偏差 mm
海防南部	0.00	100.00	52.00	31.83	60.33	8.04	4.77	17.15 999.9999999999999
海防南部	1.00	100.00	-	26.17	55.00	5.53	1.33	14.50 999.9999999999999
彰化、嘉義縣	0.00	80.00	-	11.17	53.00	5.95	1.91	8.10 999.9999999999999
彰化、彰化縣	0.00	70.00	-	-	26.15	53.00	5.53	1.25 7.37 999.9999999999999
海防南部	0.00	40.00	-	16.42	21.02	53.00	2.96	0.32 6.88 999.9999999999999
海防、台南縣	0.00	20.00	-	13.75	13.54	50.00	1.38	0.34 6.36 999.9999999999999
海防南部	0.00	0.00	-	16.25	10.00	50.00	1.62	0.65 3.20 999.9999999999999
海防南部	0.00	50.00	-	8.58	16.43	50.00	1.33	0.55 6.19 999.9999999999999
海防南部	0.00	0.00	-	-	10.15	51.00	2.40	2.40 6.00 999.9999999999999
海防南部	0.00	80.00	-	-	13.31	51.00	1.84	0.77 5.08 999.9999999999999
西南方邊界	0.00	0.00	-	-	11.50	51.00	1.15	0.47 4.64 999.9999999999999
三河、台南縣	0.00	0.00	-	12.00	9.68	51.00	0.55	0.55 4.78 999.9999999999999
台南、高雄縣	0.00	0.00	-	6.50	6.56	51.00	3.00	2.25 3.00 999.9999999999999

- Data analysis
- Storm analysis
- Storm tracking
- Rainfall estimate
- Historical case



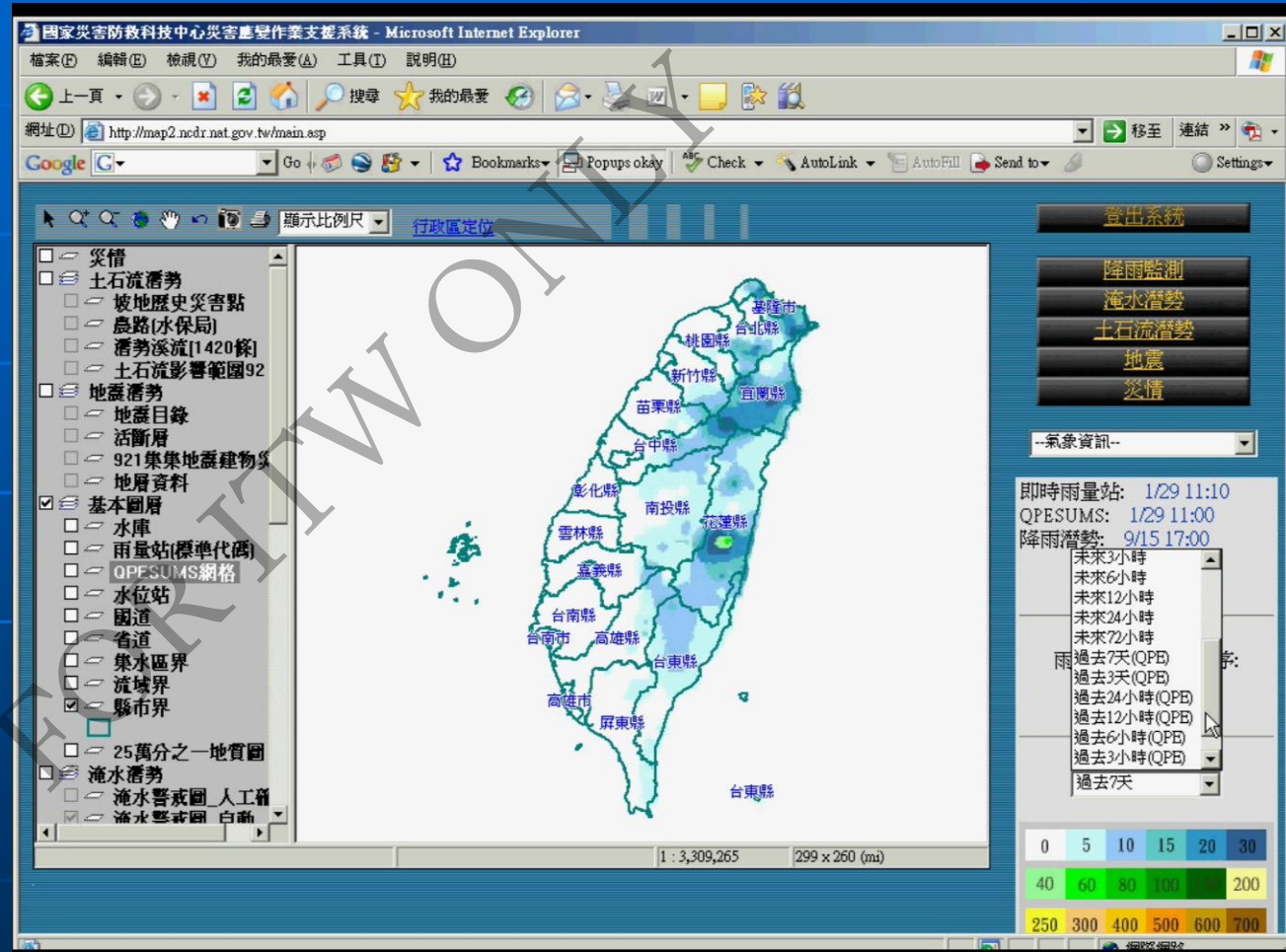
The User Interface for the Rainfall Distribution

降雨潛勢 - Microsoft Internet Explorer

網址 (D) http://map2.naphn.nhu.edu.tw/forlist.asp?accuhrs=24

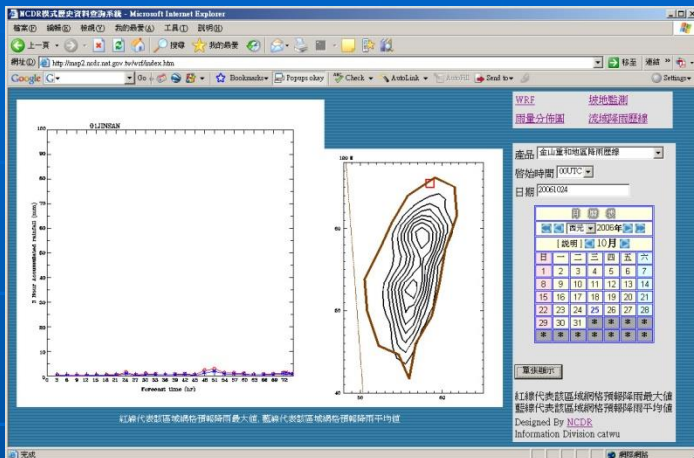
自2001/09/16 02:00起
累計未來24小時降雨量

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
COD36	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

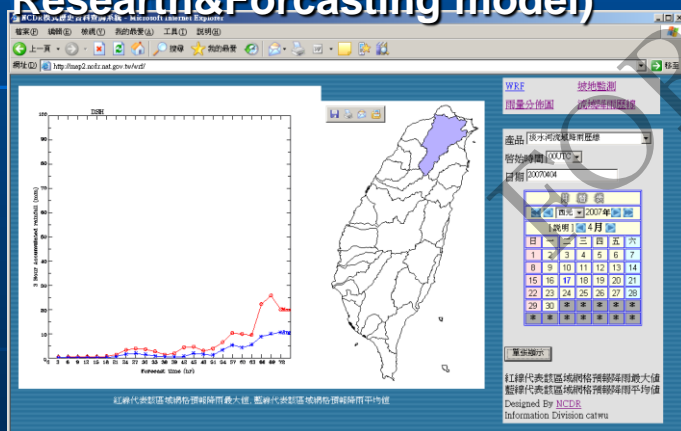


Rain gauge rainfall order The accumulated rainfall is calculated as the GIS layer

