



The extreme events impact and disasters adaptation strategy – lessons learned from Typhoon Morakot

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Brief introduction of Typhoon Morakot

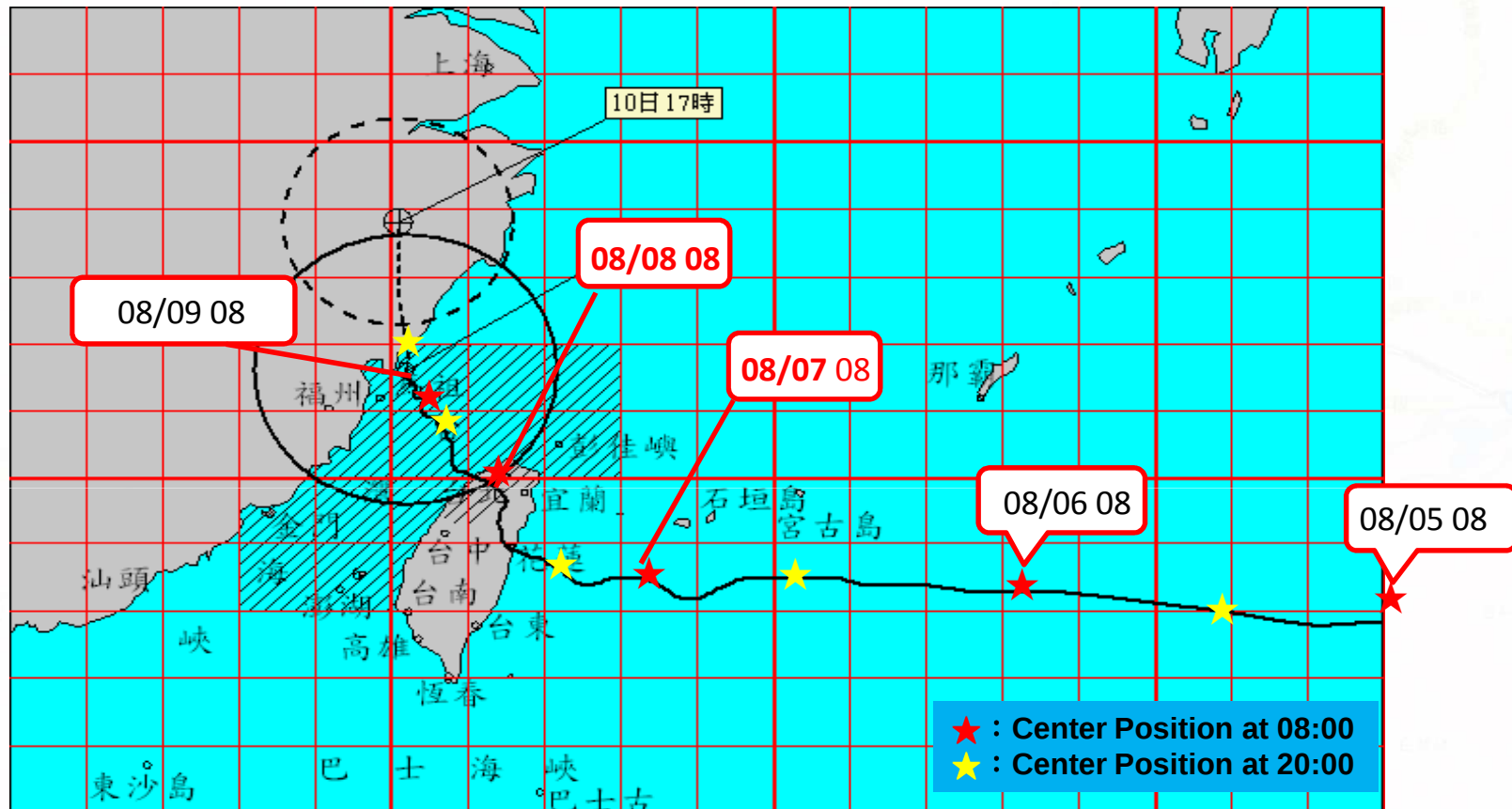
Disasters caused by Morakot

Adaptation Strategy for Extreme Disasters

Conclusion

Brief introduction of Typhoon Morakot

