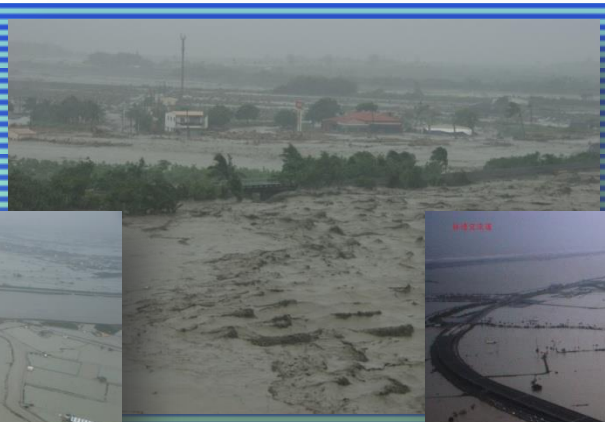
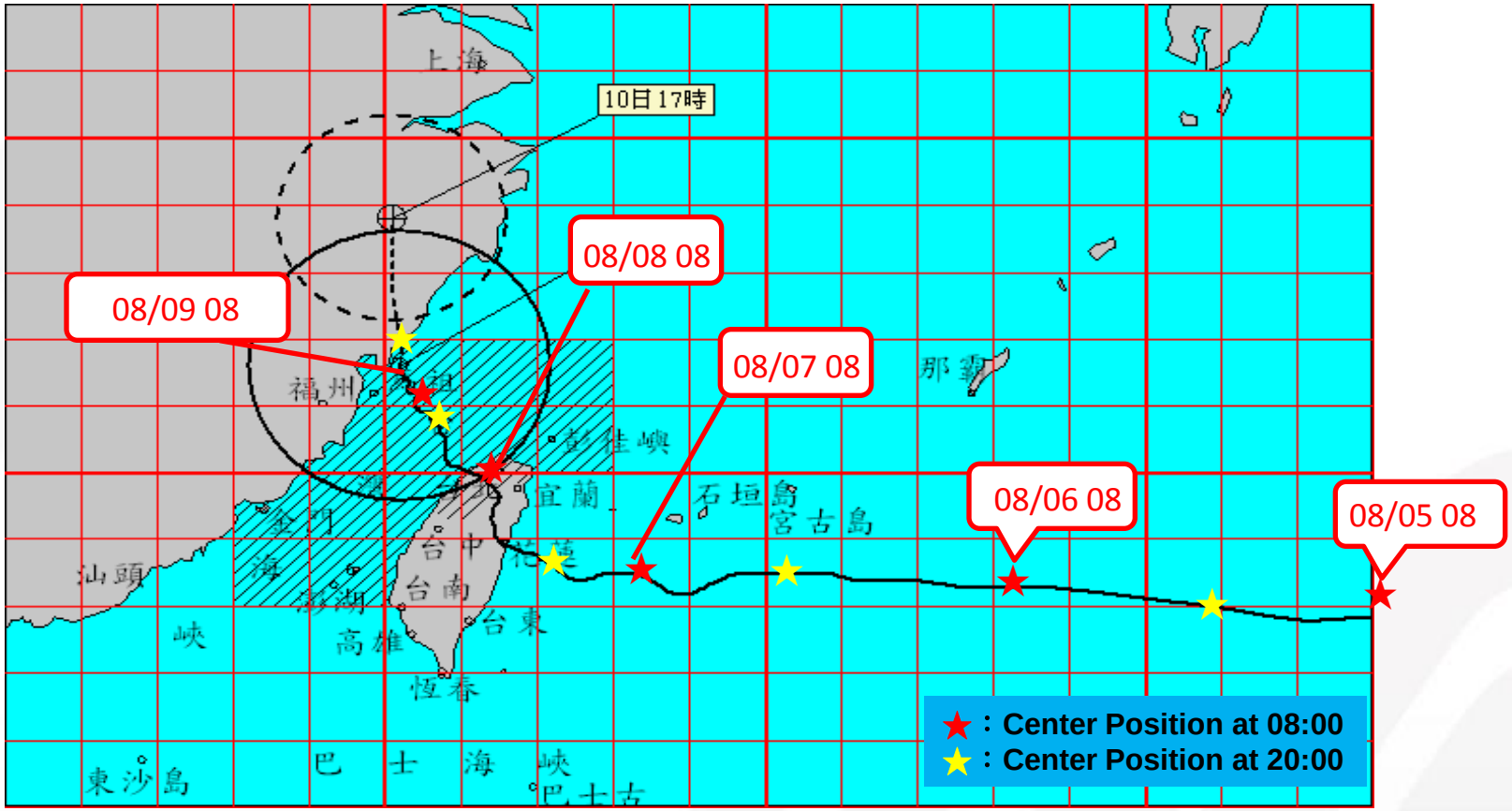
Lessons Learned from and Improvements Made after Typhoon Morakot

Wei-Sen Li

Typhoon Morakot: #8 in 2009



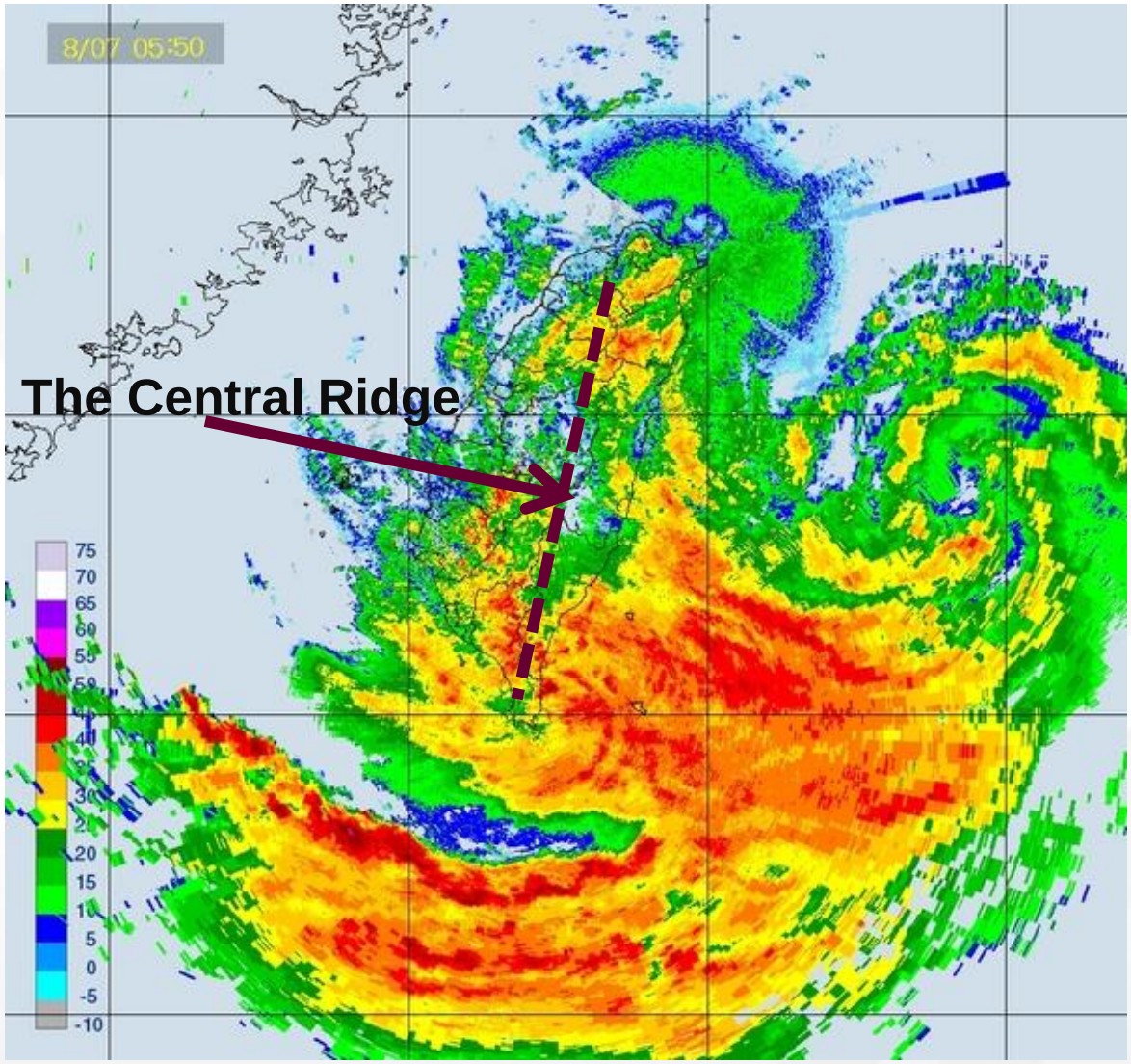
Aug 5-6: Moved fast toward Taiwan

Aug. 7 : Slowed down and out skirt touched the island

Aug. 8 : Made landfall at 00:0; Center left the island at 14:00; at very low pace; Cast influence on the whole island