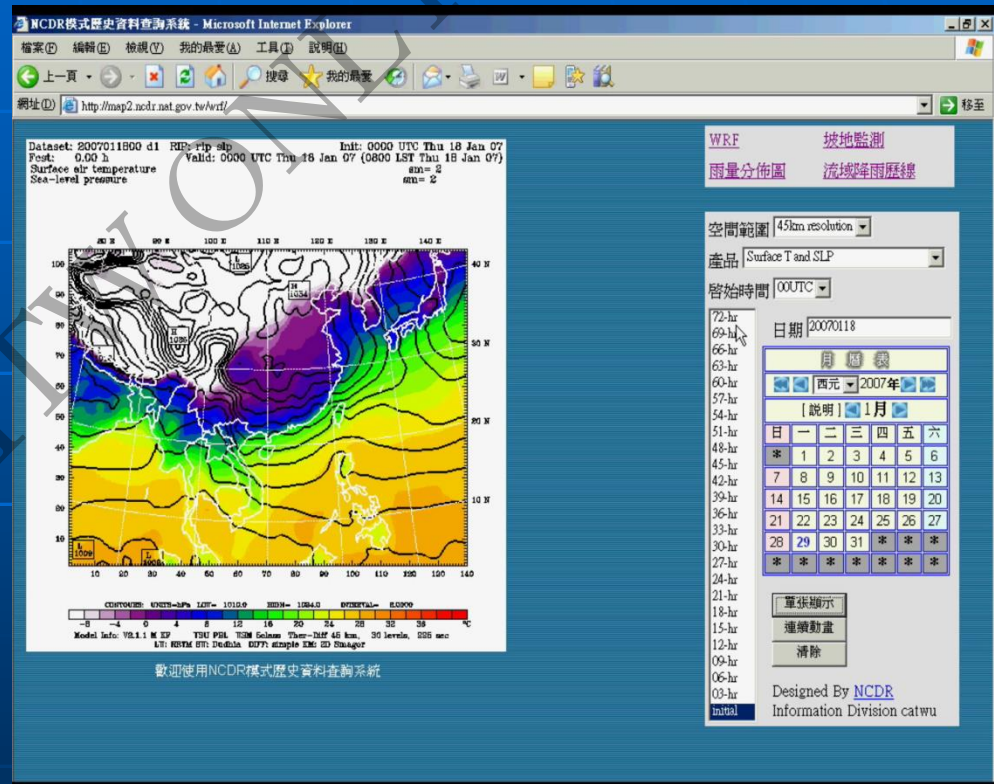
Climate forecast model



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



Forecast Basin rainfall by WRF



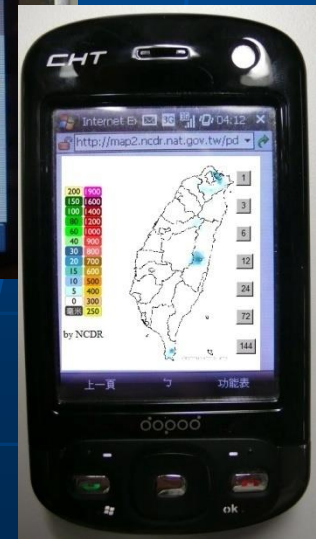
Send warning message to cell phone



(May) 27 04:10

Taitung county DaRan town NanTian
accumulate 1 hour rainfall 43mm

Taitung county DaRan town Shouka
accumulate 1 hour rainfall 45mm

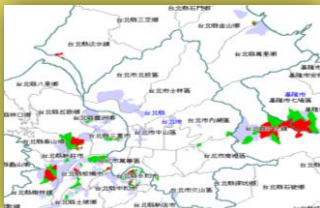


Analysis

Static basic data



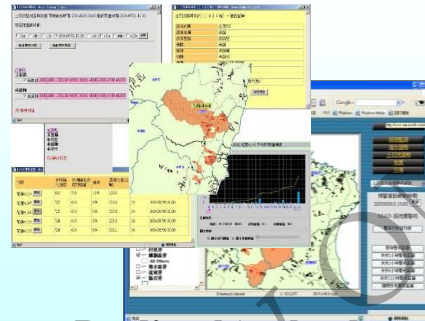
Basic map data



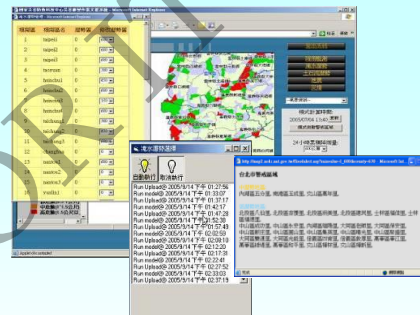
Potential inundation data



Potential debris flow data

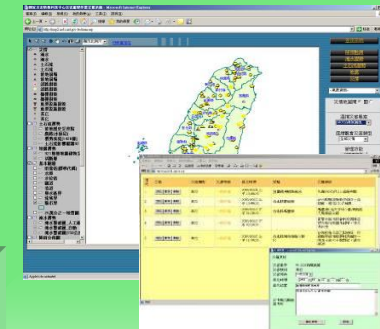


Predict slope land disaster location



Predict inundation disaster location

Real time hazard data

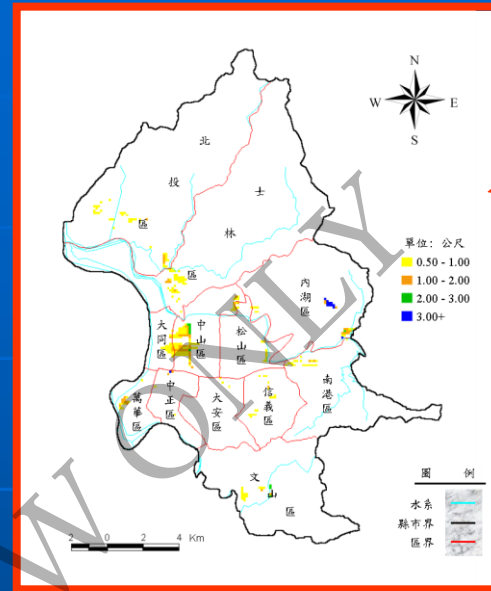


Reveal hazard location

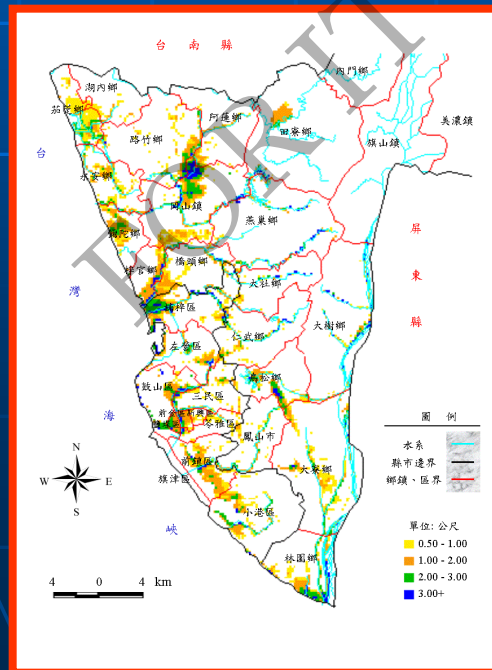
The Inundation Potential Maps in Taiwan

■ 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



Taipei City



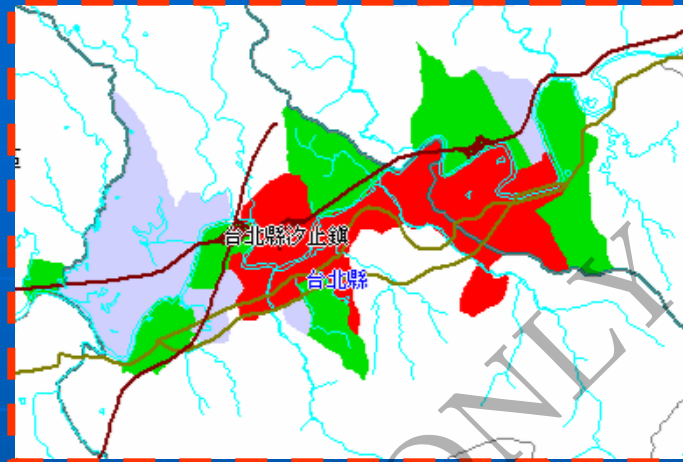
Kaohsiung City

Depth : m



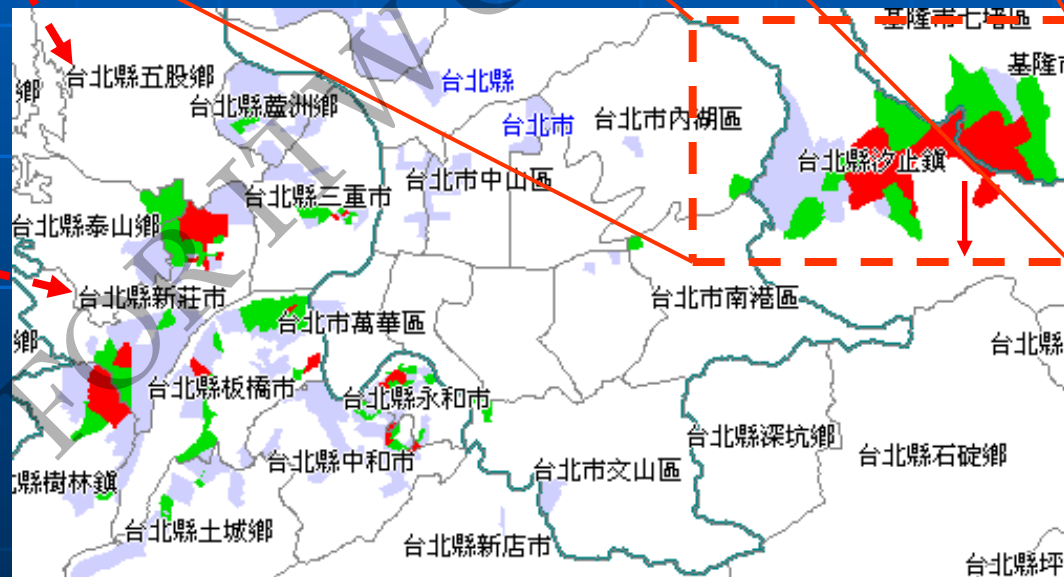
20 0 20 40 Kilometers

Estimation of Inundation and Warning Issue



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

Real-time Rainfall Records
+



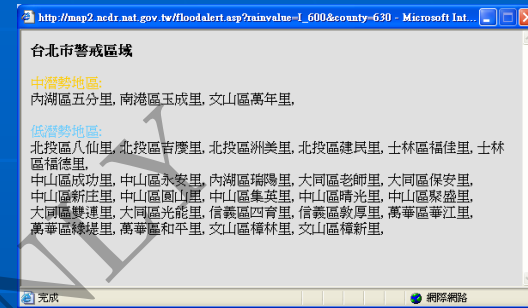
Flood Potential

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

Rainfall Forecasting