Typhoon Morakot : #8 in 2009

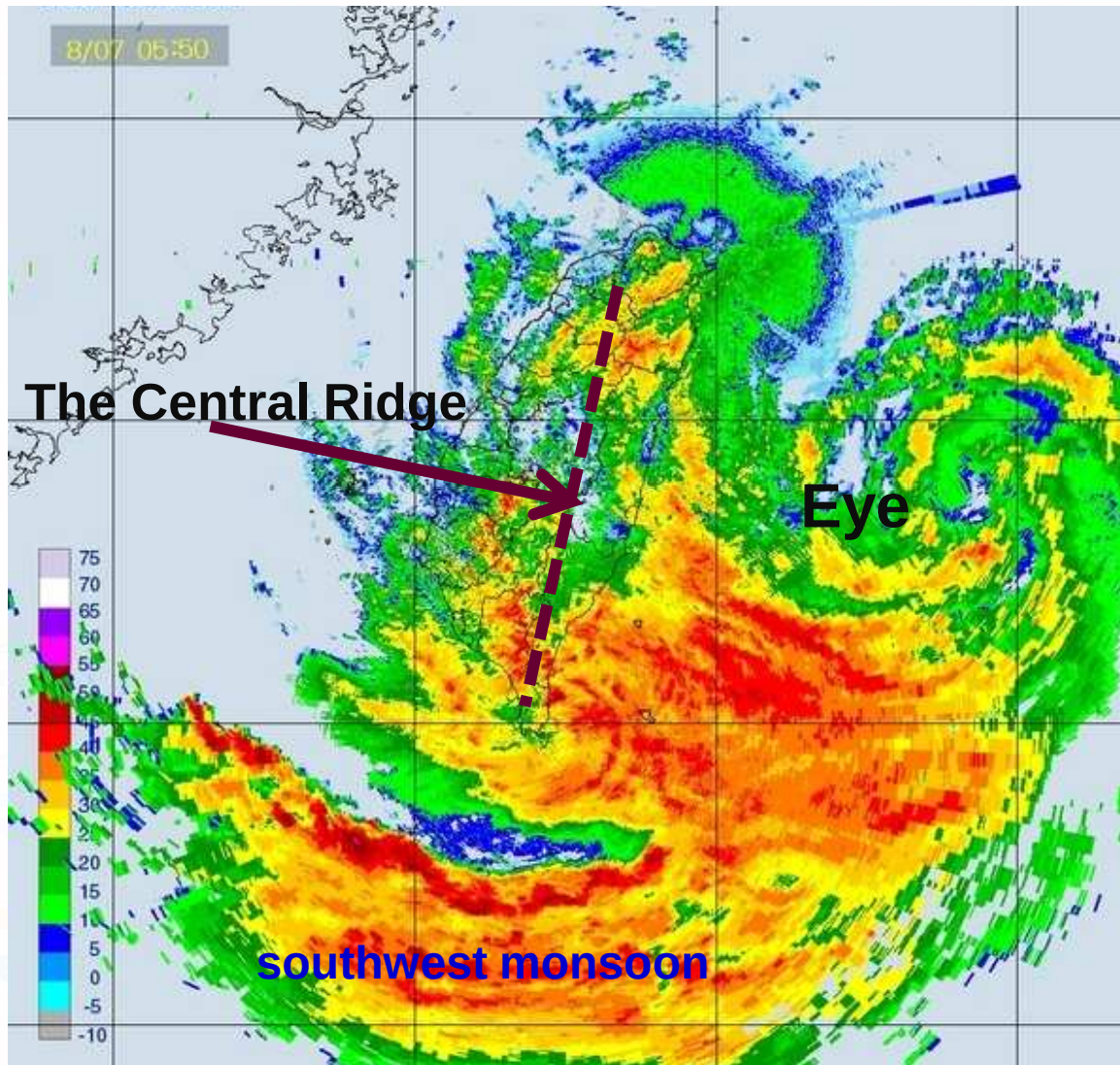


Aug 5-6: Moved fast toward Taiwan

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

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

Aug. 9 : Gradually moved toward China



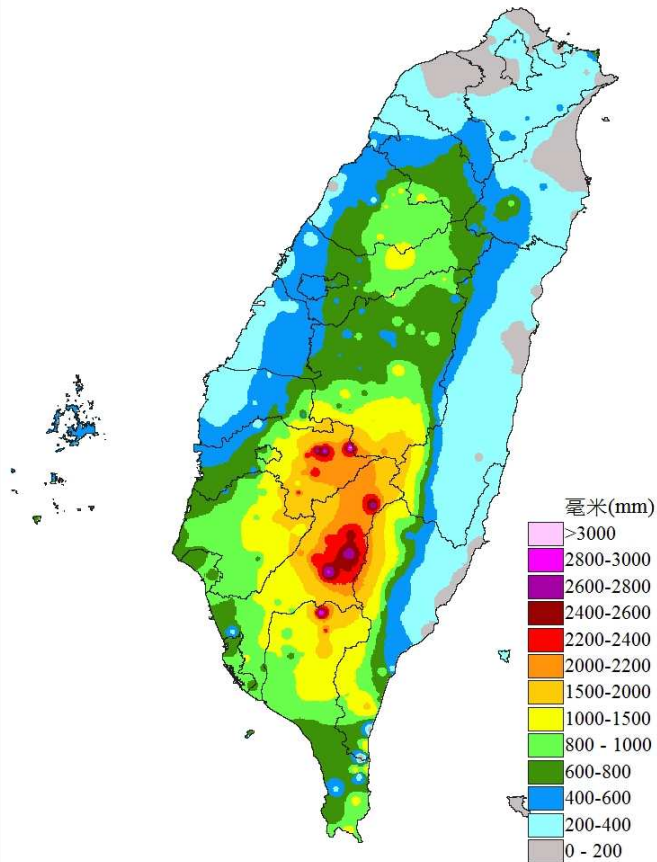
- Asymmetrical structure of rain clouds around typhoon
