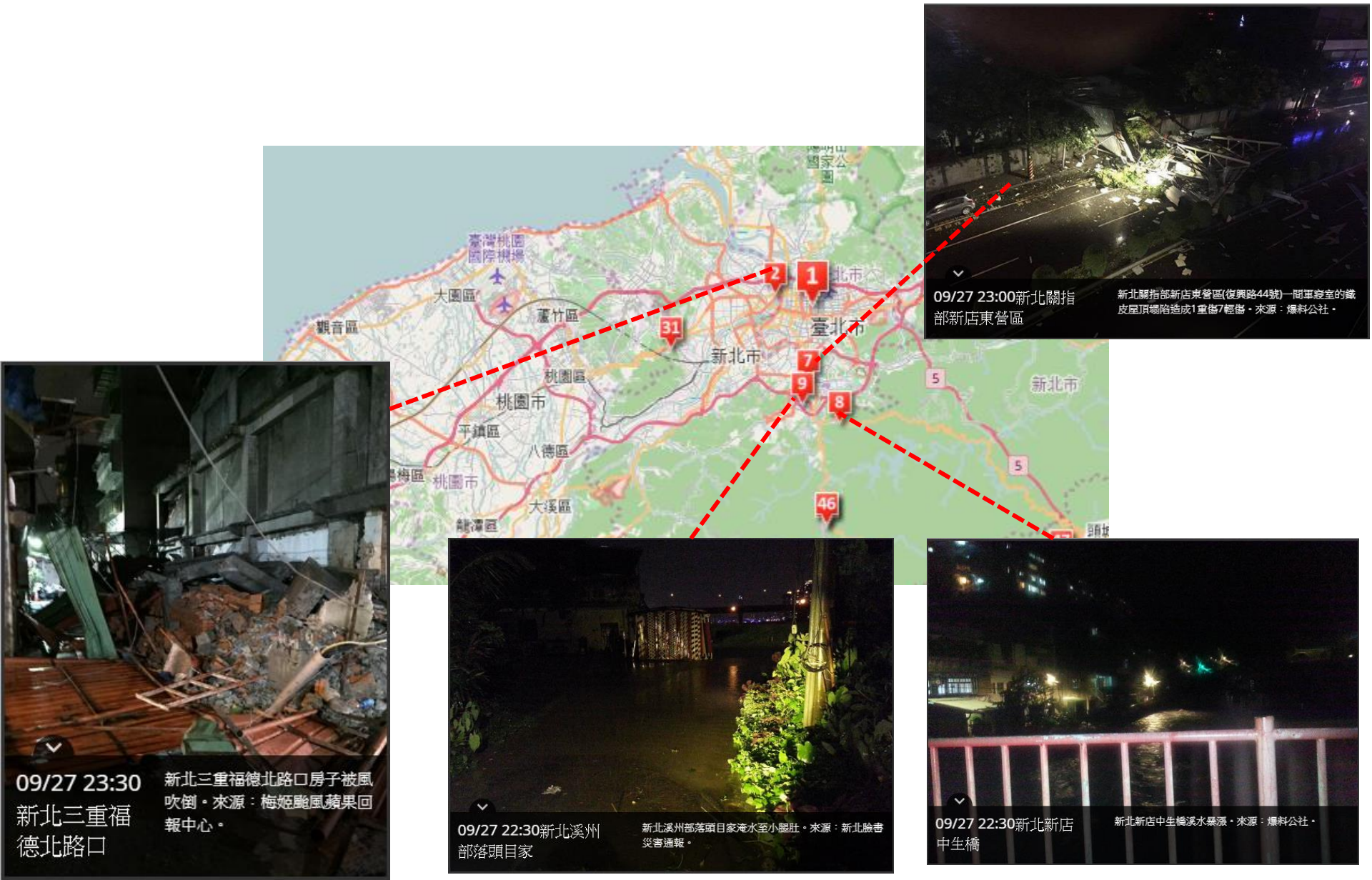
行政法人 國家災害防救科技中心
National Science and Technology Center for Disaster Reduction

Flood Disaster Early Warning under High-intensity Rainfall

Jang, Jiun-Huei

2016.09.29

Disasters, Megi (New Taipei City)



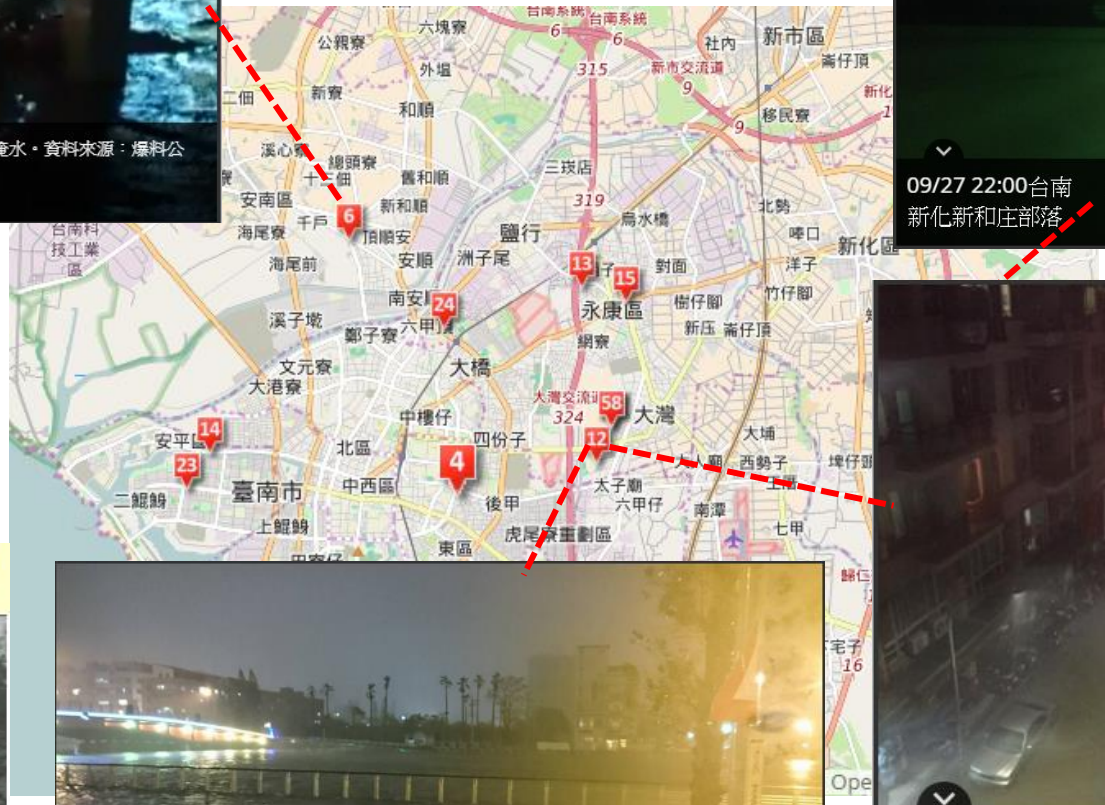
Disasters, Megi (Tainan)