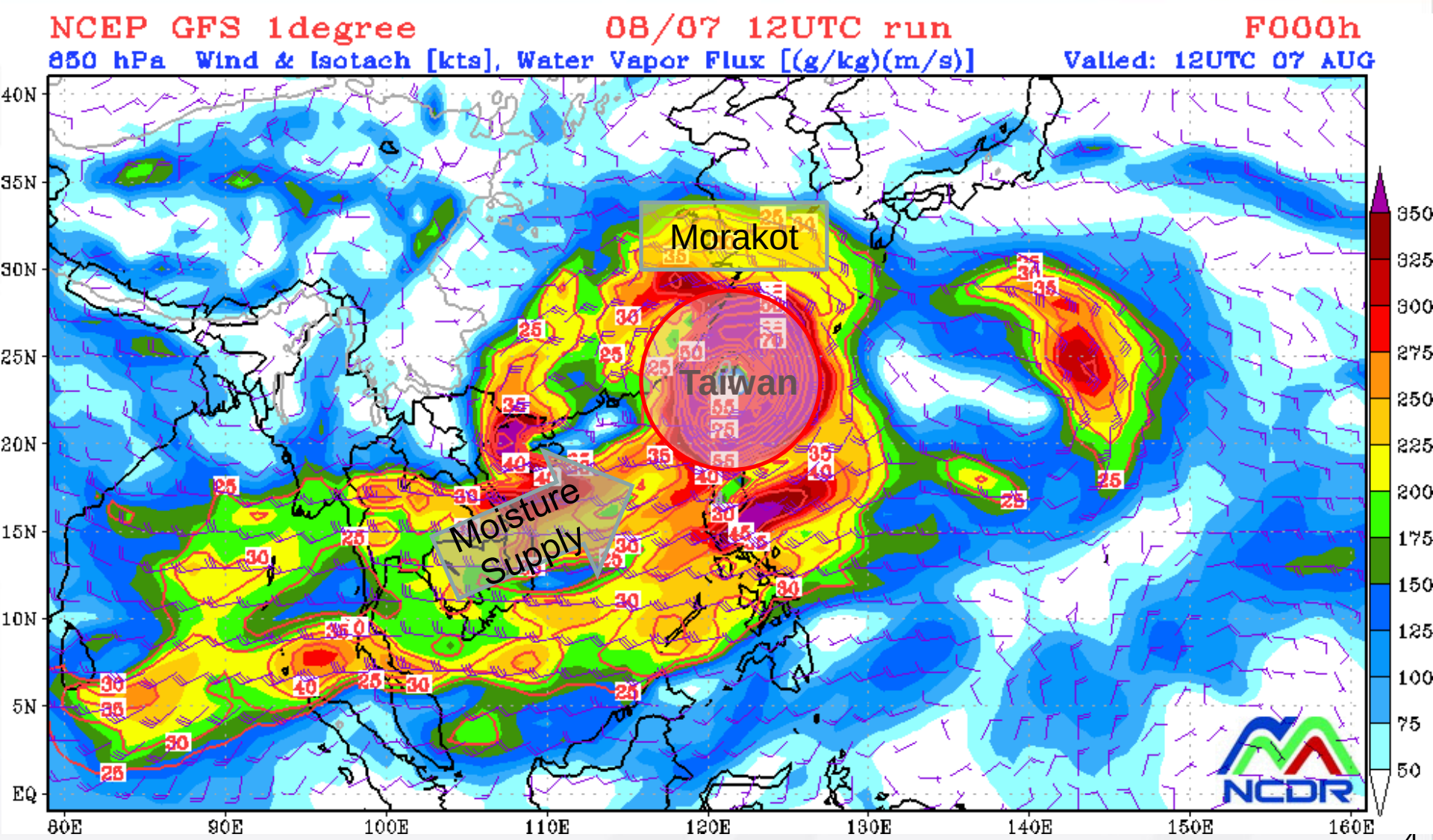
Aug. 9 : Gradually moved toward China

Unsymmetrical structure of Rain Clouds

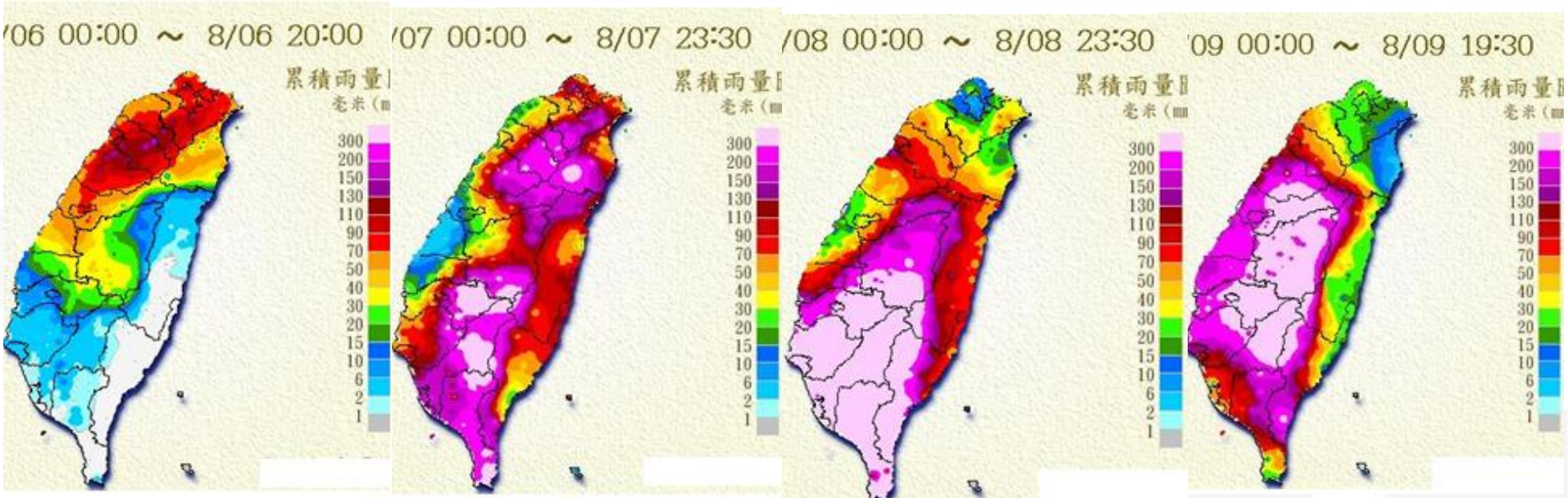


- **The unique rain cloud structure brought the record-breaking rainfalls concentrated in the southern part.**
- **The Central Ridge further intercepted the rain clouds and downpours triggered landslides and mudslides.**

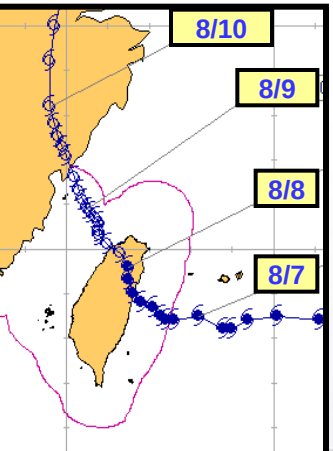
Southwest Monsoon interacted with Morakot by supplying extra moisture