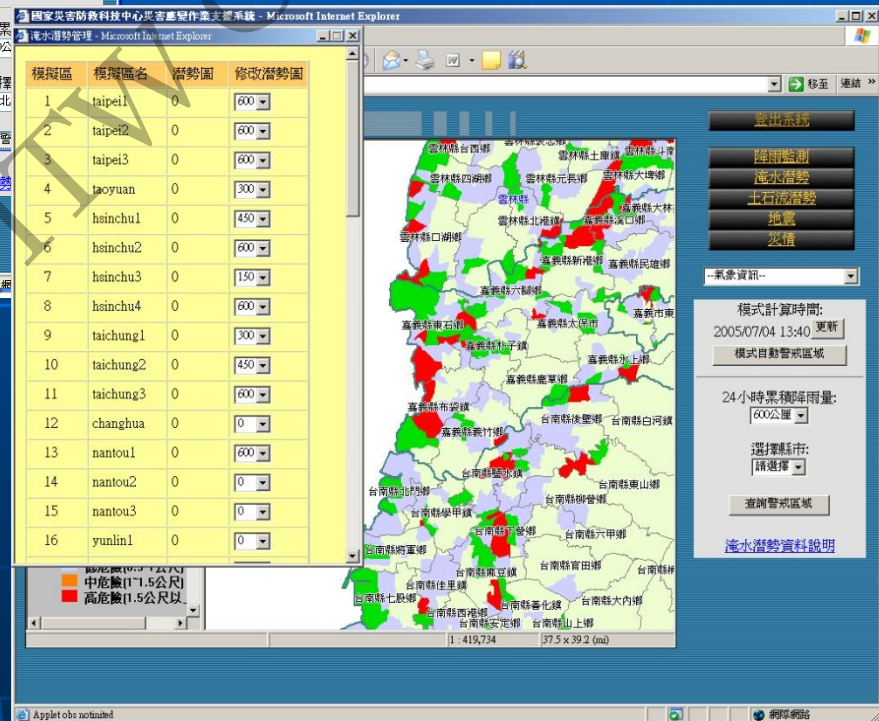
Automatically selects the inundation potential layers every 10 minutes

Forecasting of the Inundation Potential Areas



自動執行 取消執行

Run Upload@ 2005/9/14 下午 01:27:56
Run model@ 2005/9/14 下午 01:33:07
Run Upload@ 2005/9/14 下午 01:37:17
Run model@ 2005/9/14 下午 01:42:17
Run Upload@ 2005/9/14 下午 01:47:28
Run model@ 2005/9/14 下午 01:52:38
Run Upload@ 2005/9/14 下午 01:57:49
Run model@ 2005/9/14 下午 02:02:59
Run Upload@ 2005/9/14 下午 02:08:10
Run model@ 2005/9/14 下午 02:12:20
Run Upload@ 2005/9/14 下午 02:17:31
Run model@ 2005/9/14 下午 02:22:41
Run Upload@ 2005/9/14 下午 02:27:52
Run model@ 2005/9/14 下午 02:33:03
Run Upload@ 2005/9/14 下午 02:37:19



Be modified manually via the user interface of DSSER

Potential Streams of Debris Flow



**Geology Zoning of 1420
Potential Hazard
Streams**

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)

網址(1) http://map2.ncdr.nat.gov.tw/main.asp

顯示比例尺 行政區定位

0 feature(s) selected 1:618,357 50.8 x 49.9 (m)

完成

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

土石流潛勢溪流(1420條) - 屬性查詢

溪流代碼	台北A137
溪流名稱	孔孔溪
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

降雨歷線 關閉視窗

完成 網路網路

http://www.microsoft.com/sasp/...

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

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

Issues the Warning and Security for the Counties of the Slopeland Disaster Vulnerability