09/27 23:00台南市安南區安中路一段

台南市安南區安中路一段淹水。資料來源：爆料公社。

09/27 22:00台南新化新和庄部落

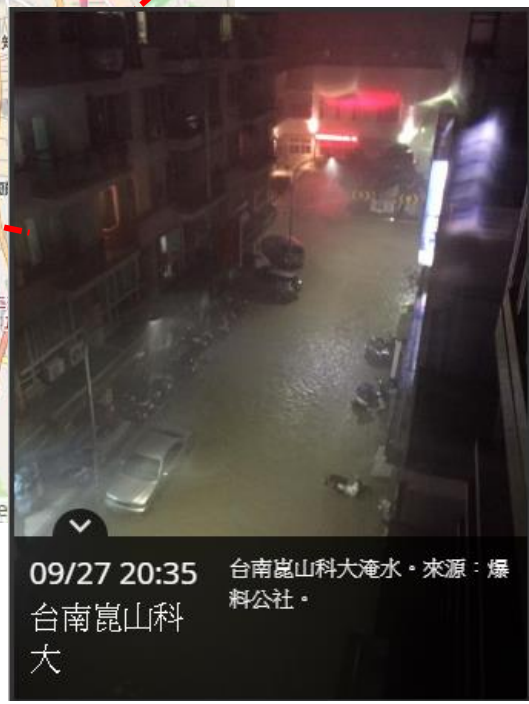
台南新化新和庄部落淹水一層樓。來源：爆料公社。



位　　置：臺南市安平區 安億路外停車場
影像來源：臺南市政府

09/27 21:00台南運河安平路附近

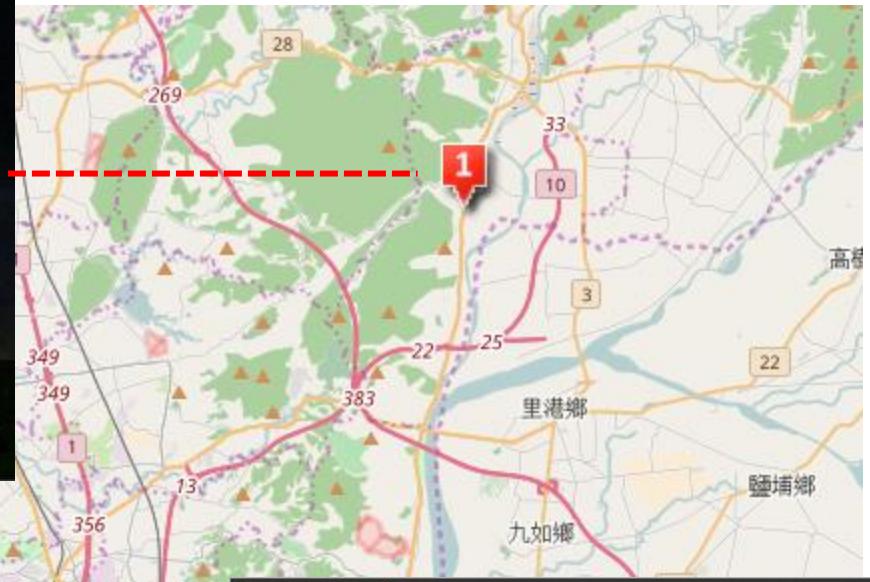
台南運河安平路附近運河水位滿出來了。來源：臉書。

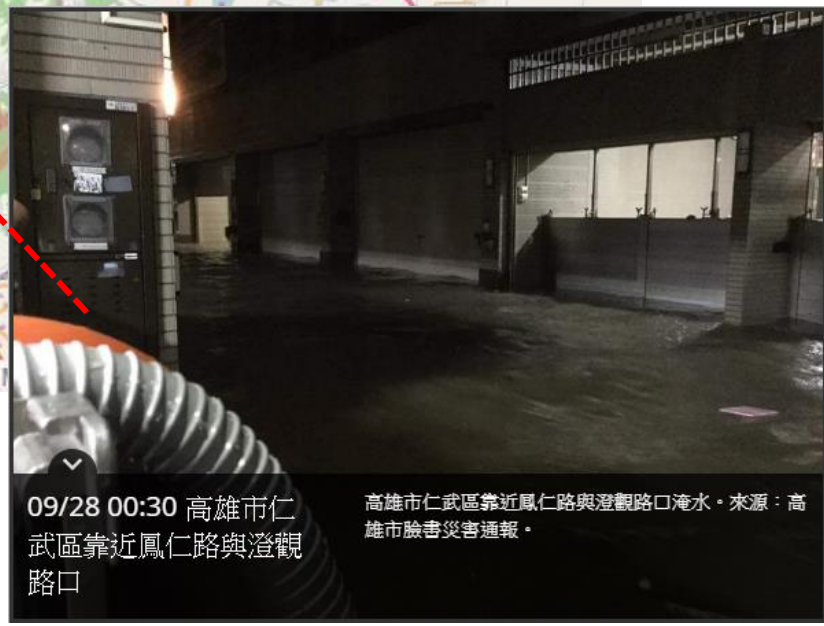


09/27 20:35台南崑山科大

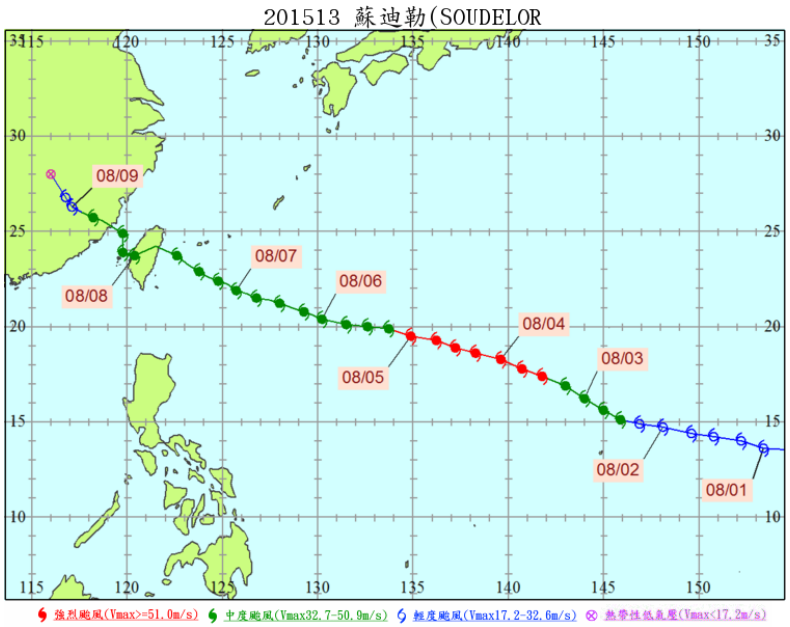
台南崑山科大淹水。來源：爆料公社。

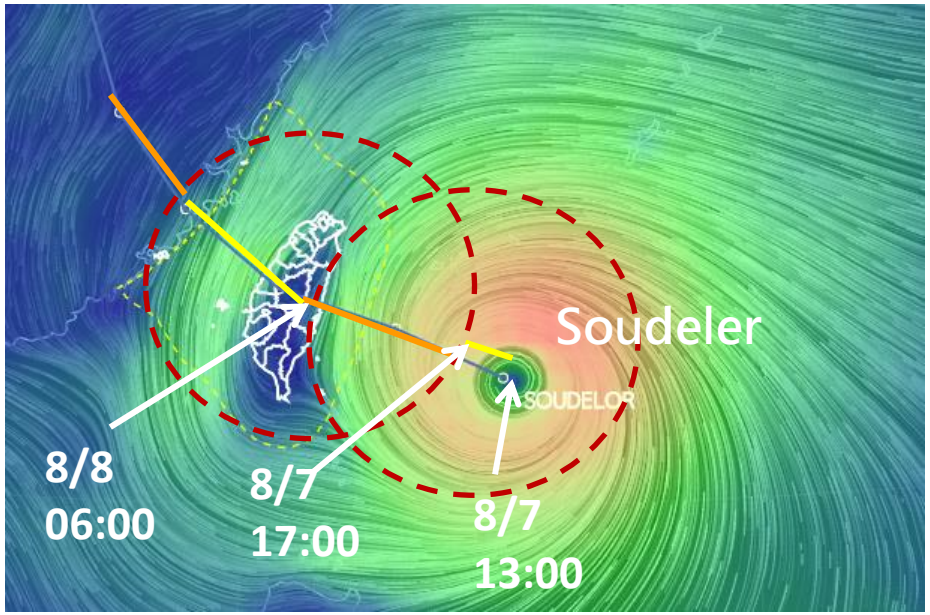
Disasters, Megi (Kaohsiung)