- The typhoon rain cloud interacted with supplying extra moisture by southwest monsoon result large amount of rainfall in the south of the island.



Amazing rainfall brought by Morakot



2009 Morakot 0805-0810 accumulated rainfall

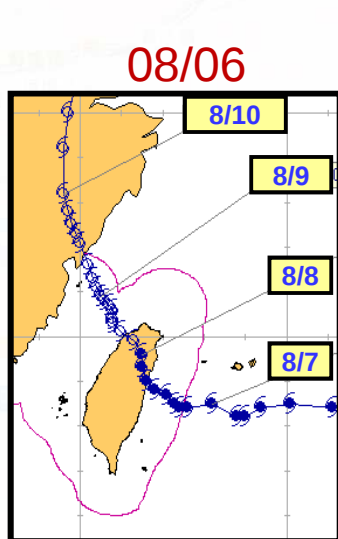
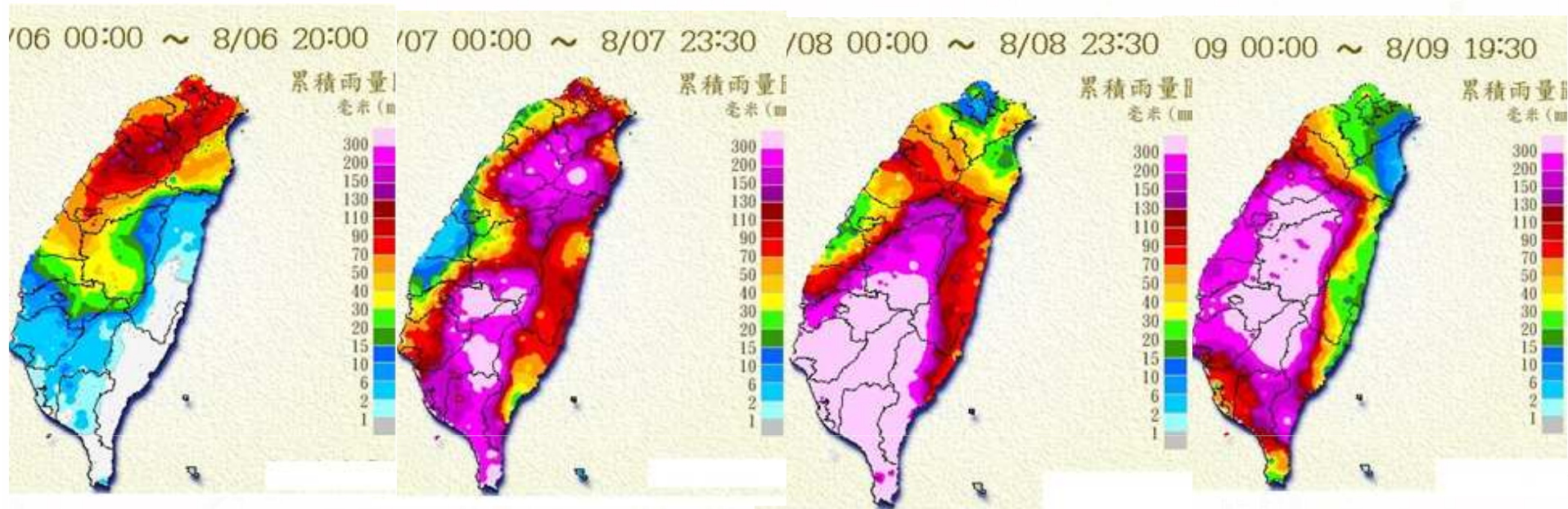