Time History of Rainfall Distribution



08/06



08/07

Rainfalls started concentrating in the south

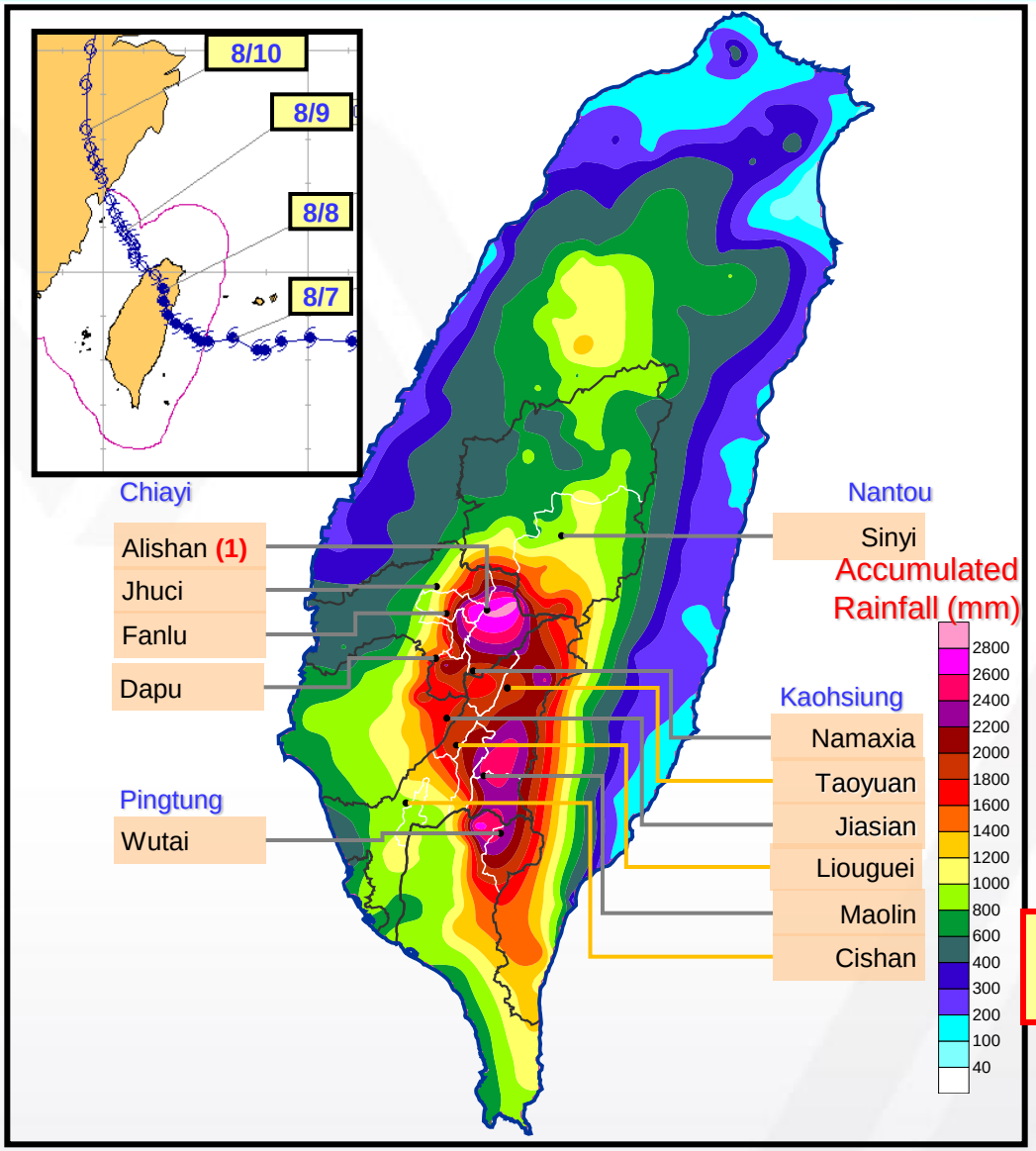
08/08

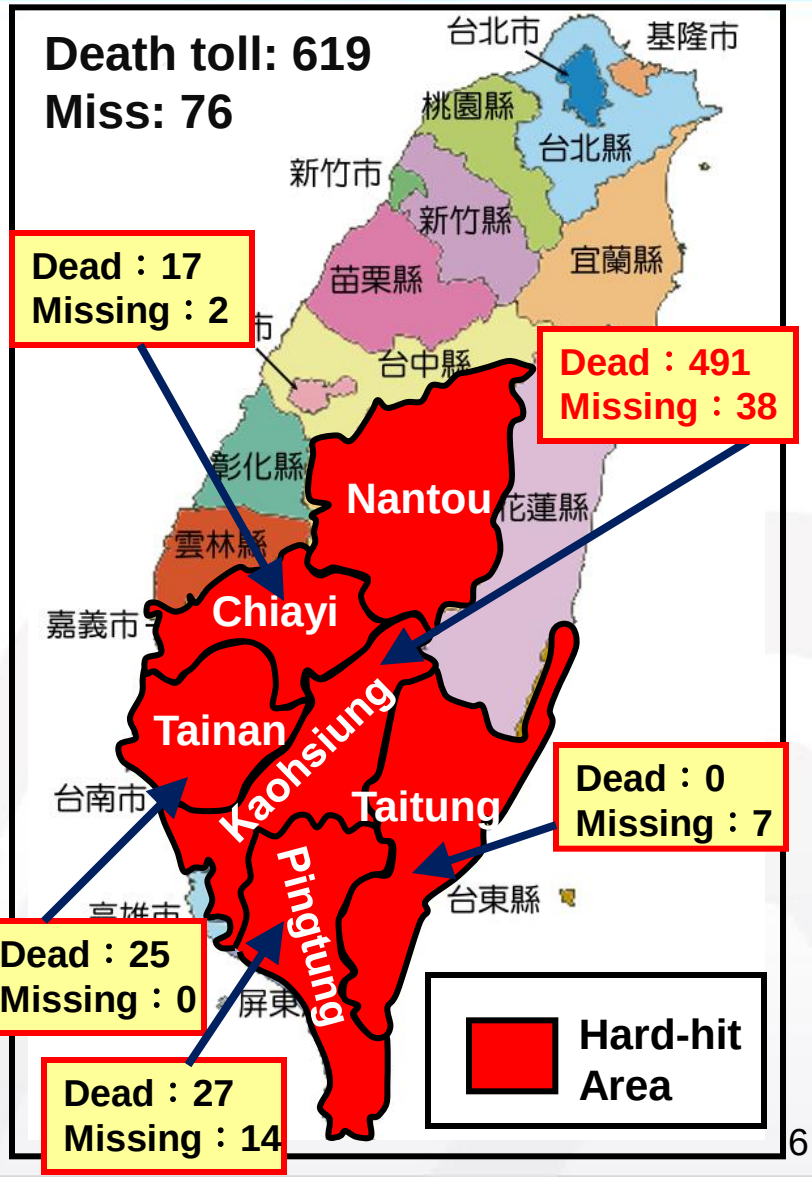
Floods along the low-lying coast areas

08/09

Landslide and Mudslide in the south

Hard-hit Areas and Accumulated Rainfall



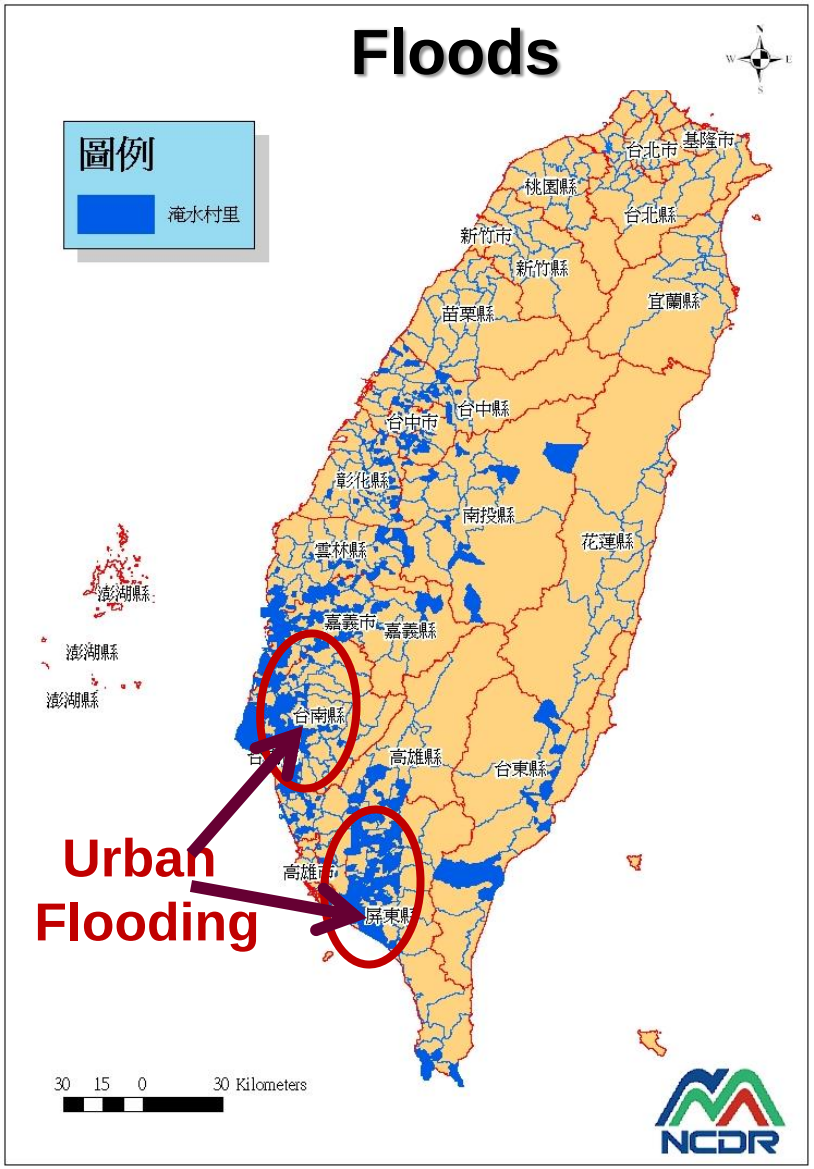


Record-breaking Rain-gauge Data

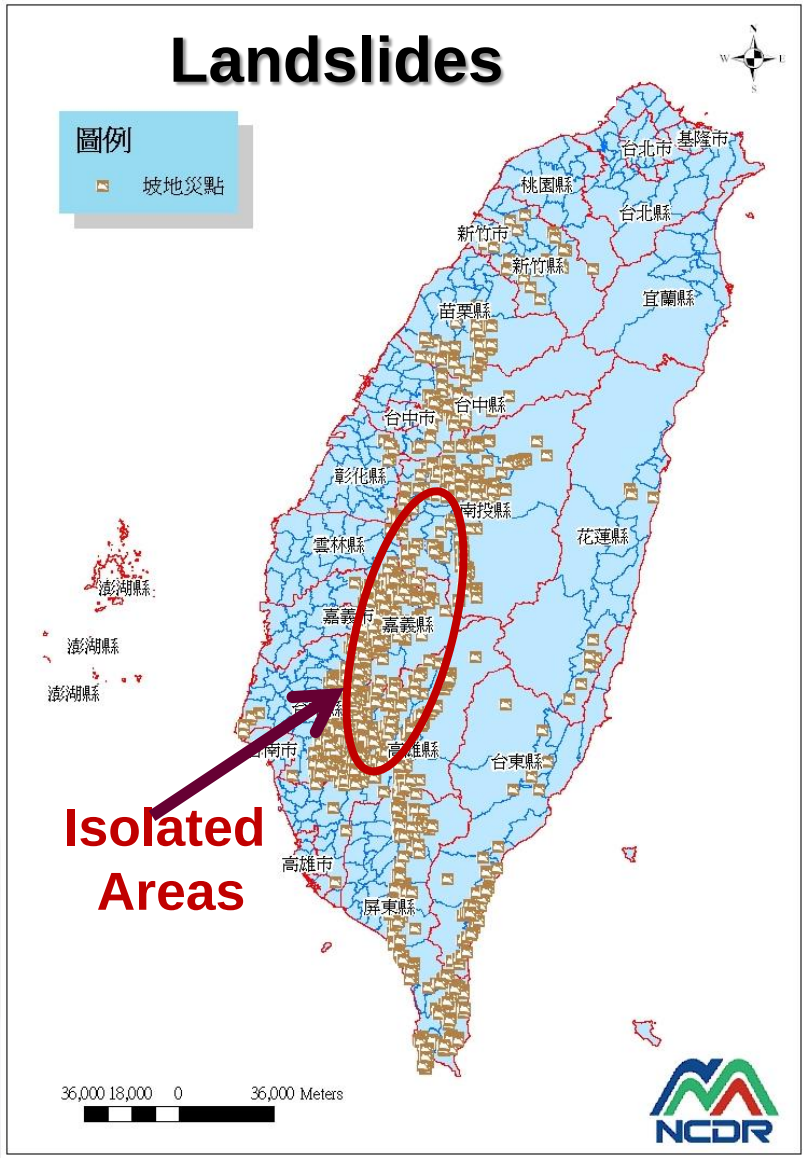
County	Township	Annual Rainfall (mm)	08/7 (mm)	08/08 (mm)	08/09 (mm)	08/10 (mm)	08/07-08/10 (mm)	08/07-08/10 vs Annual
Chiayi	Alishan	3,910	420	1,161	1,166	218	2,965	76%
Pingtung	Sandimen	3,884	745	1,402	394	332	2,872	74%
Chiayi	Jhuci	3,801	556	1,185	877	156	2,775	73%
Kaohsiung	Taoyuan	4,086	501	1,283	583	423	2,790	68%
Kaohsiung	Liouguei	3,138	236	1,178	696	351	2,461	78%
Chiayi	Fanlu	3,437	708	815	601	79	2,202	64%
Chiayi	Dapu	2,749	482	1,214	458	3	2,156	78%
Kaohsiung	Jiasian	2,861	400	1,072	345	203	2,020	71%
Nantou	Sinyi	3,254	170	717	909	134	1,929	59%
Kaohsiung	Maolin	3,152	252	743	230	179	1,404	45%
Pingtung	Wutai	2,898	206	580	208	165	1,160	40%
Kaohsiung	Cishan	2,365	91	620	128	85	924	39%