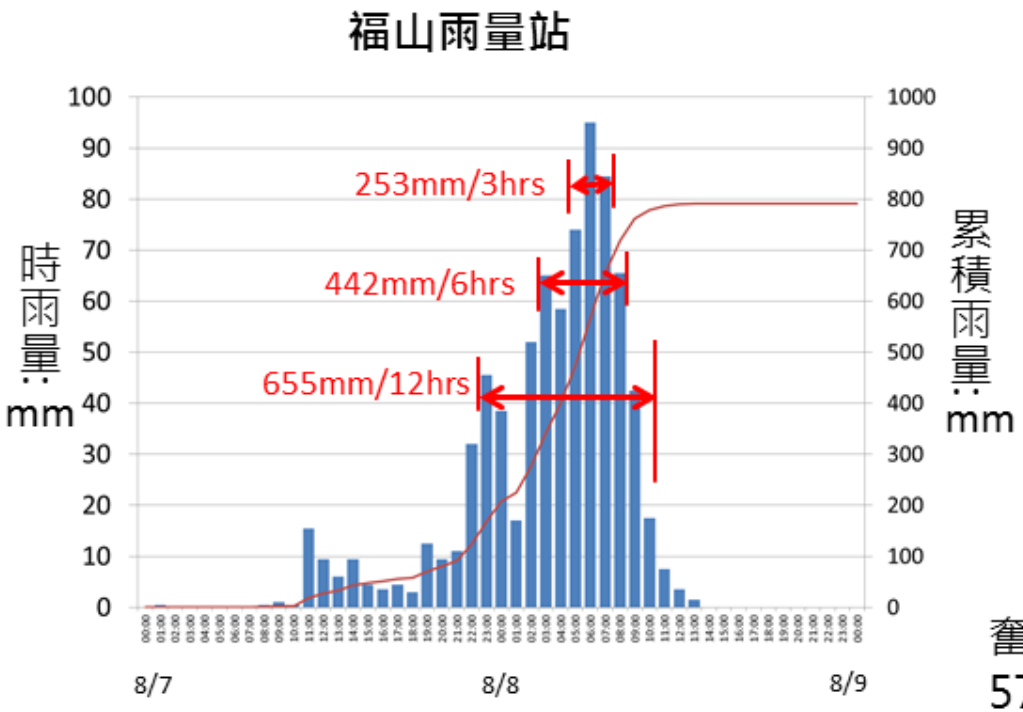
Typhoon Soudeler

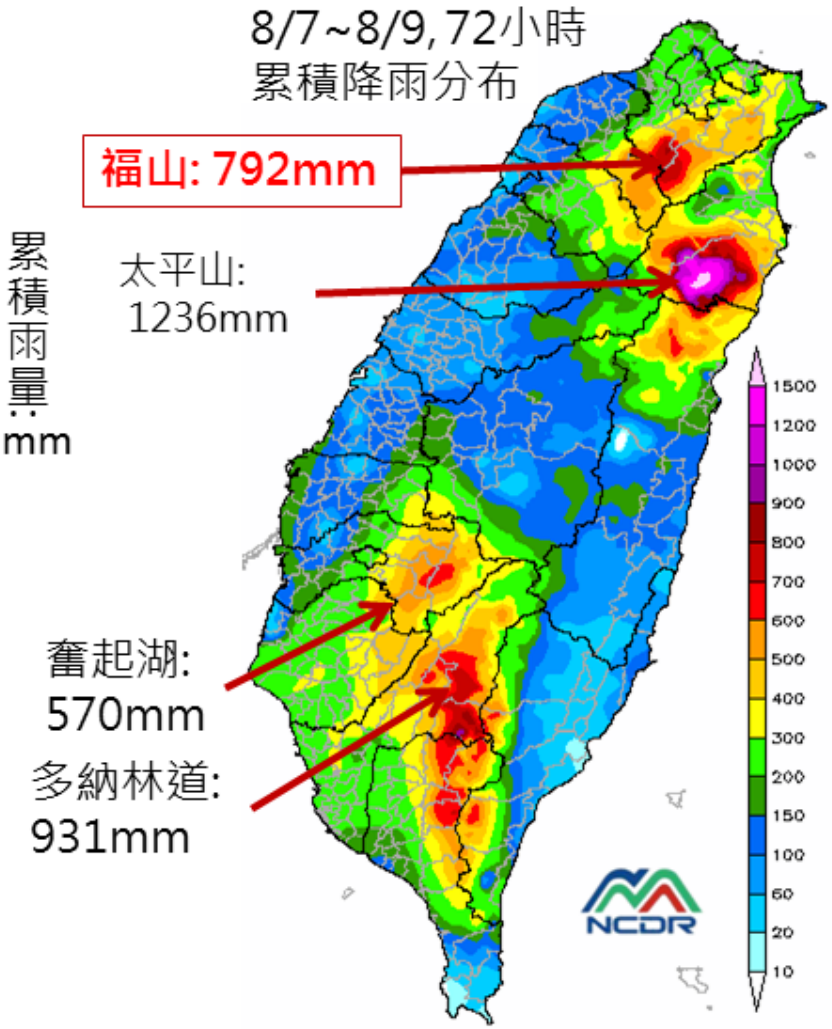




- No. 13 in 2015; hit Taiwan during 8/8-8/9
- Max sustained winds 285 km/h (Category 5, SSHS)
- 420 people injuries, 4.85 million households lost electricity (the largest blackout on record in Taiwan due to a typhoon)
- Crop losses reached US$14.3 million