Record-breaking Rain-gauge Data



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%

- Heavy rainfall happened island wide.
- Almost 3000 mm of rainfall is found in this event.
- For Alishan => Morakot brought 76% of annual rainfall to Alishan in 5 days.
- The strength of rainfall brought by Morakot is the strongest in historical records.



08/07

Rainfalls started
concentrating in
the south



08/08

Floods along the
low-lying coastal
areas

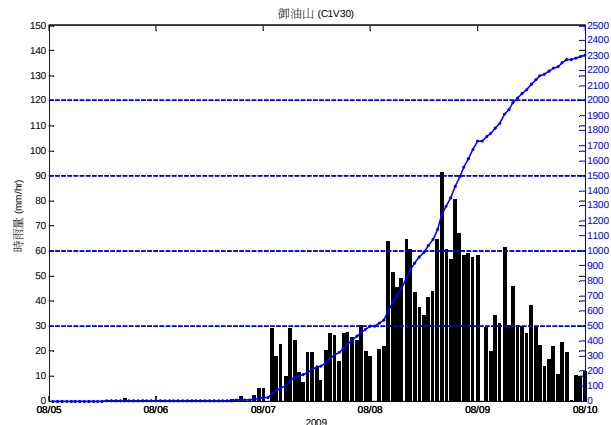


08/09

Landslide and
Mudslide in the
souther part