Meteorological data

Rainfall distribution

Forecast rainfall distribution

Threshold

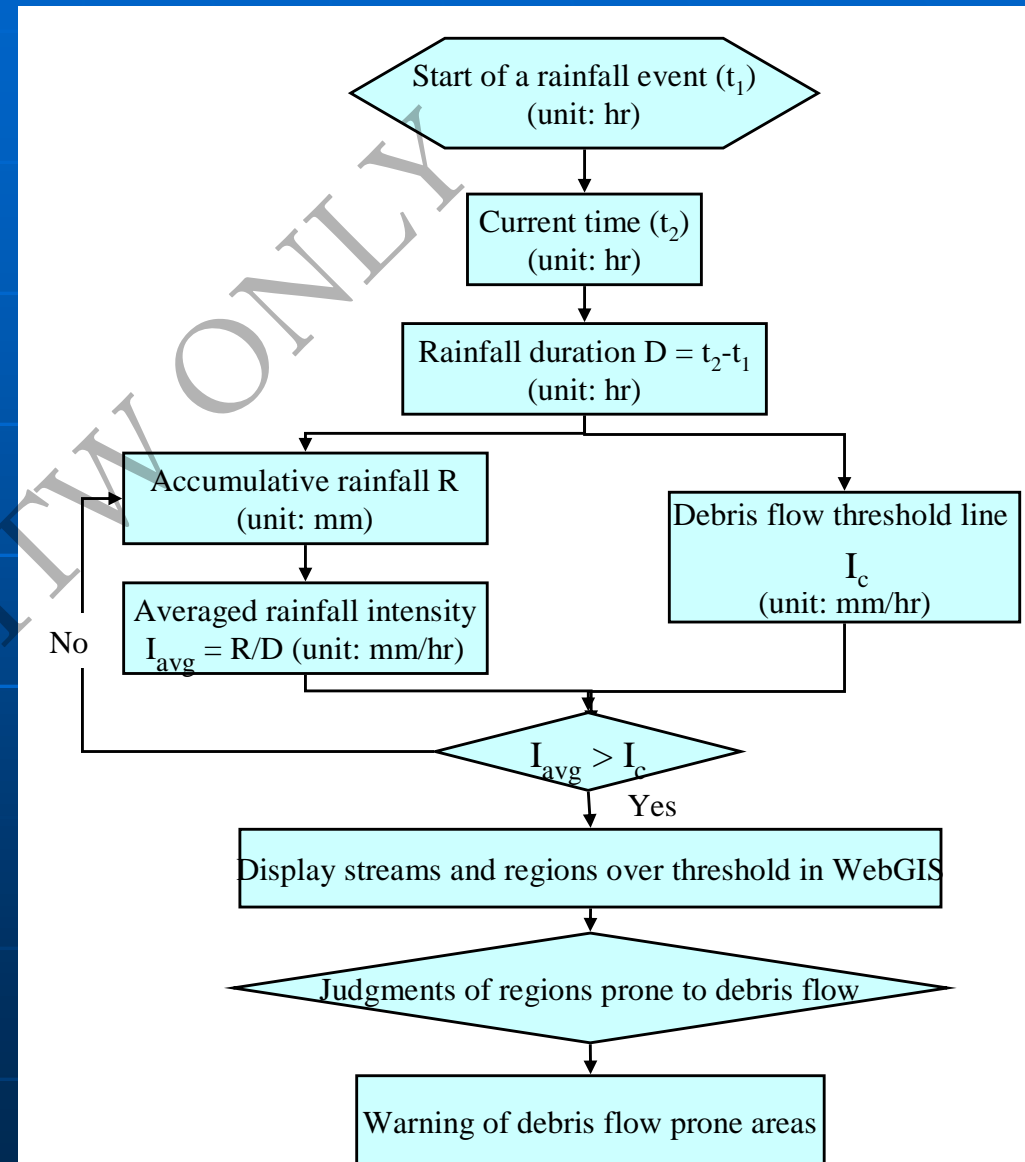
Slopeland disaster threshold

Forecast disaster locations

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

Slopeland 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

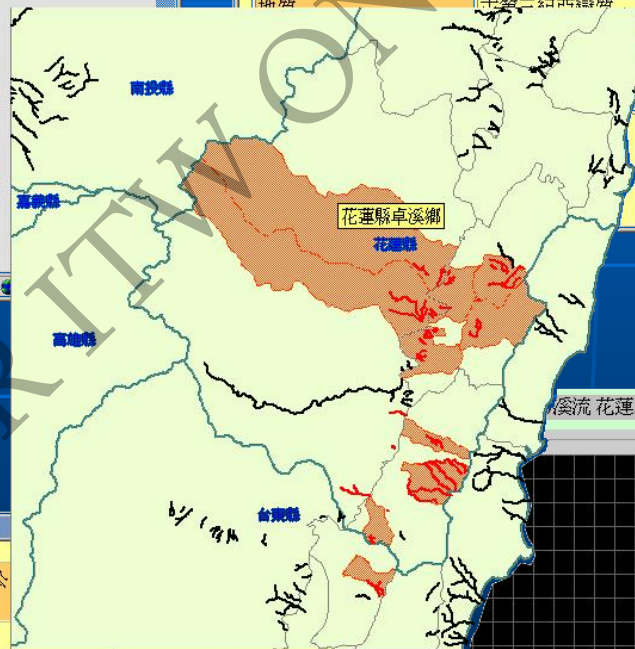
共2警戒村里

完成

土石流潛勢溪流 (1420條) 一屬性查詢

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
村別	土城二、四、五、六、七、八、九、十、十一、十二、十三、十四、十五、十六、十七、十八、十九、二十、二十一、二十二、二十三、二十四、二十五、二十六、二十七、二十八、二十九、三十、三十一、三十二、三十三、三十四、三十五、三十六、三十七、三十八、三十九、四十、四十一、四十二、四十三、四十四、四十五、四十六、四十七、四十八、四十九、五十、五十一、五十二、五十三、五十四、五十五、五十六、五十七、五十八、五十九、六十、六十一、六十二、六十三、六十四、六十五、六十六、六十七、六十八、六十九、七十、七十一、七十二、七十三、七十四、七十五、七十六、七十七、七十八、七十九、八十、八十一、八十二、八十三、八十四、八十五、八十六、八十七、八十八、八十九、九十、九十一、九十二、九十三、九十四、九十五、九十六、九十七、九十八、九十九、一百

關閉視窗

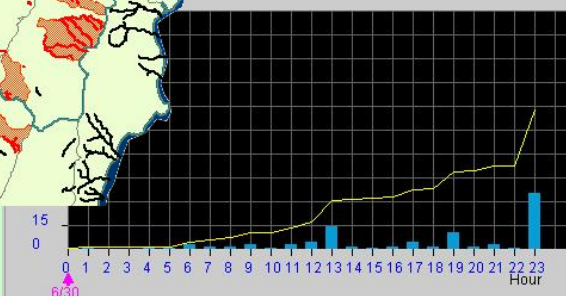


花蓮縣
玉里鎮
泰昌里
卓溪鄉
卓溪村

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="歷線"/>	8.8	7.8	13%	256.0		
花蓮A147 <input type="button" value="歷線"/>	7.5	6.9	9%	253.6	34	2004/06/30 00:00
花蓮A148 <input type="button" value="歷線"/>	7.5	6.9	8%	253.5	34	2004/06/30 00:00
花蓮A155 <input type="button" value="歷線"/>	7.4	6.9	8%	253.3	34	2004/06/30 00:00
花蓮A153 <input type="button" value="歷線"/>	7.4	6.9	8%	252.1	34	2004/06/30 00:00