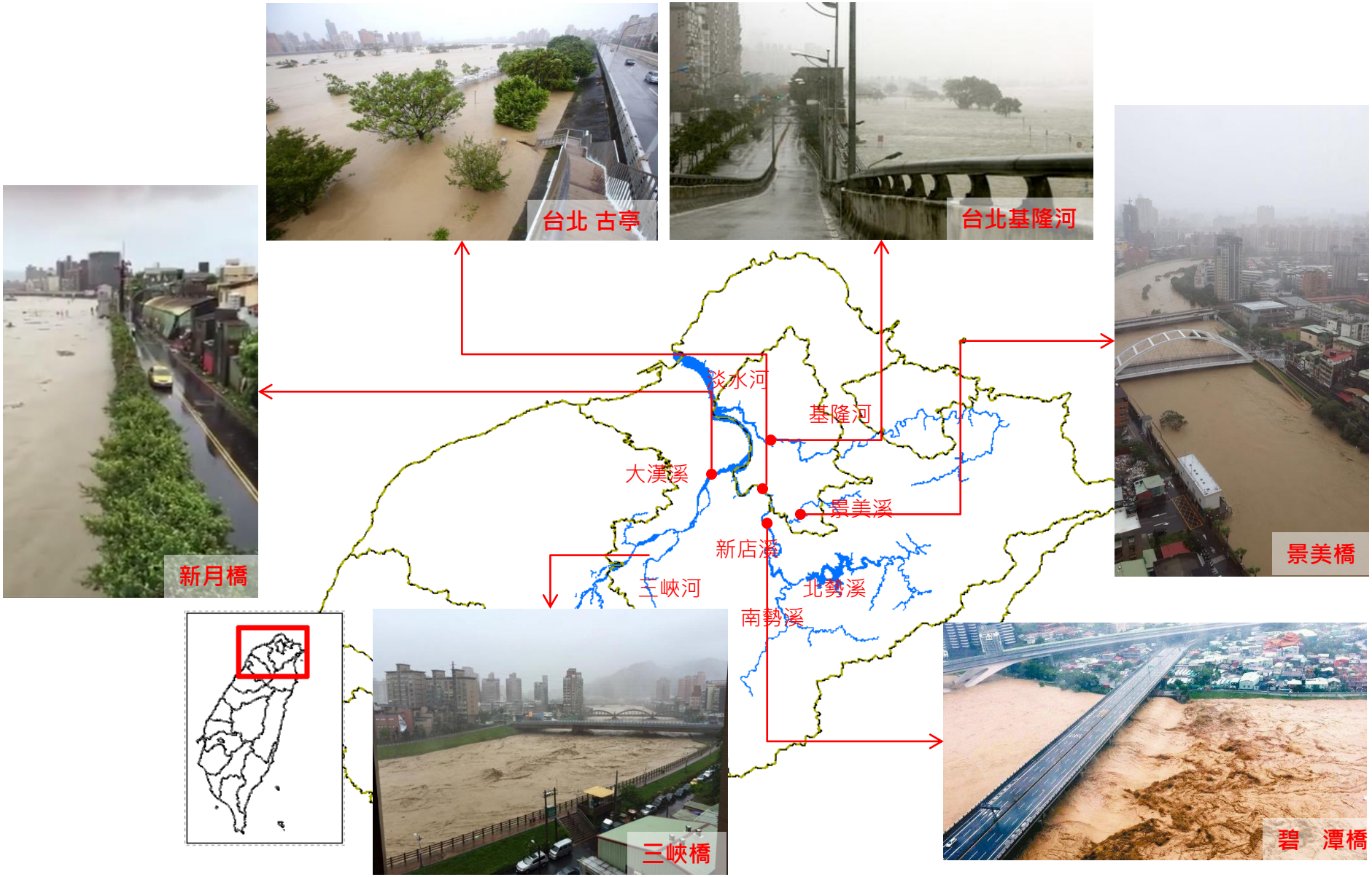
Rainfall Statistics



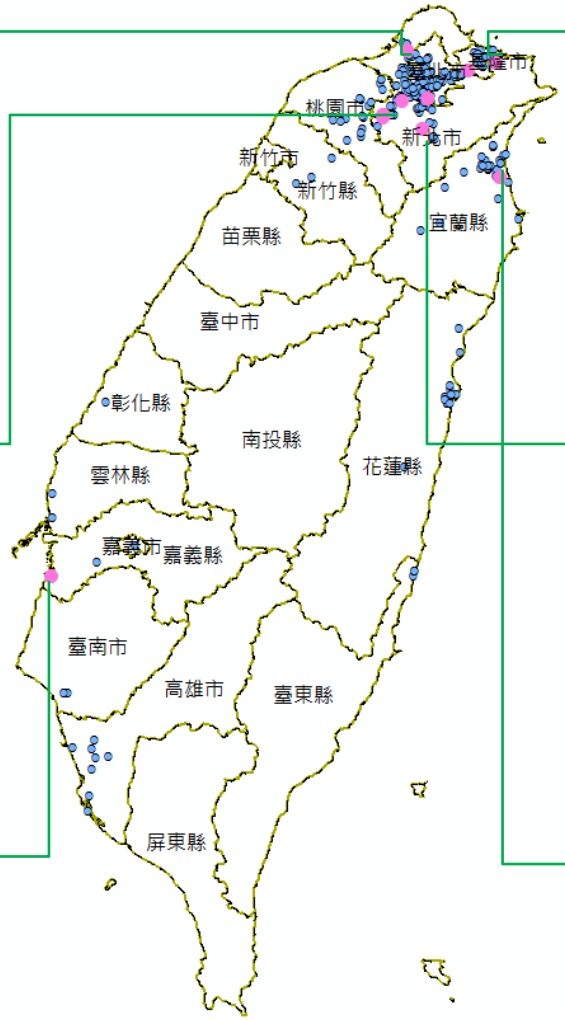


The rainfall at Fusan Station reached 722mm /24 h , breaking historical records.

River Surge in the Greater Taipei



Flood Disasters



資料來源:WRA

Slope Disasters in the North

Wulai District, New Taipei City, Pingguang Road is cut off by Collapses and residents are trapped in mountains.
(照片來源：蘇迪勒颱風中央災害應變中心第9次工作會報）

Fu-Hsing District, Taoyuan City, residents in Heliou Tribe have been evacuated in advance, a dozen houses were damaged. Landslide wiped out villages（照片來源： 聯合報）

Flash Flood along Pingguang River

During Typhoon Soudeler, Guangxing Village in New Taipei City, the flash soaring of upstream Pingguang River washed down a lot of rocks and soil, resulting in blockage of river that destroyed houses riverside.

Turbidity Rise Polluted Drinking Water

Nanshi River suffered a drastic turbidity rise that overwhelmed the regional purification system. 5 million households drinking water was polluted for several days.

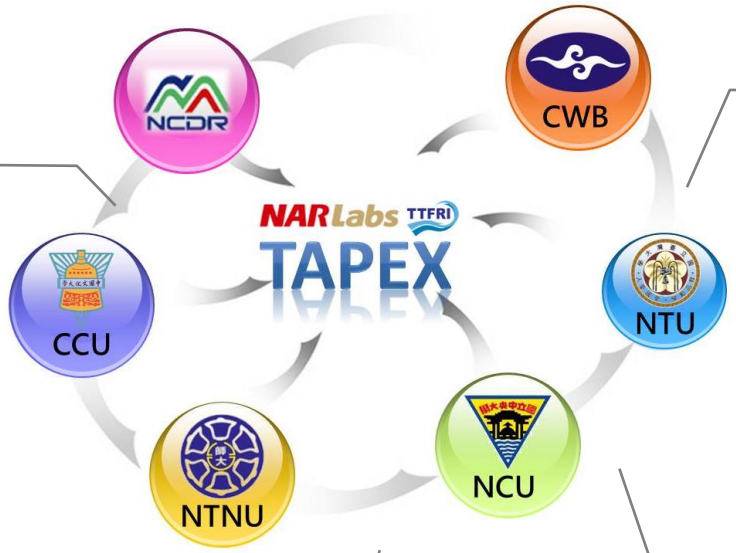
Ensemble Rainfall Forecasts

TAiwan cooperative Precipitation Ensemble forecast eXperiment

Source: TTFRI

Output data :

a) Hourly rainfall (grid size=5km)
b) Hourly typhoon track
c) Data updated each 6 hour (00,06,12,18UTC)



Multi-regional models :

ARW-WRF, MM5, Hurricane WRF, CreSS

Perturbation methods :

a) Physics (Cumulus)
b) Cold start / Partial cycling
c) I.C. & B.C.

Services :

a) Hourly rainfall connect to hydrology research and operational application.
b) Hourly rainfall for disaster reduction.