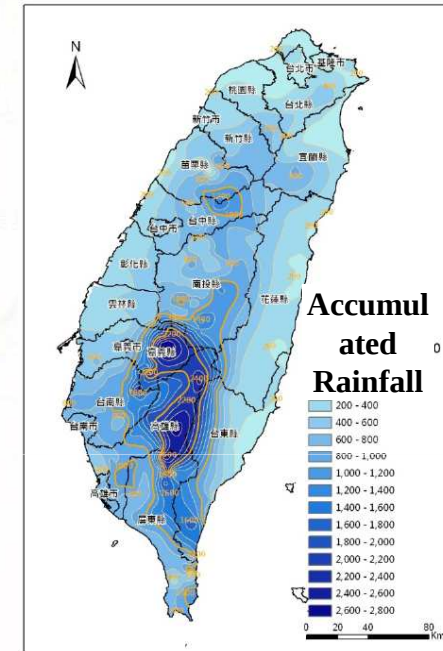
Long duration of heavy rainfall



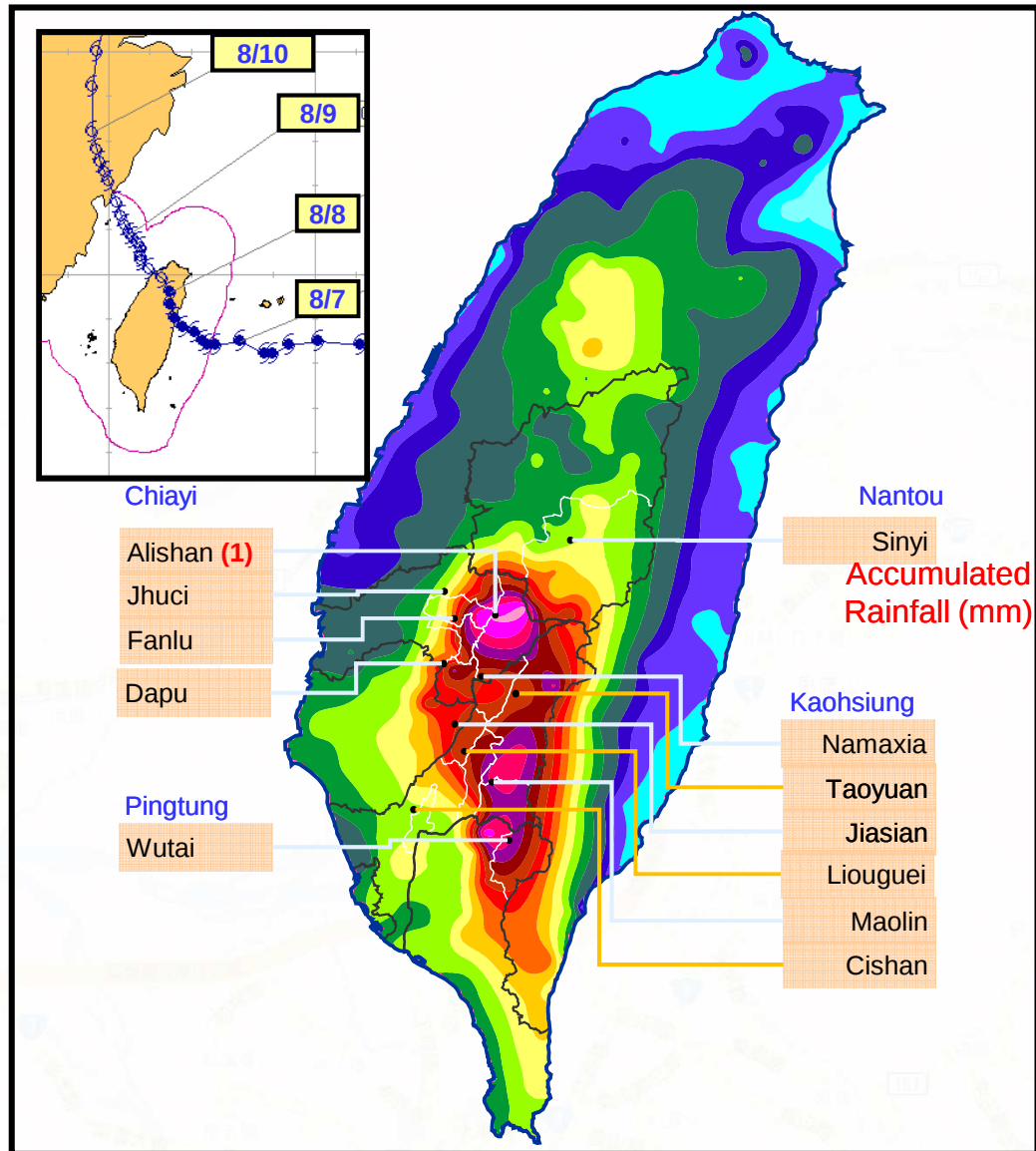
Complex topography



Extreme rainfall



- Heavy rainfall (50-60 mm/hr) lasts for over 24 hours.
- Area of the Island is about 36000 Km^2 , **over 70% in slope land.**
- *Extreme rainfall is observed mainly in mountain areas.*



- Long duration, high intensity, high accumulated rainfall depth
- About 9% area of Chinese Taipei was covered under the heavy rainfall ($\geq 2000\text{mm}$)
- Rainfall $> 2,000\text{mm}$ $\Rightarrow$ the most serious area