溪流 花蓮A148 平均降雨量線圖

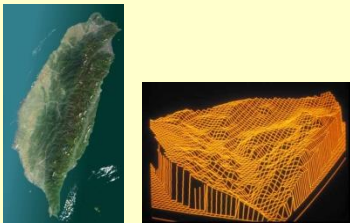


目前資訊
時間: 2004/6/30 00:00 逐時雨量: 0.5 累積雨量: 0.5

顯示控制
☒ 顯示逐時雨量
 ☒ 顯示累積雨量

Presentation

Image and
3D land form data



Information
dashboard



3D demonstration

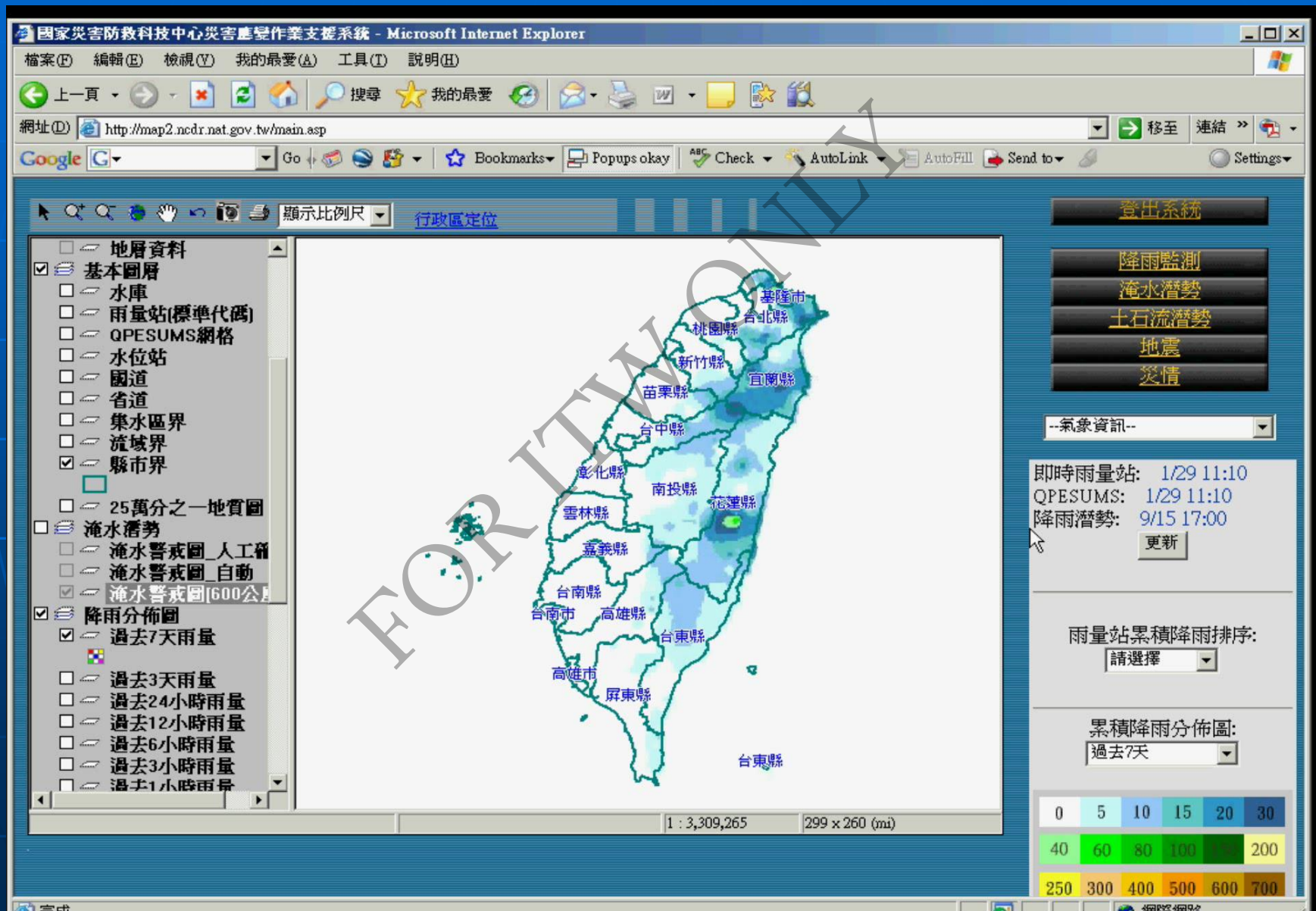
Decision making

Central
Emergency
Operations
Center

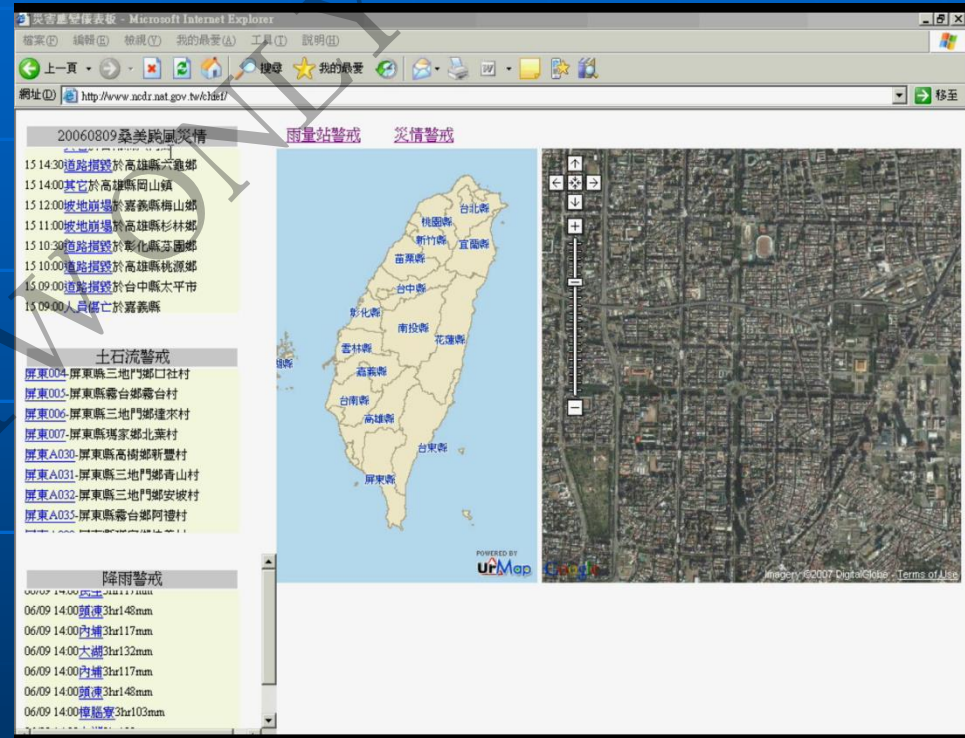
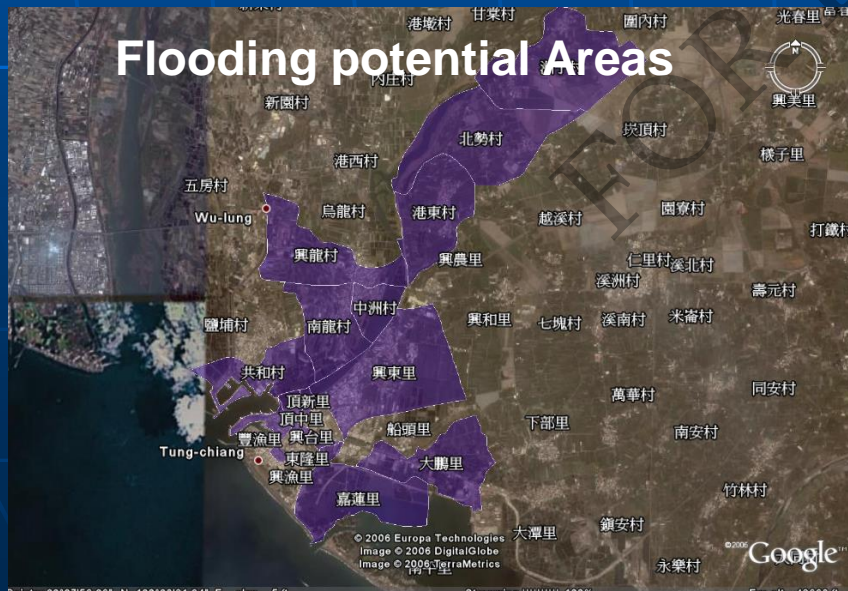