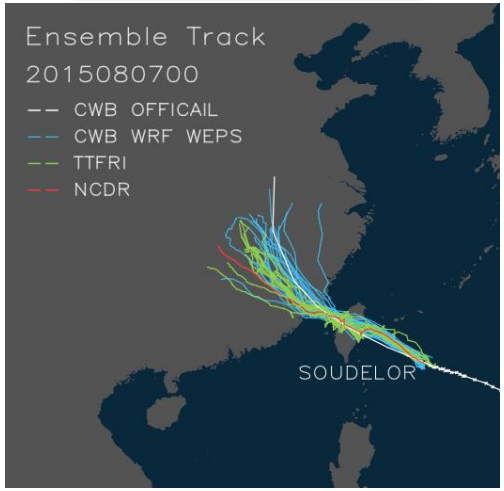
Ensemble Members in TAPEX, 2013

Source: TTFRI

#-Group	model	ICs			LBCs	Cumulus scheme	Microphysics scheme	Boundary Layer	note
11-C1	WRF	partial cycle	3DVAR (CV5+OL)		NCEPGFS	KF	Goddard	YSU	with blending
01-C2	WRF	partial cycle	3DVAR (CV5+OL)		NCEPGFS	GD	Goddard	YSU	
02-C3	WRF	partial cycle	3DVAR (CV5+OL)		NCEPGFS	G3	Goddard	YSU	
03-C4	WRF	partial cycle	3DVAR (CV5+OL)		NCEPGFS	BMJ	Goddard	YSU	
06-C5	WRF	cold start	3DVAR (CV5+OL)		NCEPGFS	KF	Goddard	YSU	
07-C6	WRF	cold start	3DVAR (CV5+OL)		NCEPGFS	GD	Goddard	YSU	
08-C7	WRF	cold start	3DVAR (CV5+OL)		NCEPGFS	G3	Goddard	YSU	
09-C8	WRF	cold start	3DVAR (CV5+OL)		NCEPGFS	BMJ	Goddard	YSU	
10-I1	WRF	partial cycle	3DVAR (CV3)		NCEPGFS	KF	Goddard	YSU	
12-I2	WRF	partial cycle	3DVAR (CV3)		CWBGFS	KF	Goddard	YSU	
04-I3	WRF	partial cycle	3DVAR (CV5)		NCEPGFS	KF	Goddard	YSU	
05-I4	WRF	partial cycle	3DVAR (CV5+OL)		NCEPGFS	KF	Goddard	YSU	no RO data; VS 11
13-I5	WRF	cold start	3DVAR (CV3)		NCEPGFS	KF	Goddard	YSU	
14-I6	WRF	cold start	3DVAR (CV5)		NCEPGFS	KF	Goddard	YSU	
15-I7	WRF	cold start	3DVAR (CV5+OL)		NCEPGFS	KF	Goddard	YSU	no RO data; VS 06
16-O1	CreSS	cold start	NODA		NCEPGFS	No CPS	Cold rain	Mellor and Yamada	grid size 5km
17-O2	CreSS	cold start	NODA		NCEPGFS	No CPS	Cold rain	Mellor and Yamada	grid size 2.5 km
18-O3	WRF	cold start	NODA		NCEPGFS	KF	WSM5	YSU	e_vert=28,two way,d03cu
19-O4	MM5	cold start	NODA		NCEPGFS	Grell	Goddard	MRF	
20-O5	MM5	cold start	4DVAR	bogus	NCEPGFS	Grell	Goddard	MRF	
21-H1	HWRF	cold start	NODA		NCEPGFS	SAS	Ferrier	NCEP GFS	45/15/5
22-H2	HWRF	cold start	NODA	HWRF bogus	NCEPGFS	SAS	Ferrier	NCEP GFS	27/9/3, moving nested
23-C9	WRF	partial cycle	3DVAR (CV5+OL)		NCEPGFS	Tiedtke	Goddard	YSU	cu=Tiedtke
24-C10	WRF	cold start	3DVAR (CV5+OL)		NCEPGFS	Tiedtke	Goddard	YSU	cu=Tiedtke
25-Ra	WRF	cold start	3DVAR (CV5)		NCEPGFS	KF	Goddard	YSU	Radar DA, two way, 30 hrs
26-O6	WRF	cold start	NODA		NCEPGFS	KF	Goddard	YSU	Large d03:301*241

Ensemble Tracks for Soudeler

08/07 00:00



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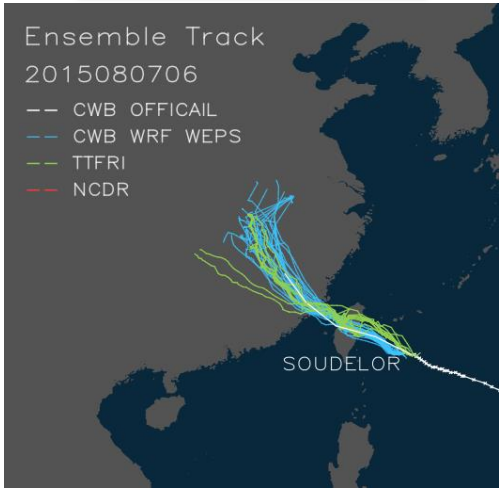

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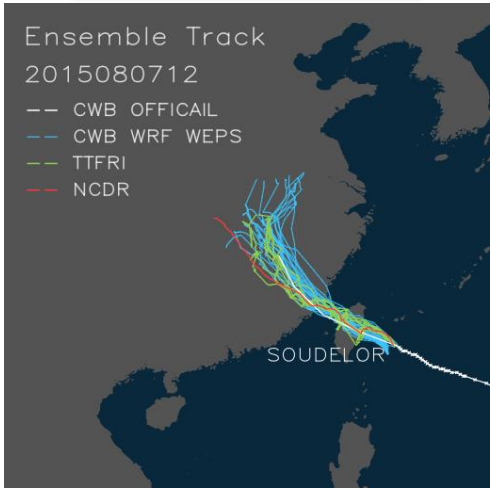

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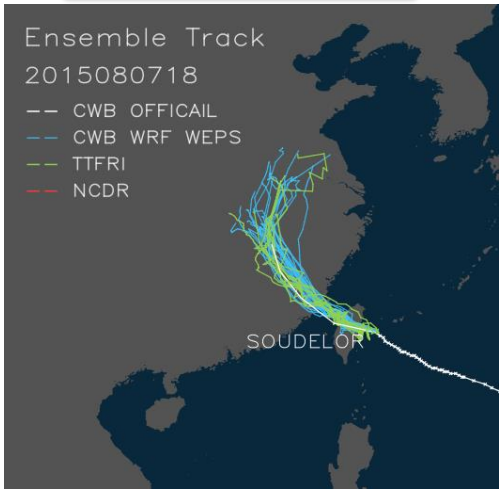

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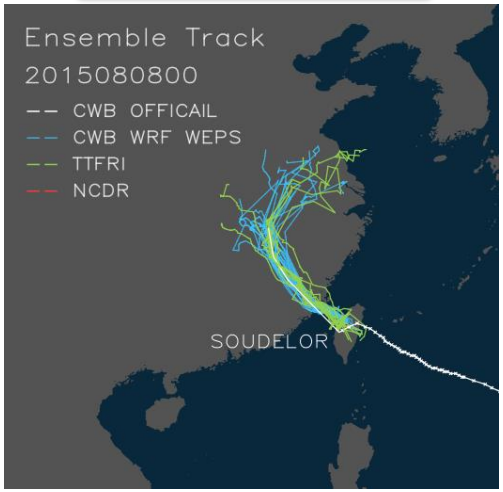

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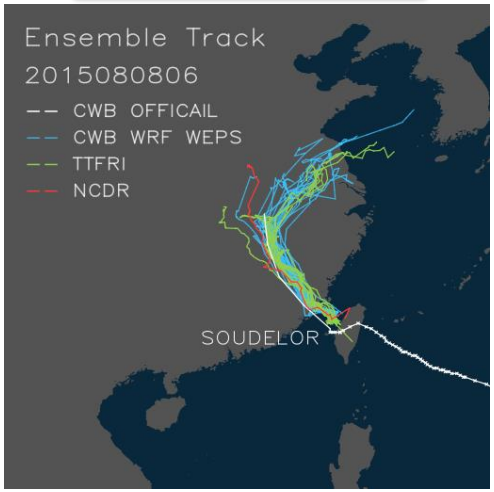
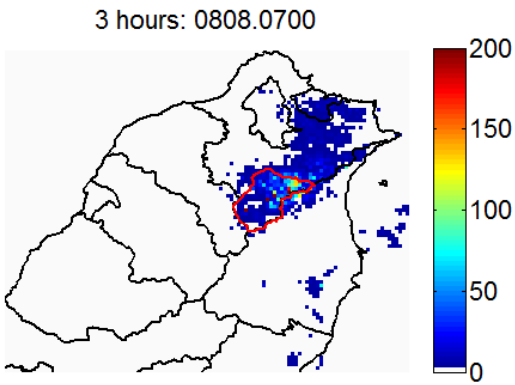
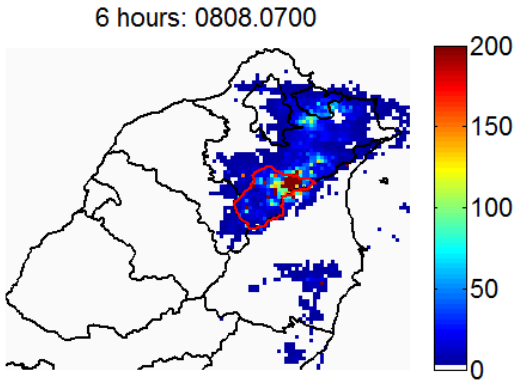