Gradual efforts in Taiwan to reduce death tolls related to typhoons



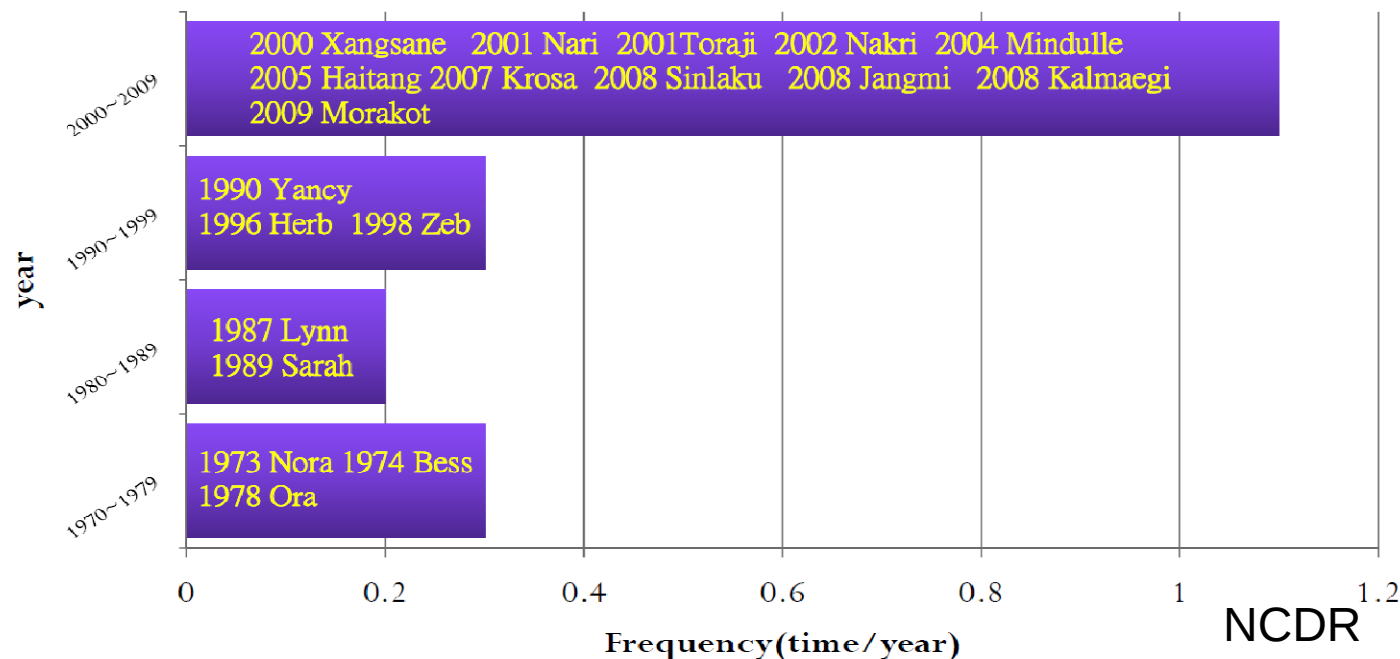
Typhoon	Maximum Rainfall Intensity (mm/hr)	Total Accumulated Rainfall (mm)	Evacuation (person)	Casualty and Missing (person)
90.7.28 Toraji	147 Hualien County	757 Nantou County	----	214
90.9.17 Nari	142 Yilan County	1,462 Yilan County	24,000	104
93.6.30 Mindulle	167 Nantou County	2,005 Kaohsiung County	9,500	41
94.7.18 Haitang	177 Pingtung County	2,124 Pingtung County	1,208	15
94.9.1 Talim	119 Chiayi County	766 Kaohsiung County	1,207	5
95.7.12 Bilis	95 Pingtung County	1,013 Pingtung County	409	3
96.08.16 Sepat	122 Pingtung County	1,399 Pingtung County	2531	1
97.07.16 Kalmaegi	161 Tainan County	1,027 Kaoshiung County	179	26
97.09.10 Sinlaku	97 Nantou County	1,608 Taichung County	1,987	22
97.08.08 Morakot	139.5 Chiayi County	3060 Chiayi County	24,950	698

NCDR

- number of casualties is decreasing in the last ten years
- unpredictability and diversity of natural disasters can still be found from events of Morakot, Kalmaegi and Sinlaku.