Response and
arrange resource

Presentation by Web GIS



Visualization of the disaster Information Using Google Earth / Map



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

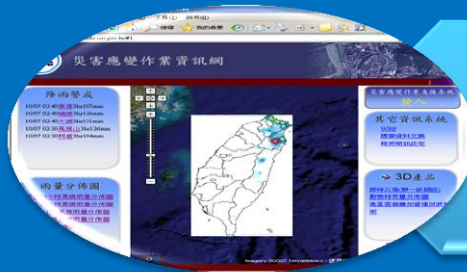
Suggestion

- 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

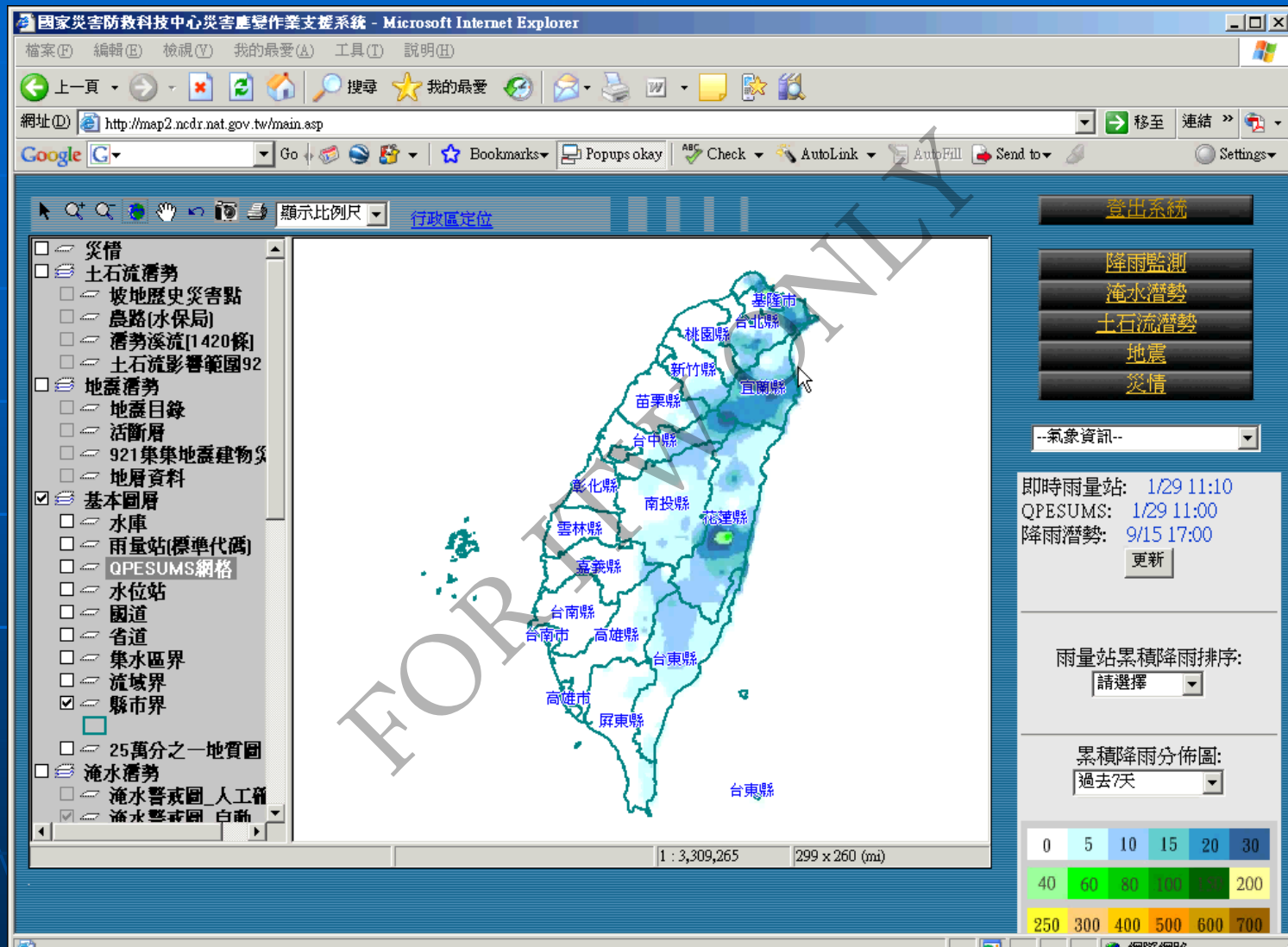


Decision Support Sub-System for Typhoon Hazard

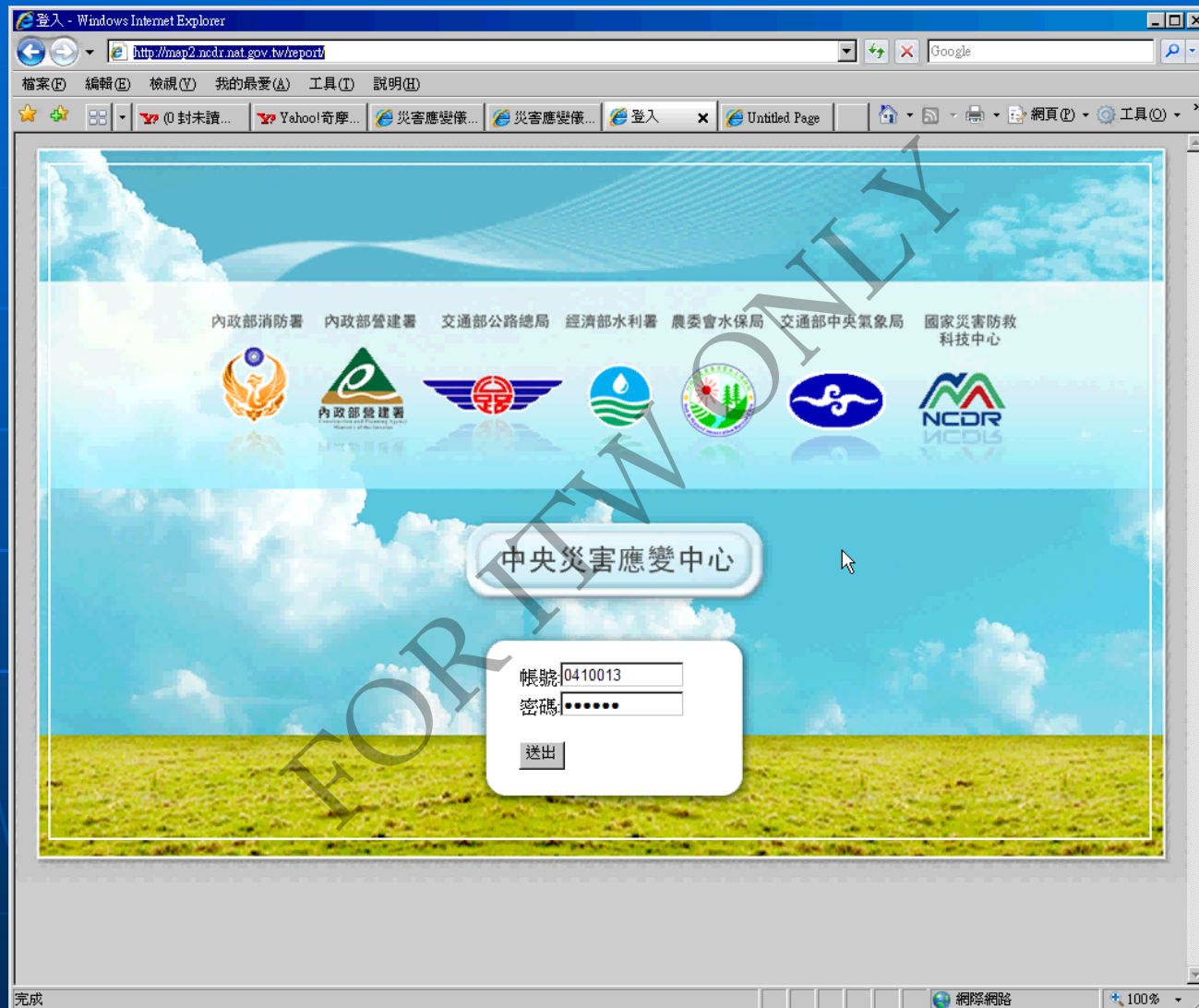


Remote Sensing Sub-System for Post-Disaster Investigation

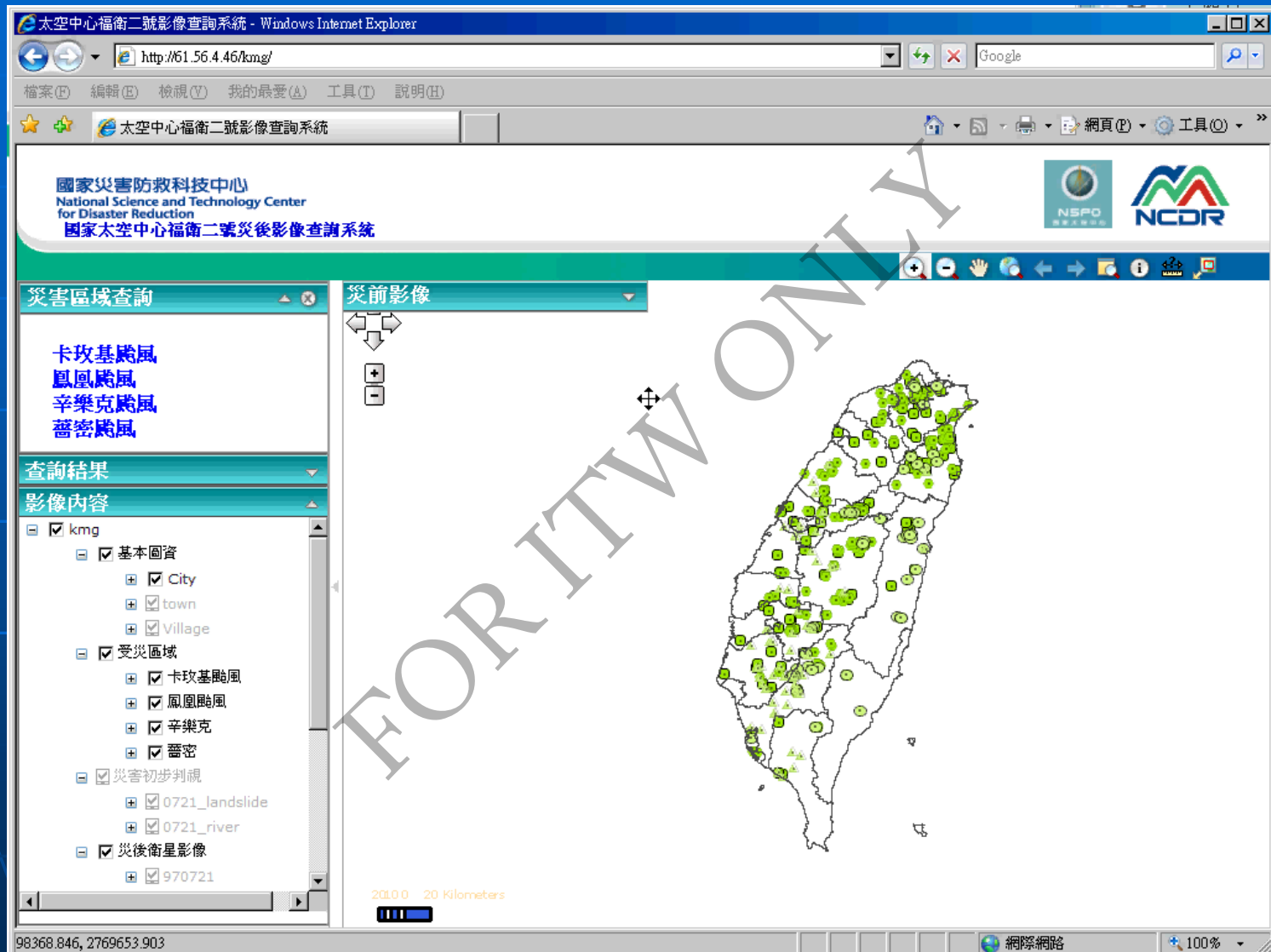
Response Operation Sub-System for Typhoon Hazard