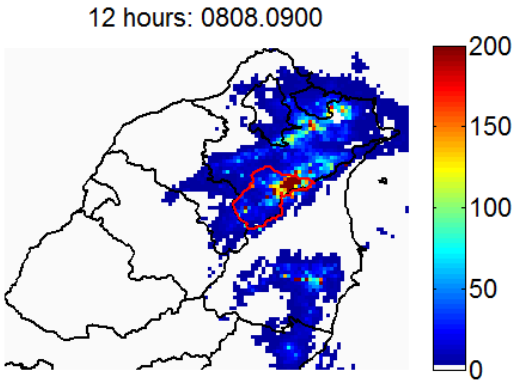
Over 200-y Return Period in Wulai



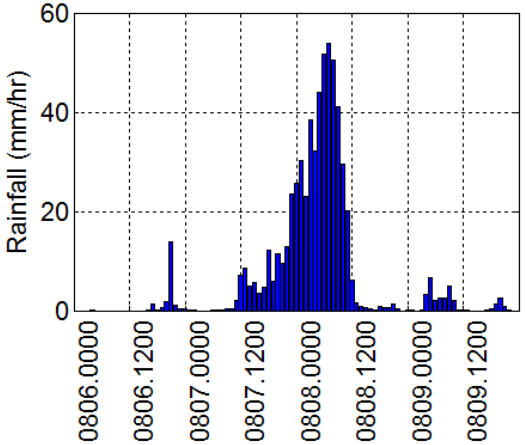
3-h rainfall



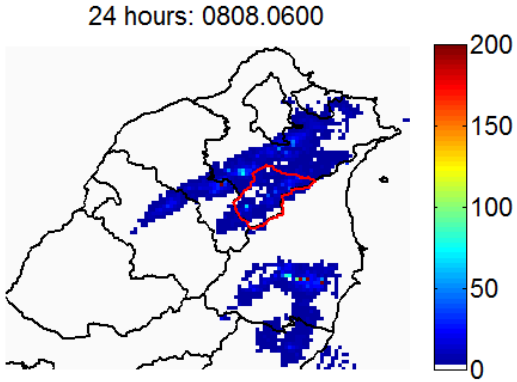
6-h rainfall



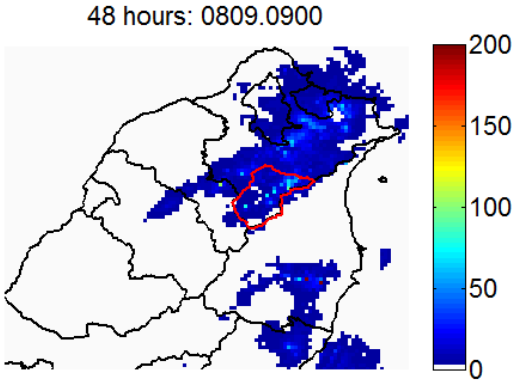
12-h rainfall



Obs. Rainfall in Wulai



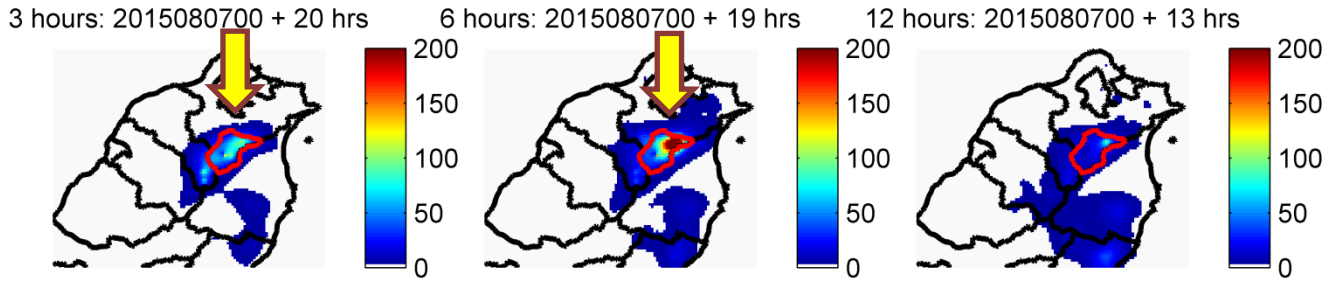
24-h rainfall



48-h rainfall

Ensemble Rainfall Frequency Forecasts (M01)

08/07 00:00 UTC



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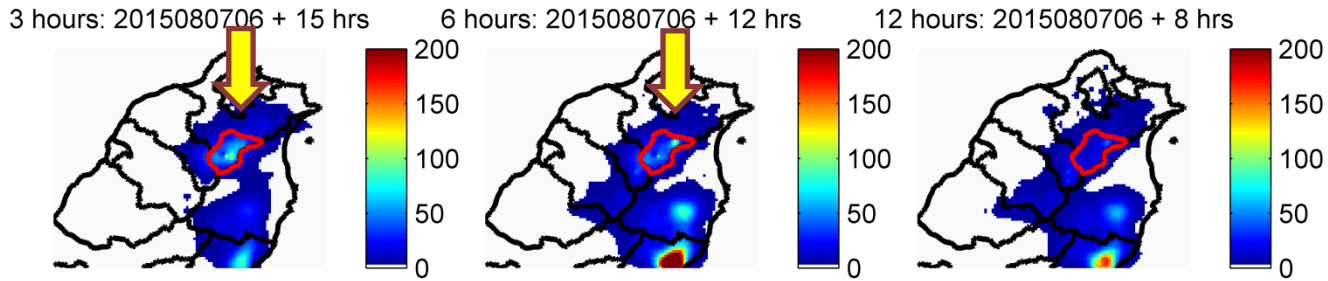

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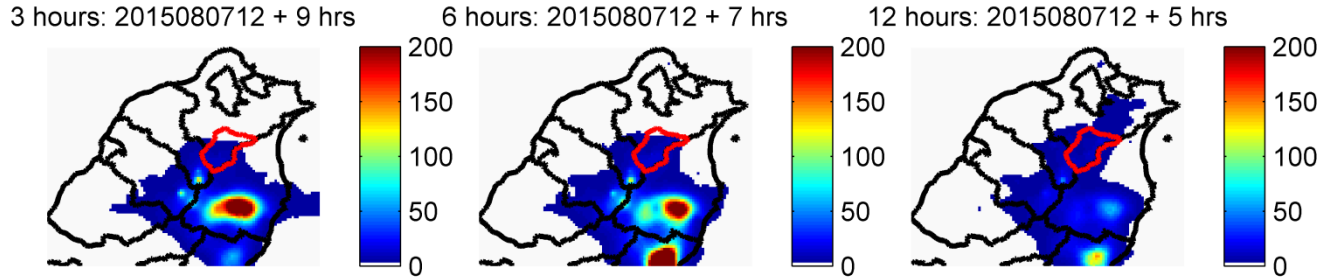