Climate Variability of Extreme heavy rainfall based on index of top 20 typhoons

The top 20 extreme heavy rainfall typhoons during 1970~2009



Frequency of Typhoons accompanied with heavy rainfall :

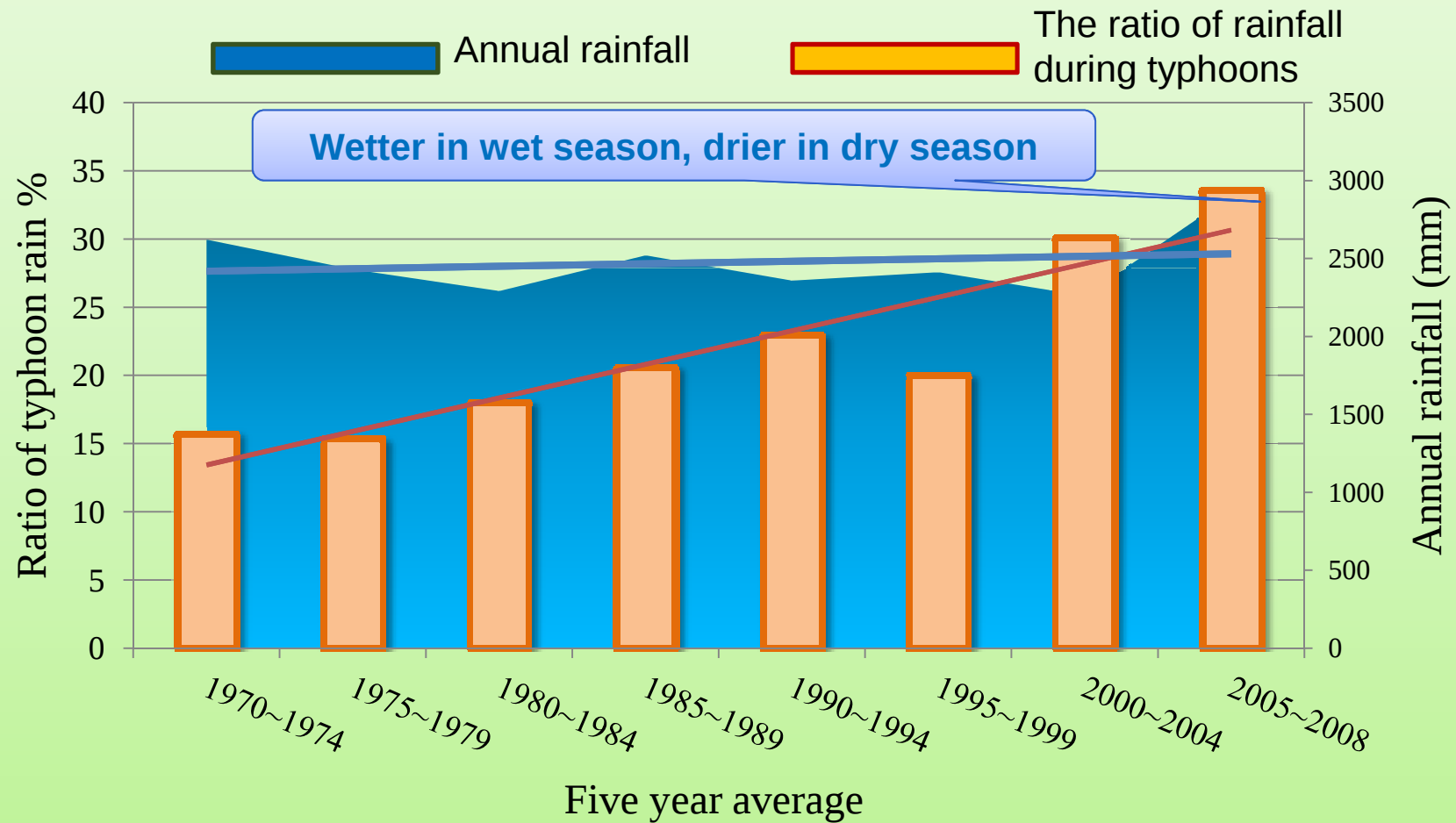
Before 2000 => once per 3~4 years

After 2000 => once per 1 year

Taiwan has suffered from serious flooding and typhoon disasters
more frequently in recent years