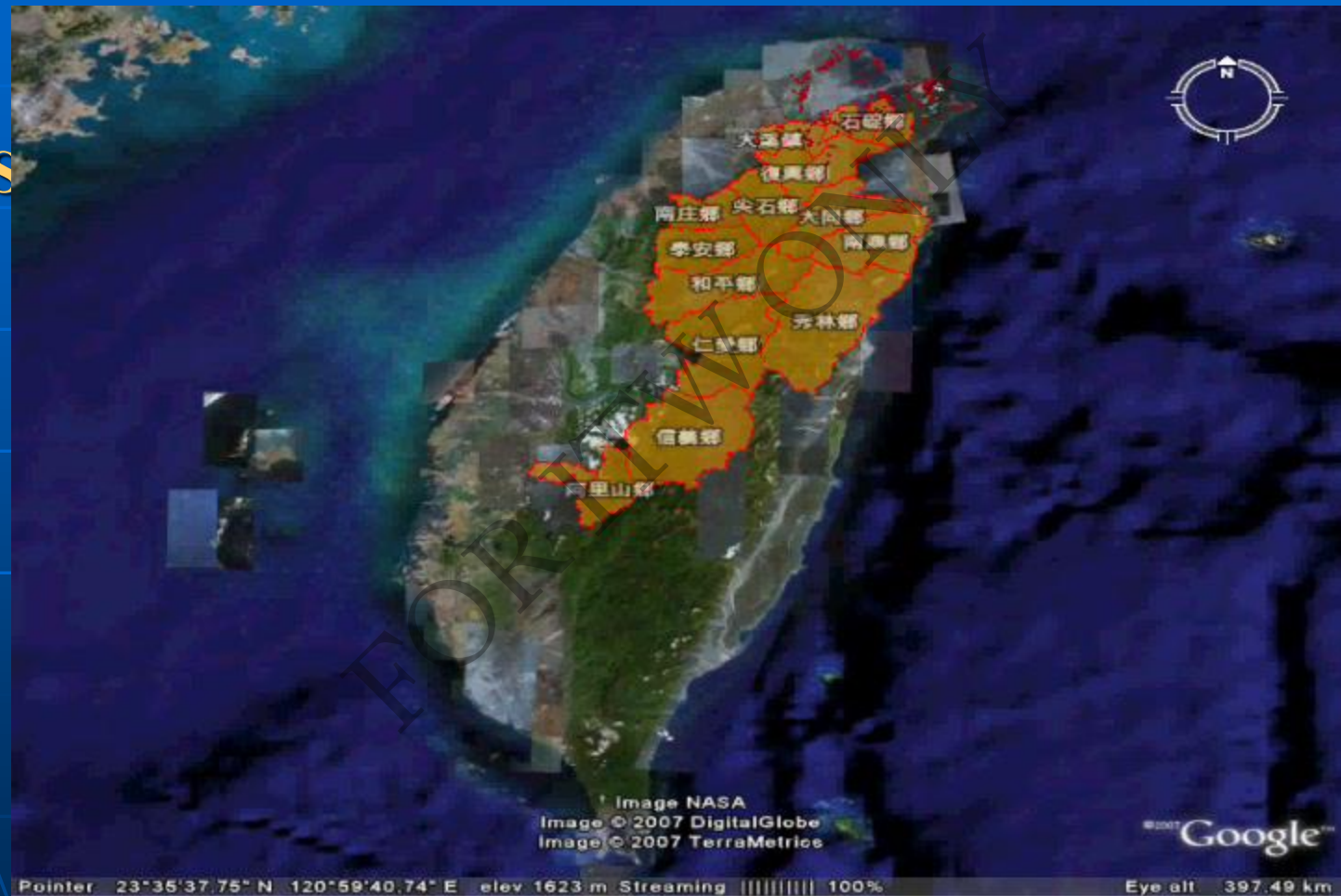
Decision Support Sub-System for Typhoon Hazard



Remote Sensing Sub-System for Post-Disaster Investigation



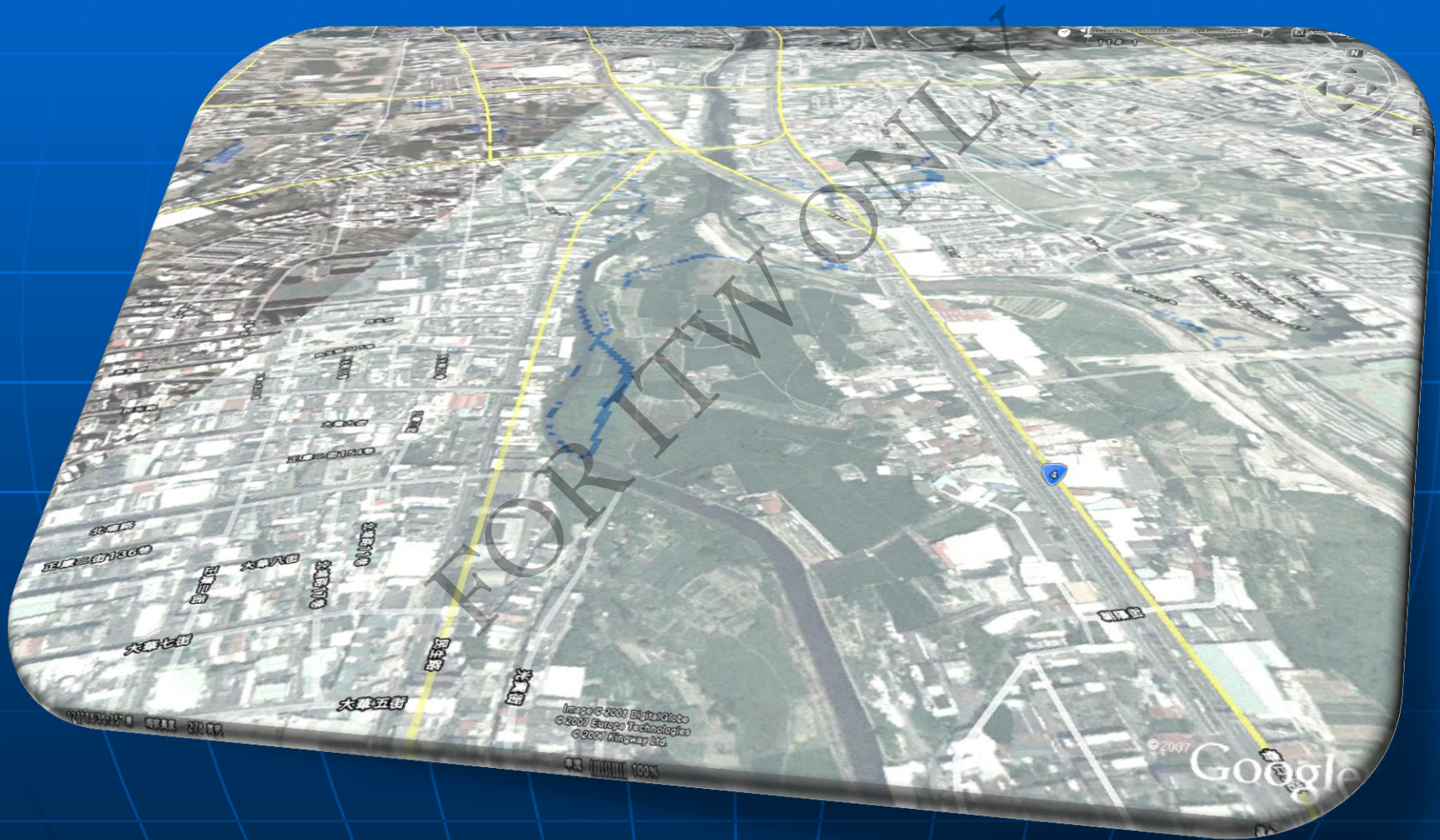
Display of Disaster Information in 3D Google Earth