Locations of Damaged Areas

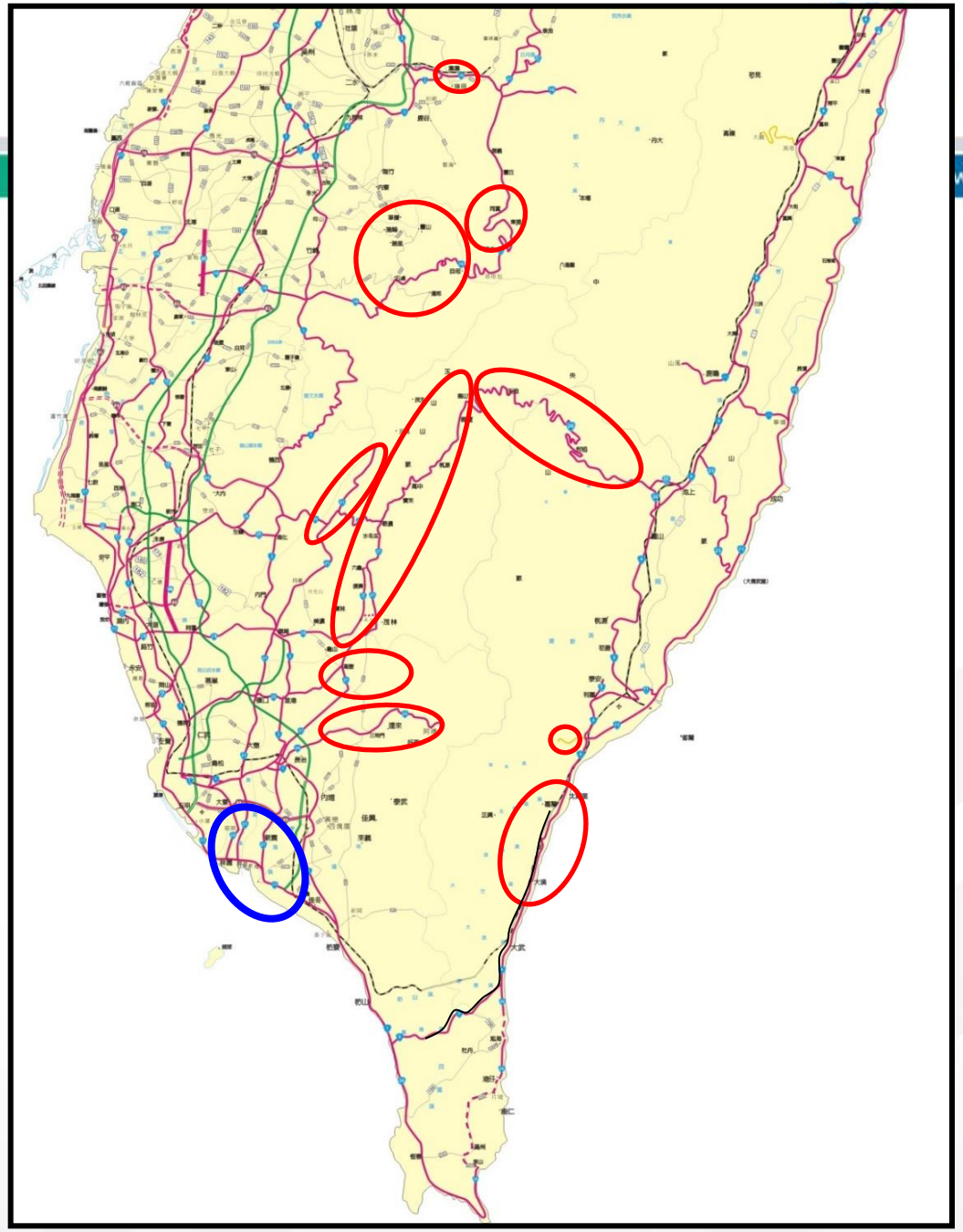
Floods



Landslides



重大
災區分佈



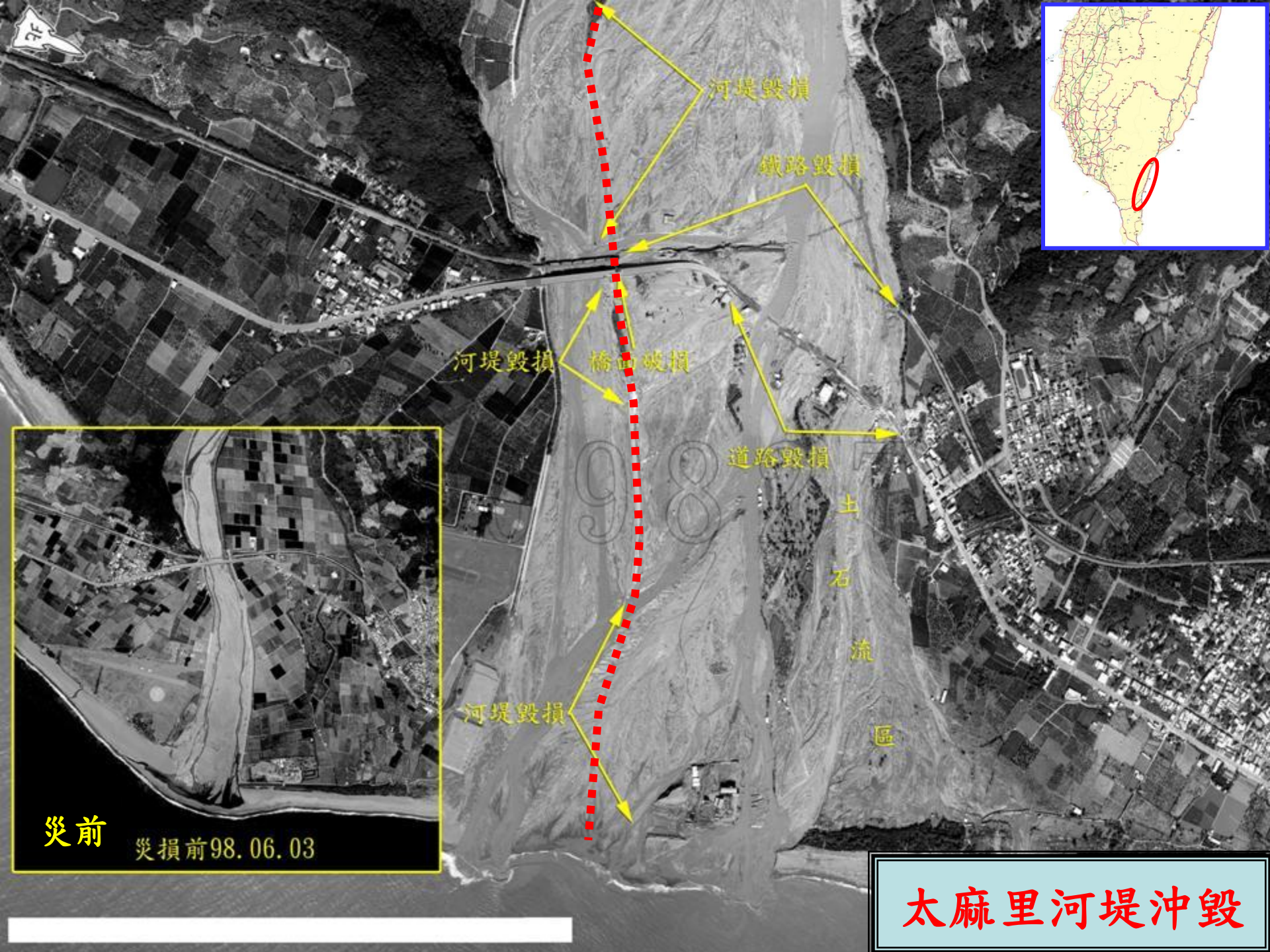
孤島型山區災區

淹水型海邊災區

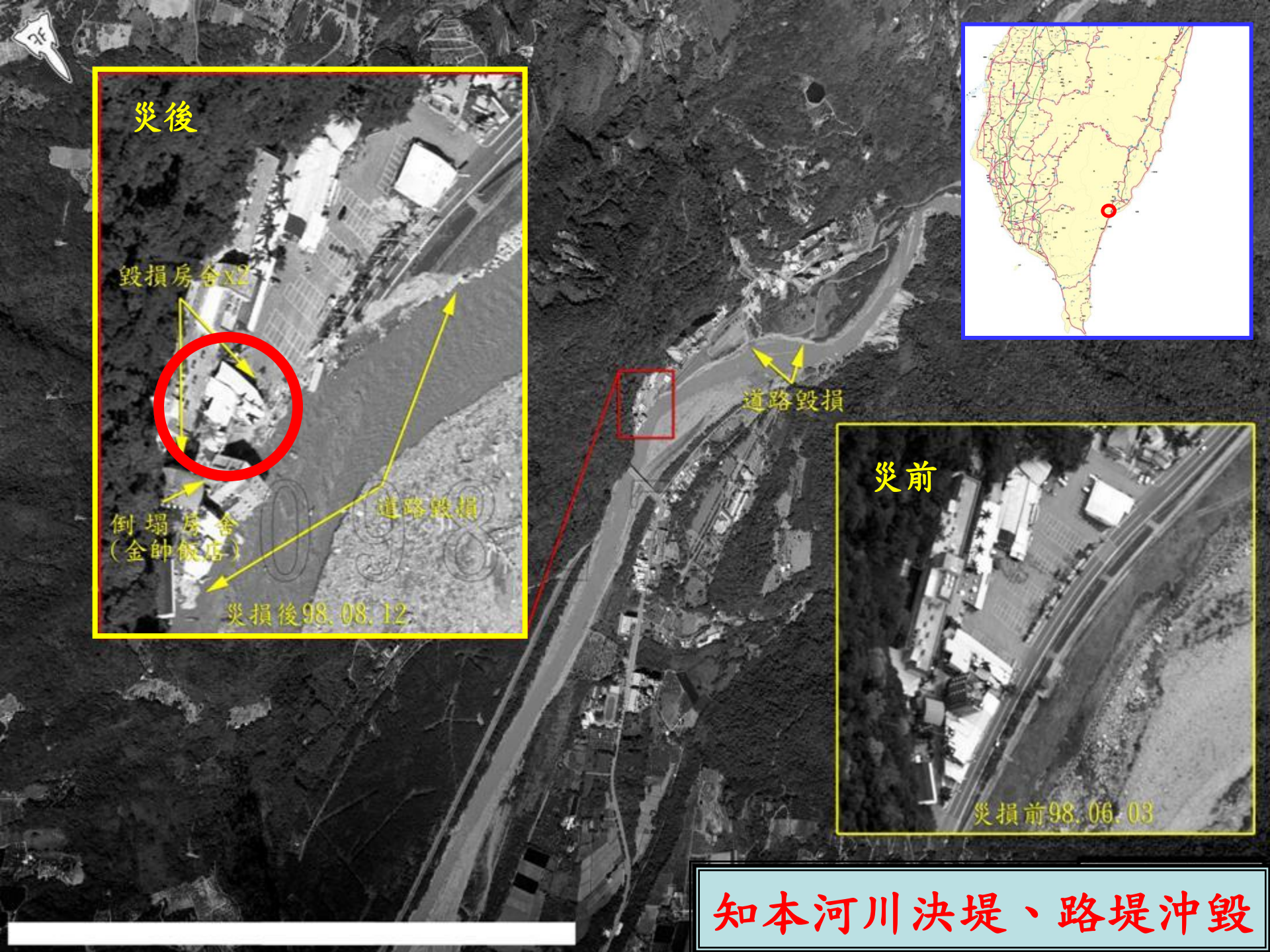
淹水地區災情

屏東：林邊、佳冬、東港、新園

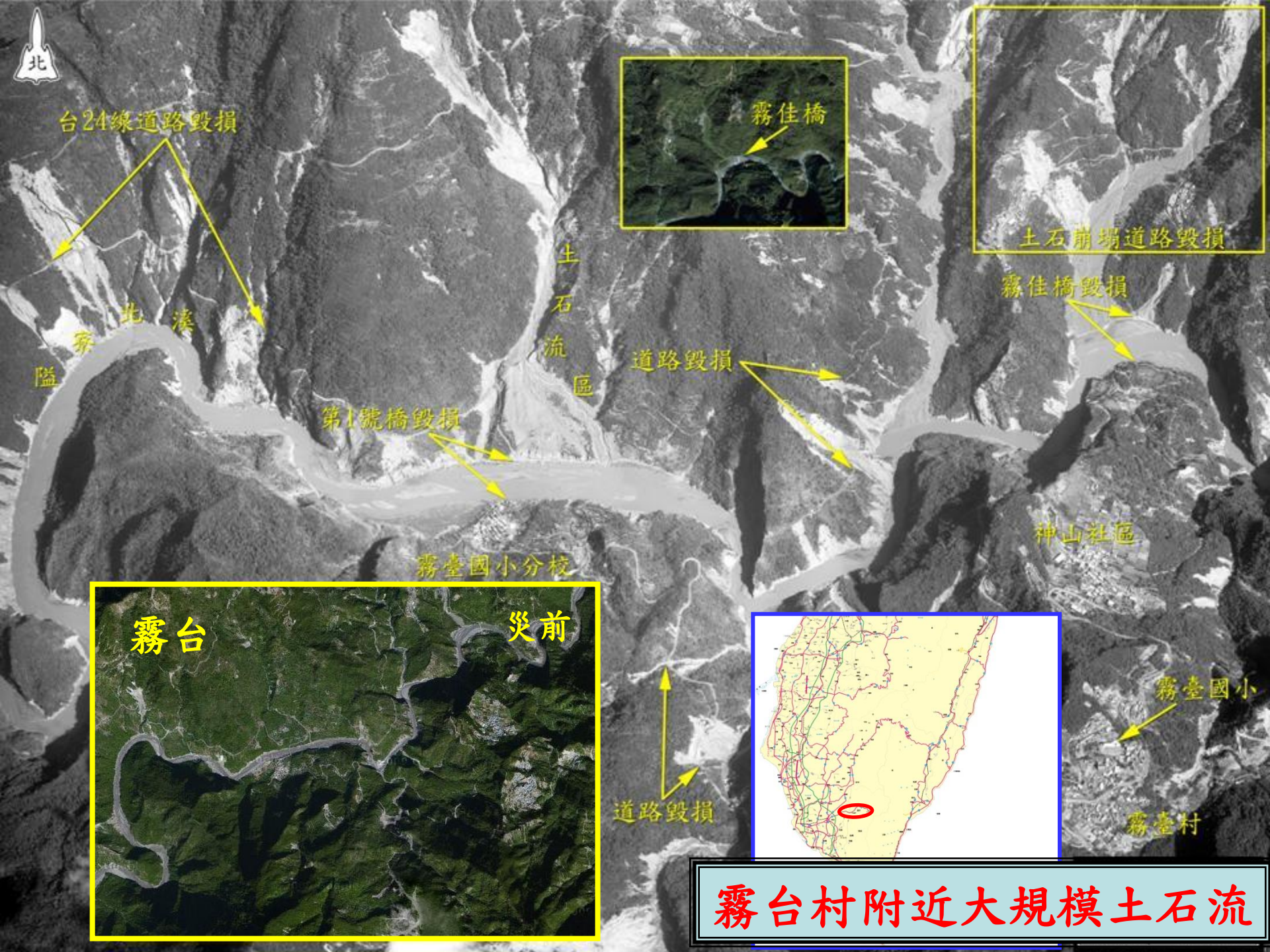

北
原小林村位置
原楠峯大橋位置
旗
山
溪
原第八號橋位置
台
21
線
角
埔
溪
災前
小林
81
災損前90.03.04
小林村土石流


河堤毀損
鐵路毀損
河堤毀損
橋面破損
道路毀損
土石流區
河堤毀損
災前
災損前98.06.03
太麻里河堤沖毀


北
台
鐵
集
集
線
第二隧道
振達砂石場
往水里
往林尾
濁
水
溪
台16線毀損路段
災前
集集水里段台16路堤沖毀



知本河川決堤、路堤沖毀



霧台村附近大規模土石流

Observations from of Typhoon Morakot

- **Extreme rainfall in very short period**
- **Large-scale and wide-rage compound disaster included flood, land slide, debris flow i in multiple locations**
- **Isolated areas due to interruption of communications traffic.**
  - **Severe damage to infrastructures like roads, bridges and dikes.**
- **Communications interruption**

Observations from of Typhoon Morakot

- **Response time of Emergency response challenged**
  - **Joint operation**