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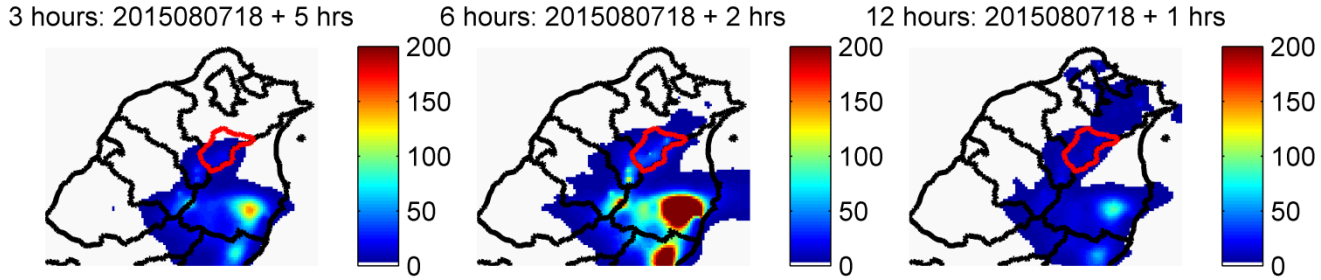
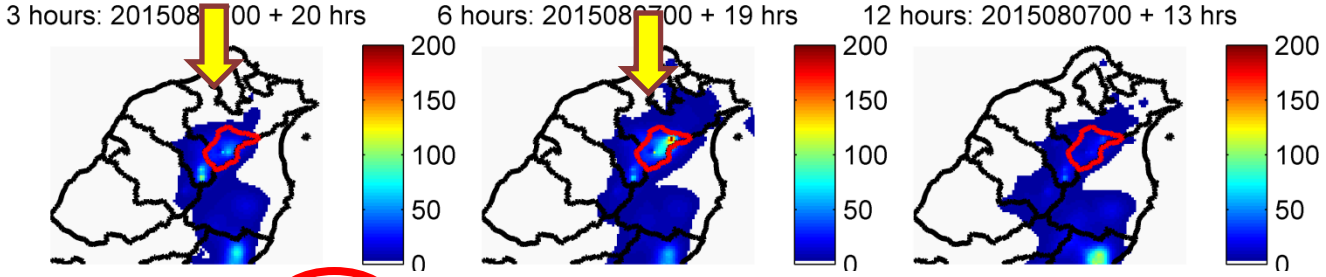


Ensemble Rainfall Frequency Forecasts (M02)

08/07 00:00 UTC



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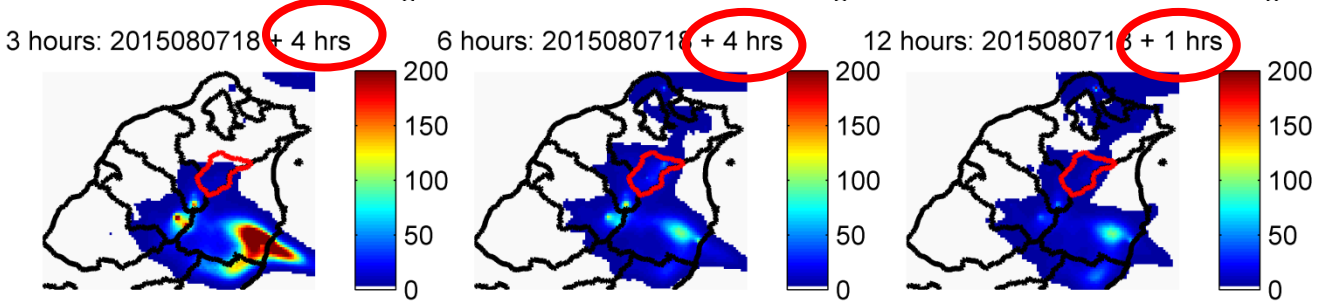

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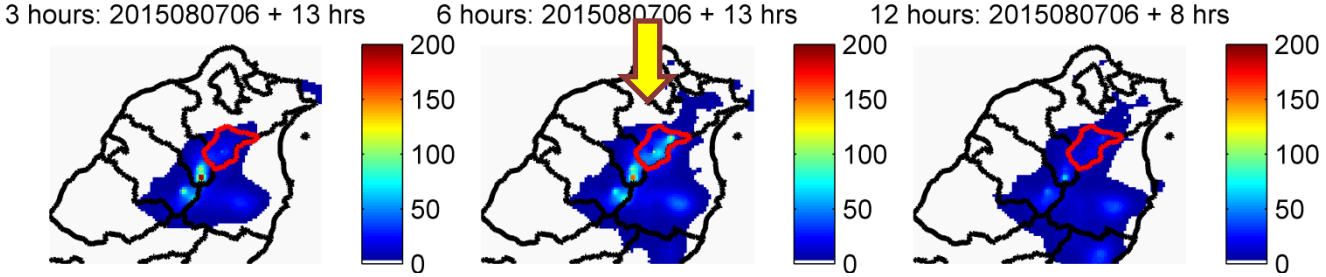

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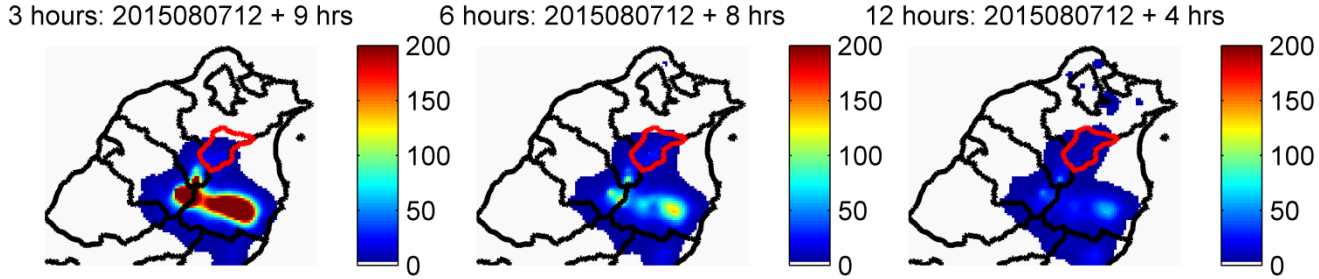

Ensemble Rainfall Frequency Forecasts (M03)

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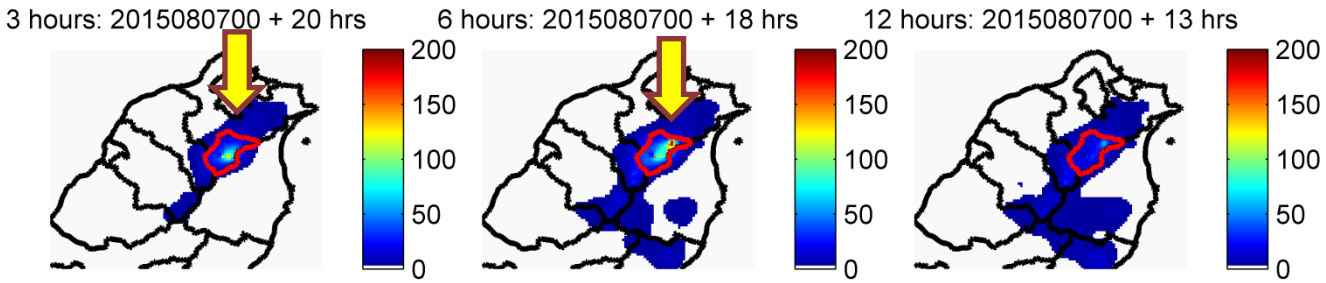

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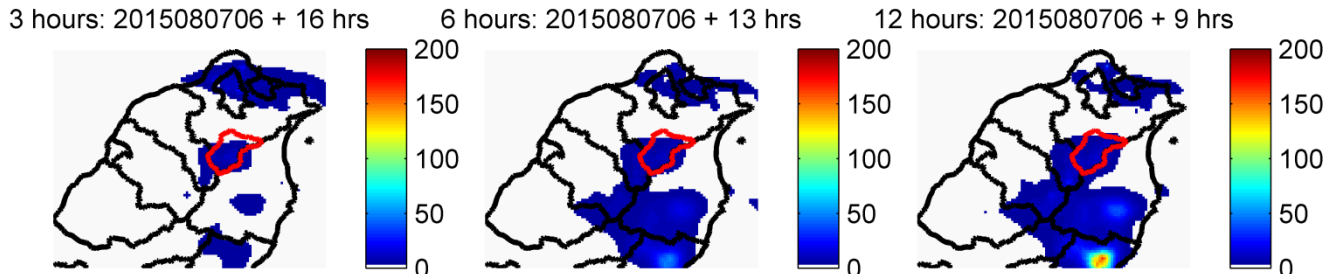