The Changing Seasonal Distribution of Rainfall



Disasters caused by Morakot

(1) Wide area of *Flooding*



Source: 成功大學防災中心、元智大學¹⁴



(2) Numerous places of *Land slope disaster*



Source: MPRC

(3) Massive deep landsliding



**More than 400
killed at this area**



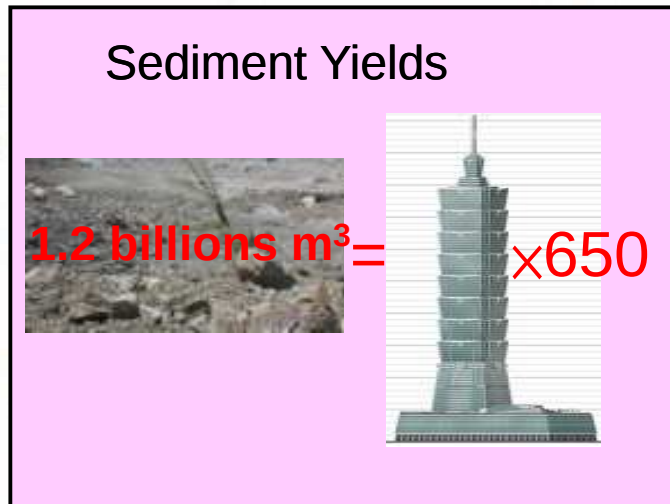
32 killed at this area

Soil Deposition in Rivers

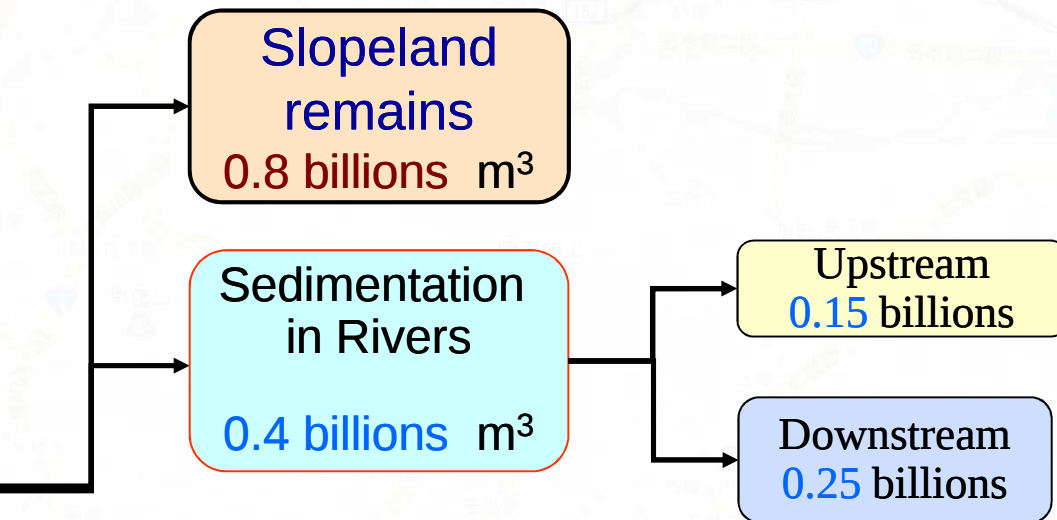


➤ More than **394.92 km²** hill collapse or landslide during Morakot

➤ The land collapse produced **1.2 billion m³** sediment. Only **0.4 billion m³** was taken with flood, **0.8 billion m³** sediment was still accumulated on hill slope



Source: SWCB



Before



After



(4) Damages of infrastructure



Roads



Bridges



(5) Problem of driftwood

Total amount of driftwood is
about **1.33 million ton**
(Forestry Bureau)