- **Insufficient handling of Information and situations**
- **Capacity at local levels**
- **Problems of land use, development project and public construction could worsen the damage.**
- **Difficulty of recovery**

Topics of flood, typhoon and land slide 1/2

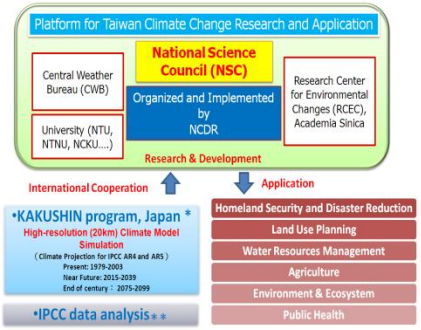
1)Conduct risk and potential analysis of floods and land slide to provide assessment in Central Emergency Operation Center.

2)Upgrade information to support needs in Central Emergency Operation Center

3)Carry out post-disaster investigation to identify the possible causes.

4)Continue research on enhancing operation and efficiency.

Topics of flood, typhoon and land slide 2/2



training

exercise

5) Coordinate a task force to provide a collective information platform of climate change.

6) Develop adaptation strategy of Climate change, especially for disaster risk reduction.

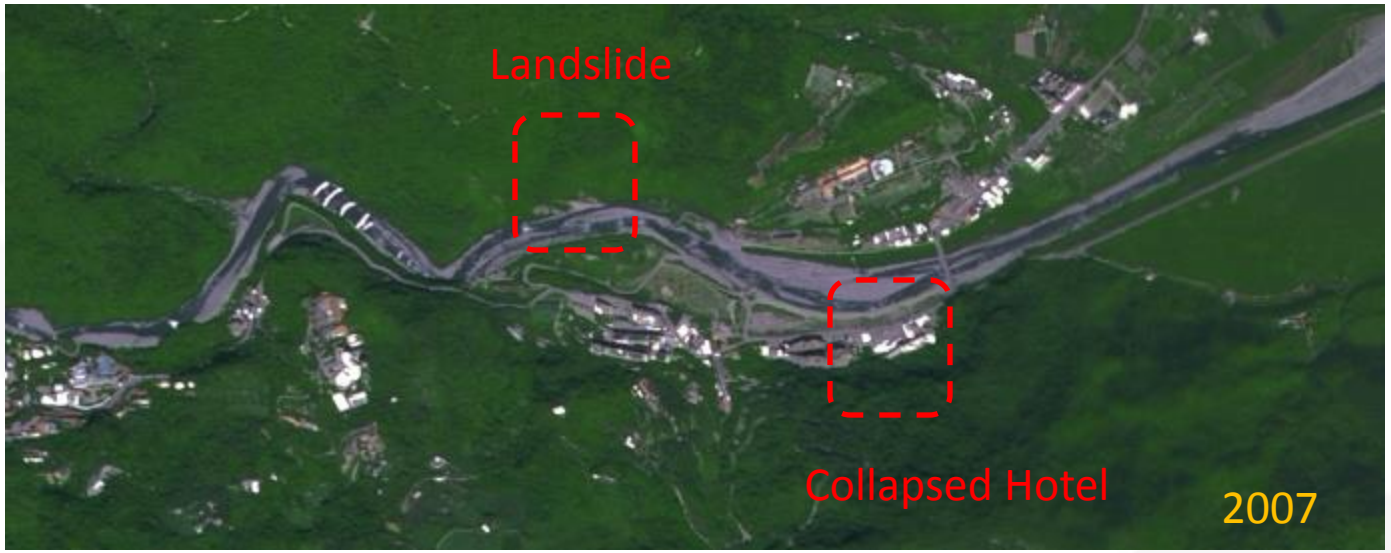
7) Promote and implement Community-Based Disaster Management