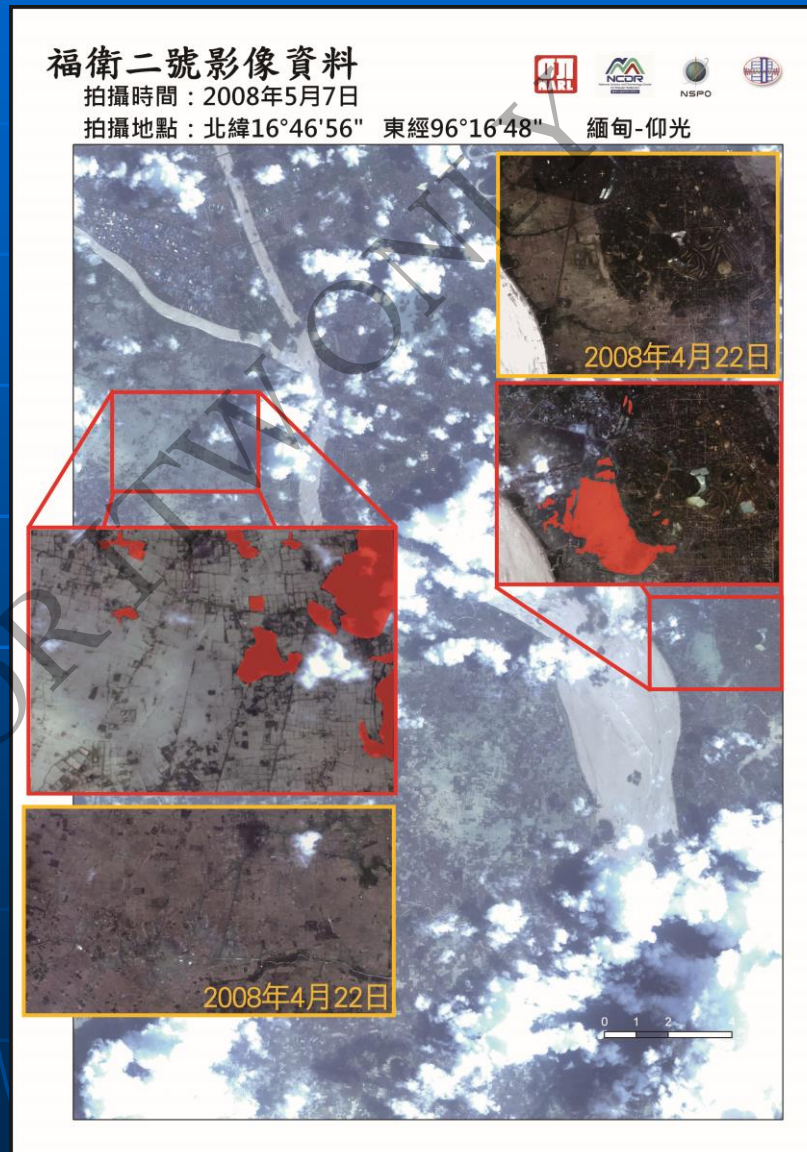
Display of Disaster Information in 3D Google Earth



Display of Flood Simulation in 3D Google Earth



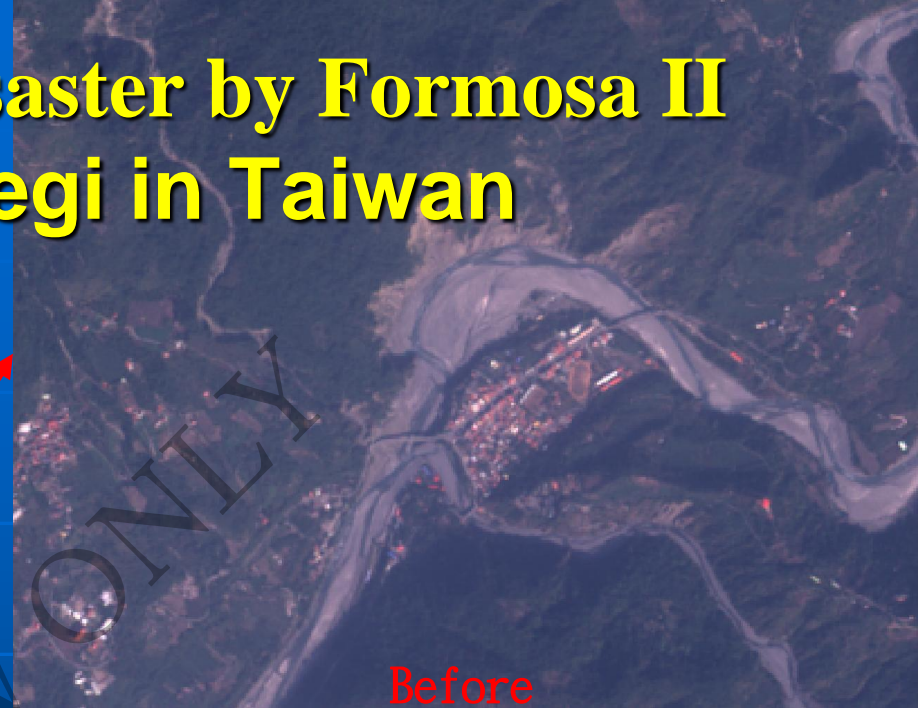
Interpretation of Disaster by Formosa II -Flooding in Myanmar 5/7/2008



Interpretation of Disaster by Formosa II -Typhoon Kalmaegi in Taiwan

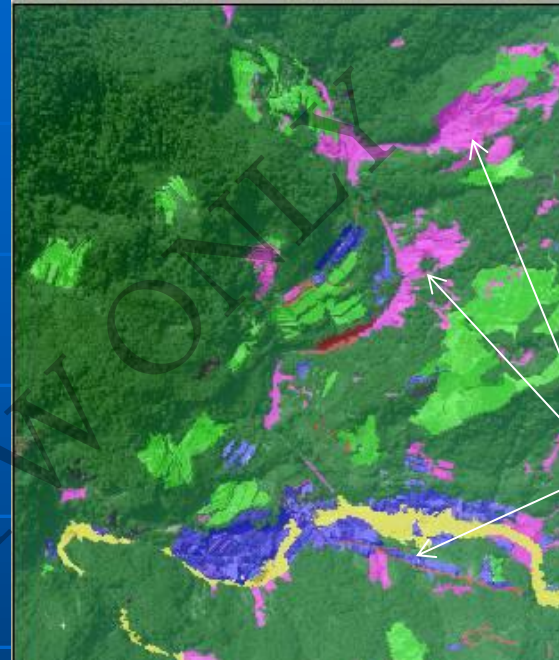


高雄縣六龜鄉



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!!!**