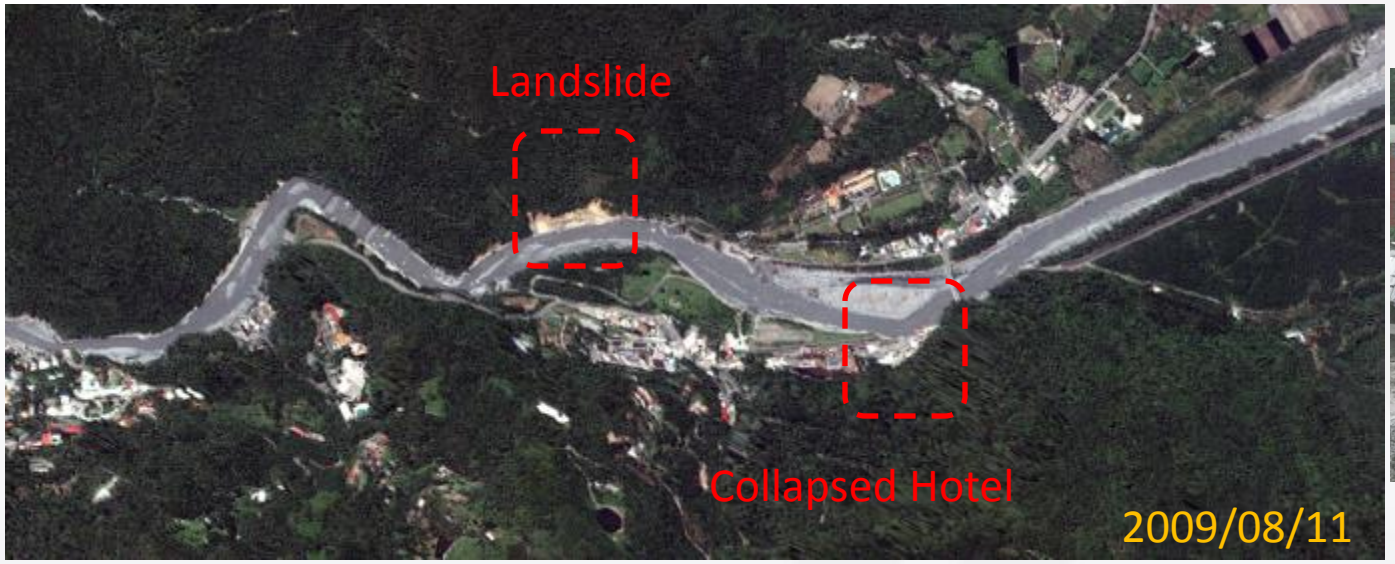
8) Propose suggestions related to recovery issues after Typhoon Morakot

Damaged Levees by flood water

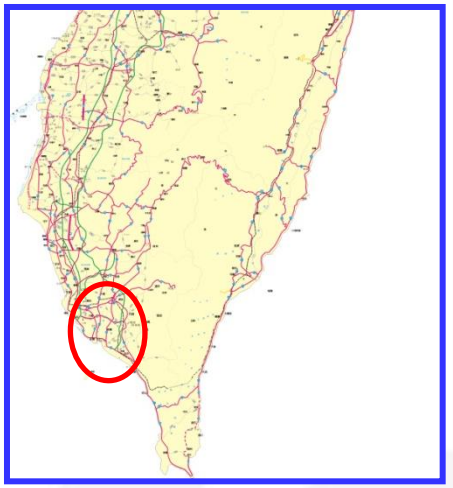
- InTaimali Township of Taitung County, east coast

Damaged Levees and Collapsed Hotel
In Chihpenof Taitung County

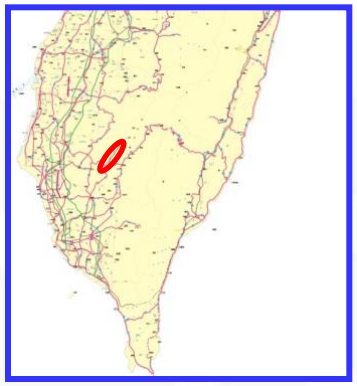




Floods in coast and low-lying areas of Pingtung County

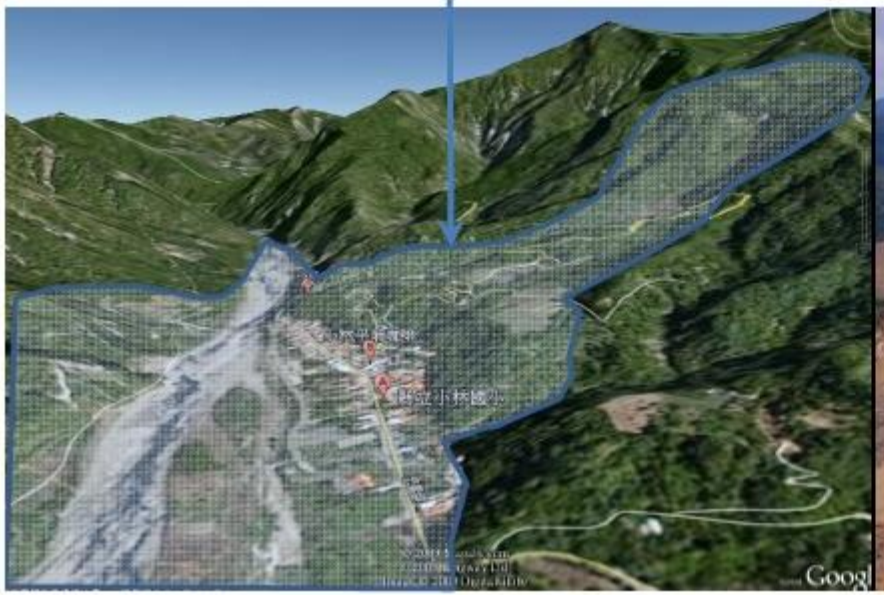


Siaolin Village
the hardest-hit area



- In Jiasian Township of Kaohsiung County
- 400 died and 53 missing
- Landslide, barrier lake and mudslide

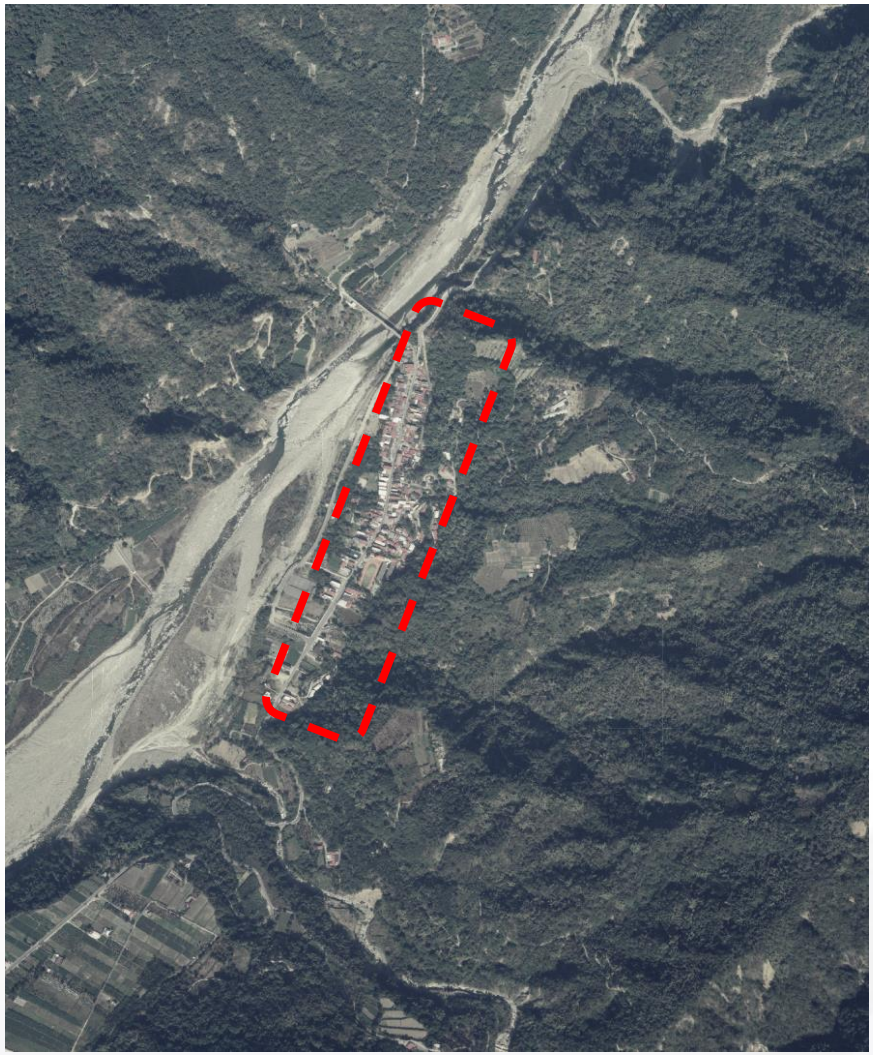
Buried Area



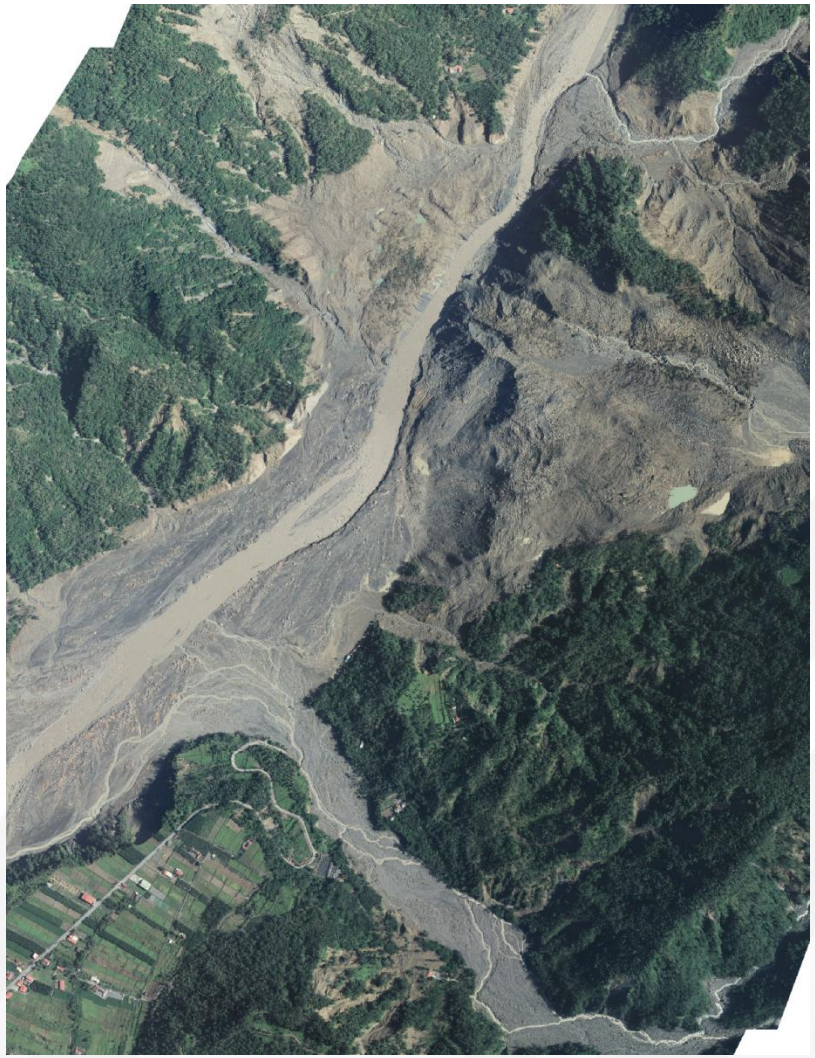
Before

After

Aerial imageries of Siaolin Village



Imagery in 2007



Imagery of Aug. 15, 2009

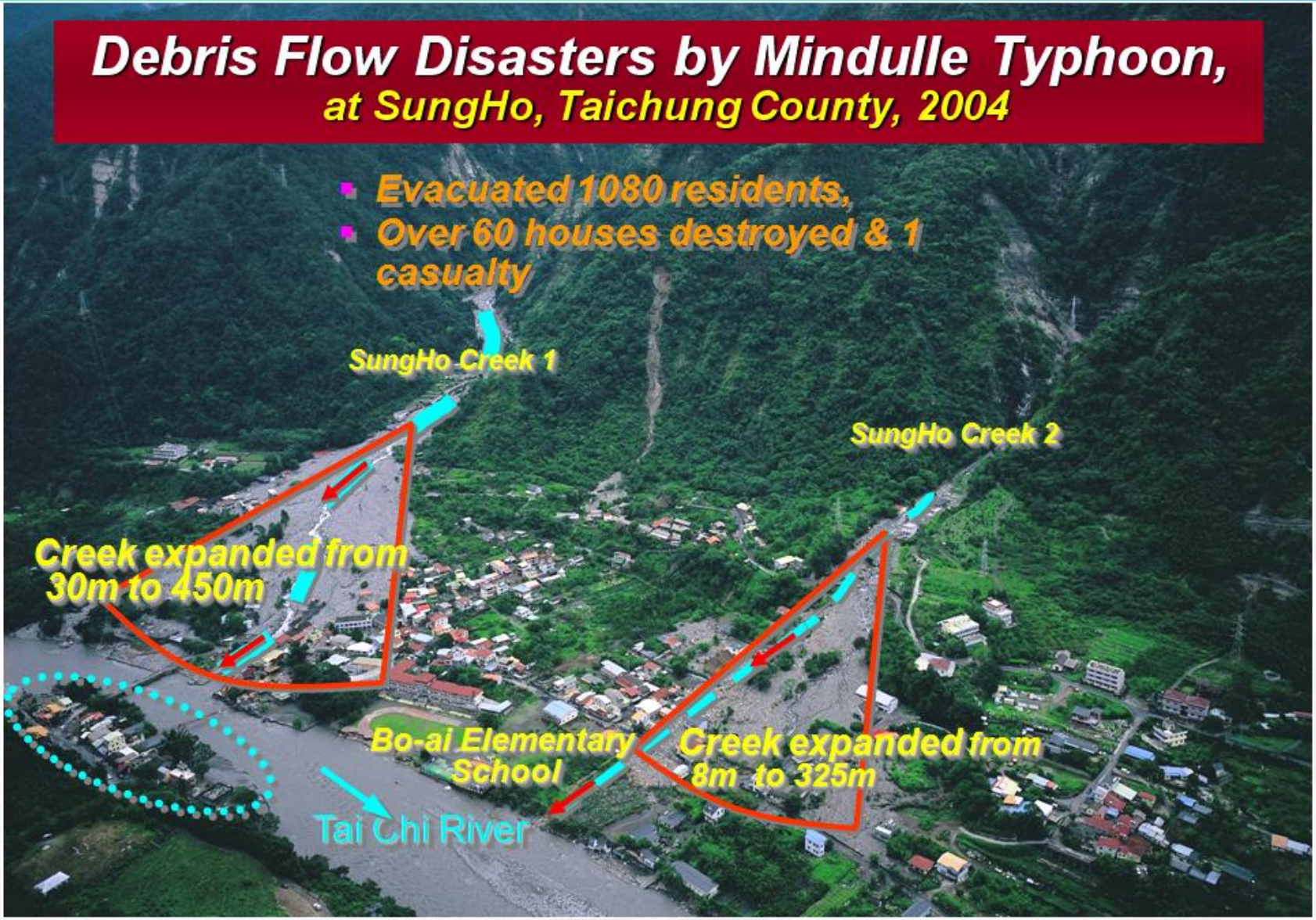
Progressive Improvement against Typhoons

Typhoon Event	Maximum Intensity (mm/hr)	Total Accumulated Rainfall (mm)	Evacuation (Person)	Ceased and Missing (Person)
2001.07.28 Toraji	147	757	----	214
2001.09.17 Nari	142	1,462	24,000	104
2004.06.30 Mindulle	167	2,005	9,500	41
2005.07.18 Haitang	177	2,124	1,208	15
2005.09.01 Talim	119	766	1207	6
2005.10.02 LongWang	154	776	945	2
2006.07.12 Bilis	95	1,013	409	3
2007.08.16 Sepat	122	1,399	2531	1
2008.07.16 Kalmaegi	161	1,027	179	26
2008.07.28 Fung-Wong	121	830	1,303	2
2008.09.10 Sinlaku	97	1,608	1,987	22
2008.09.27 Jangmi	85	1,137	3,361	4
2009.08.07 Morakot	100	2,965	24,775	695

Precise Evacuation

Decreasing Death Toll

Case of Success in evacuation



Findings after the Typhoon Morakot (1/2)

- **Risk communication and perception**
  - Leading to different attitudes in face of warning
- **Frequent sever weather relate climate change**
  - Adaptation strategy for risk reduction
- **Compound disaster and countermeasures**
  - Typhoon triggers flood, landslide, mudslide and interruption of lifeline systems
- **Scenario-based measures by stages**
  - Shelters, response plan and codes….
- **Operation continuity of business and public sectors**

Findings after the Typhoon Morakot (2/2)

- **Integration and inter-agency sharing of Information**
  - **Static presentation vs. Dynamic Web-based GIS**
- **Reliable and robust communications system**
  - **Under harsh weather condition, how to build up multiple channels. Especially, in isolated areas.**
- **Scenario-based plans reviewed by performance-based evaluation**
  - **Indentify the disaster scale of protection level**

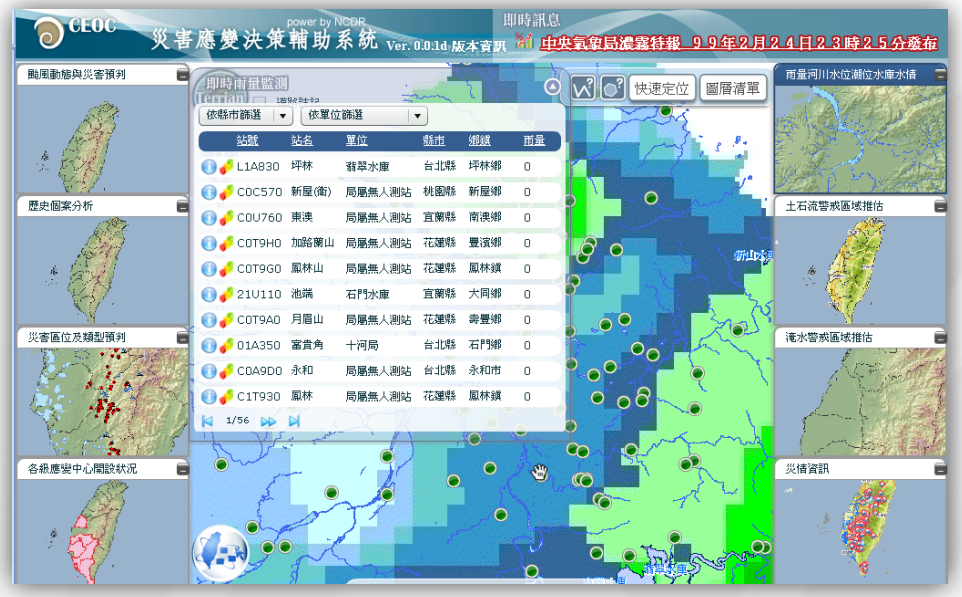
Information Integration

Challenage1: Lack of information integration

- ✓ Lots of individual systems, but linkages and integration
- ✓ Hard to apply for GIS overlapping

Solutions：

- ✓ Develop assisting system for exchange, linkage and integration
- ✓ GIS-based architecture



Warning | Monitoring | Remote Sensing | Situations | Operation

GIS-based Situation Awareness

Challenge: Static description of situations

- ✓ **Statistic data difficult to produce map**

solutions：

- ✓ **Situation + Spatial Description**

伍、災情統計

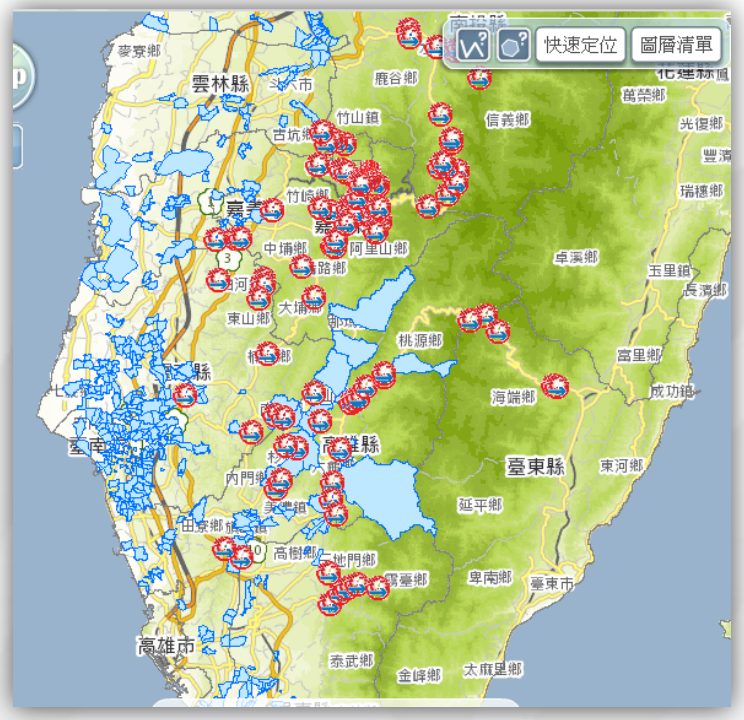
一、人命傷亡（資料來源：內政部消防署）

縣市別	死亡(人)	失蹤(人)	受傷(人)	備註
台北縣	0	0	10	
台南縣	0	0	1	
宜蘭縣	0	0	4	
南投縣	0	0	1	
花蓮縣	0	0	1	
台東縣	0	5	0	7 日 18 時民眾黃志峰於成功鎮白守蓮公墓海域放網捕魚不慎落海、達仁鄉南田村民黃榮貴 7 日早上自魚永產業道路進去約 15 公里路程捕魚未歸失聯。 8 日 18 時太麻里鄉溪水暴漲 3 人失蹤(員警 2 人江文祥、許金次，民眾 1 人不詳)。
屏東縣	0	2	0	8 月 7 日 16：00 屏東縣林邊水利園小外海約 100 公尺處，高雄籍漁船翻覆 3 人落海，其中 1 人（船長杜明南）自行游上岸，另 2 人（陳昭依、王德龍）失蹤待援。
高雄縣	1	1	2	8 月 7 日 18：10，一婦人（林王月珠，67 歲）於湖內鄉大湖村大湖社區活動中心東面基地旁溝渠騎乘機車，遭強風吹落溝渠死亡。 8 日 11:15 獲報女子 50 歲張簡美華落入高屏溪失蹤待援。
合計	1	8	19	

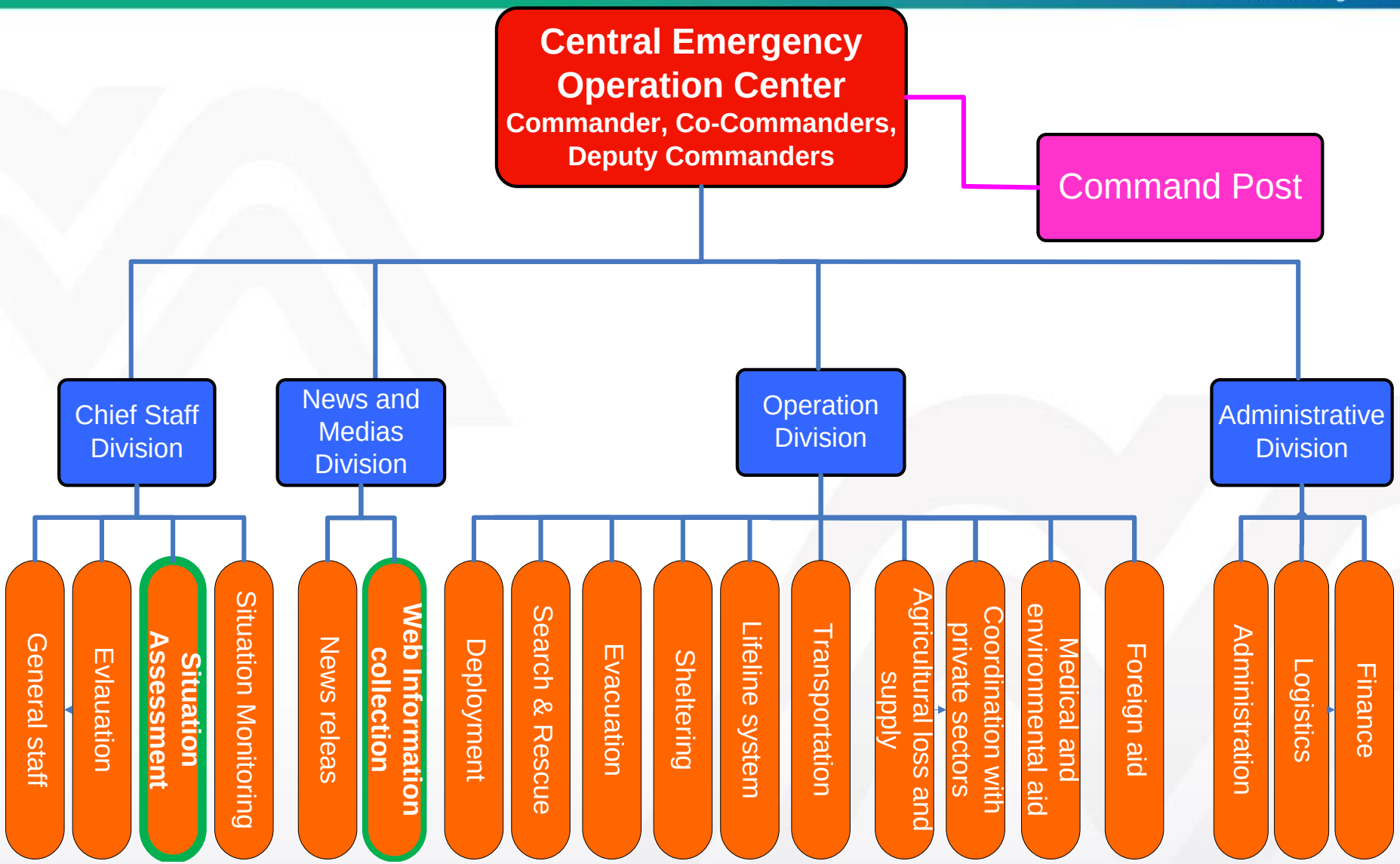
1. 高雄市區老榕樹墜傷人，經查證 1 男子（張榮耀，77 歲）走路不慎摔傷，本案不列入颱風災情。
2. 基隆港和平橋 1 女子（呂怡萍、39 歲）落海，救起時即無生命跡象，因死亡原因不明，尚待調查，故未列入本次颱風傷亡案件。

（四） 維生管線災情（資料來源：經濟部、國家通訊傳播委員會）

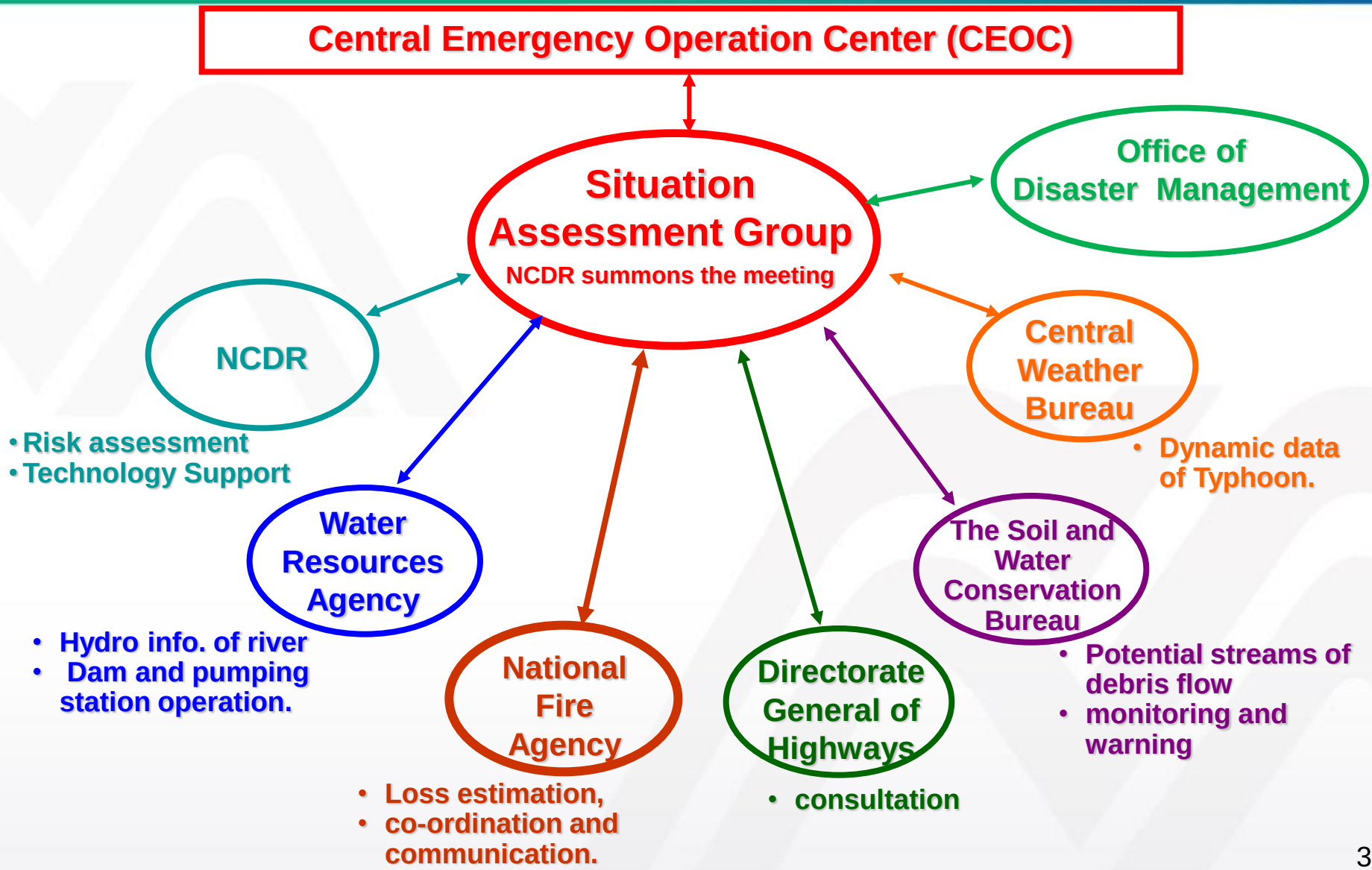
項目	影響數目	搶修完成(戶、處)	尚待修復(戶、處)	備註
自來水	54000	0	54000	
電力	1052330	948859	103471	
電信（市話）	38298	837	37451	
電信（基地台）	3064	2178	986	



Current Structural Chart of CEOC



Operation of the CEOC Assessment Group (Typhoon)



Three elements to succeed emergency response

Scientific Prediction	Rea-time Monitoring	In-time Operation
• Provide forecasting based on models • Tool for pre-disaster deployment • Reference for decision support • Limited by technology development	• Provide updated data based on gauges • Tool for pinpointing blind areas by forecast • Reference for revising decision support • Limited by number, location, transmission	• Provide reaction based on well-defined plan • Tool for saving more time before it's too late • Reference for allocating emergency support • Limited by determination of all-leve administrators

Thank for your attention