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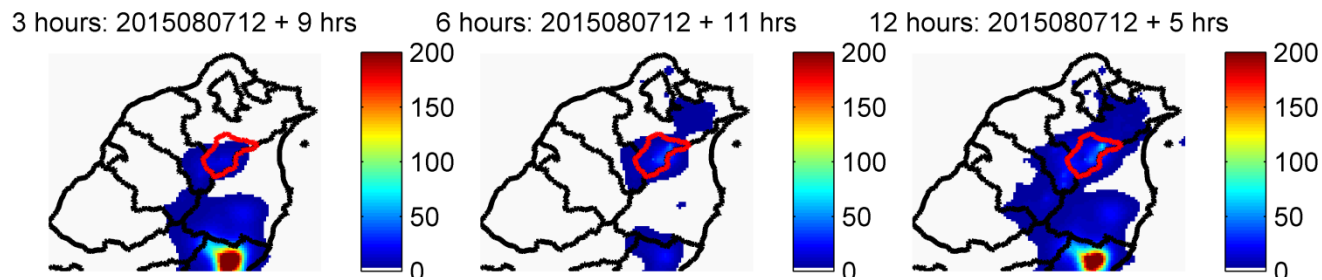

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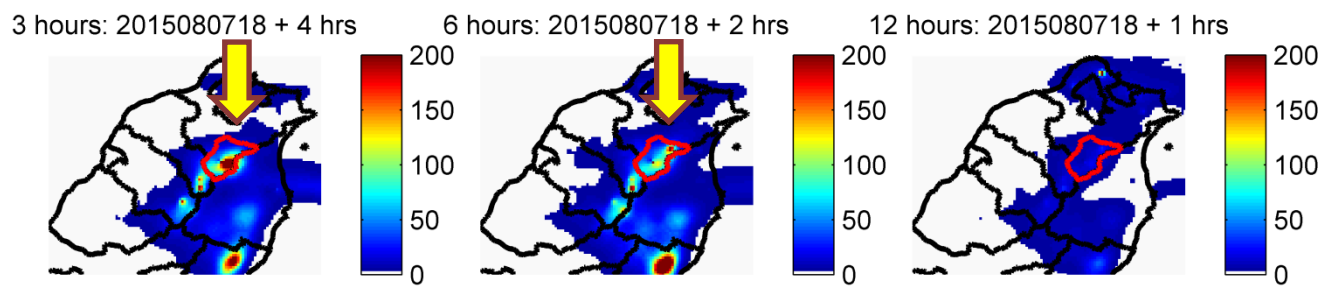

Ensemble Rainfall Frequency Forecasts (M04)

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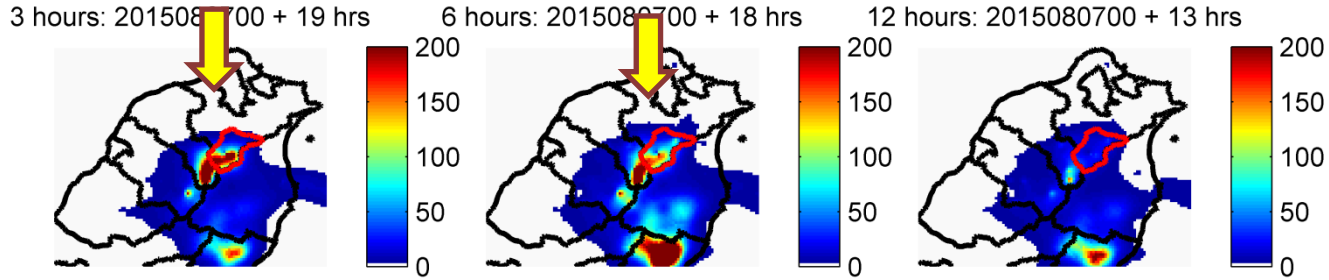

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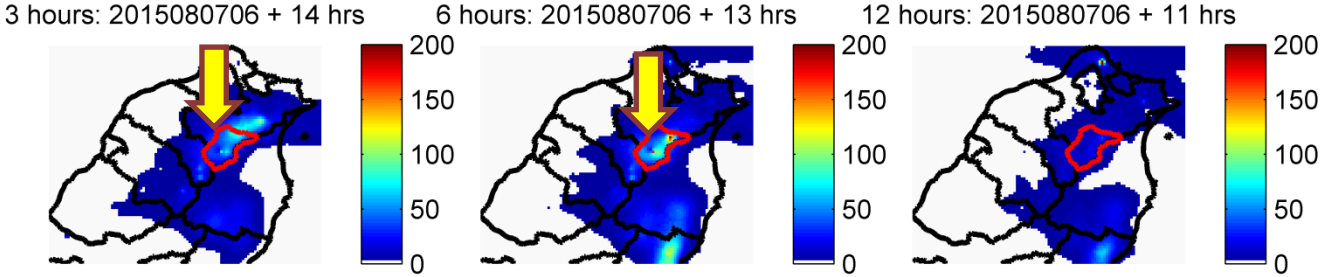

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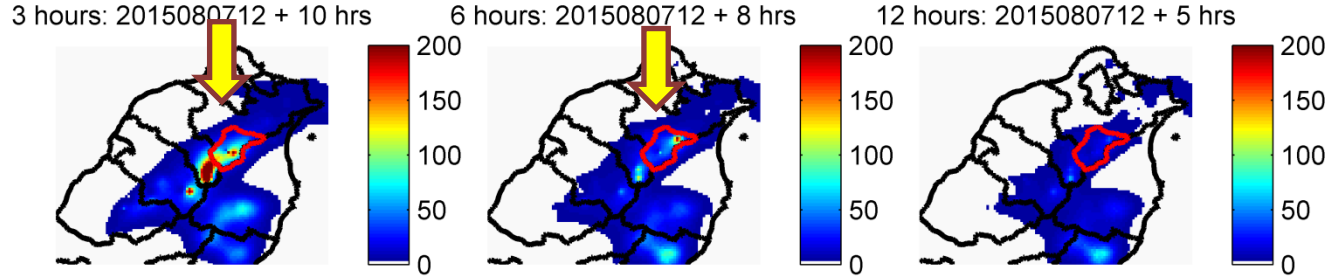

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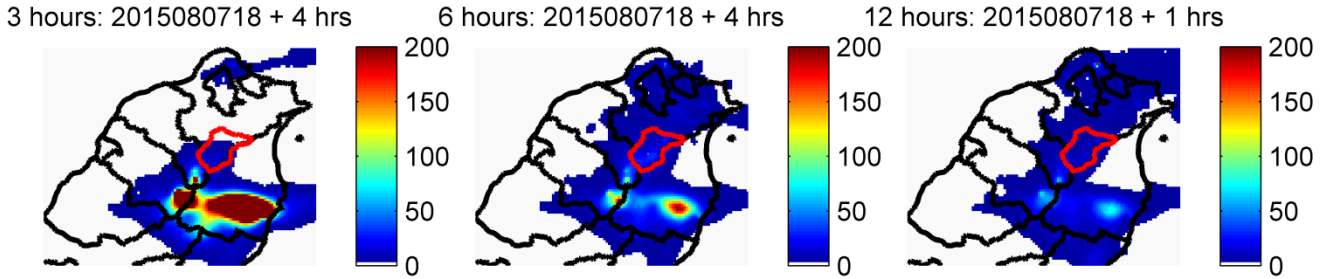
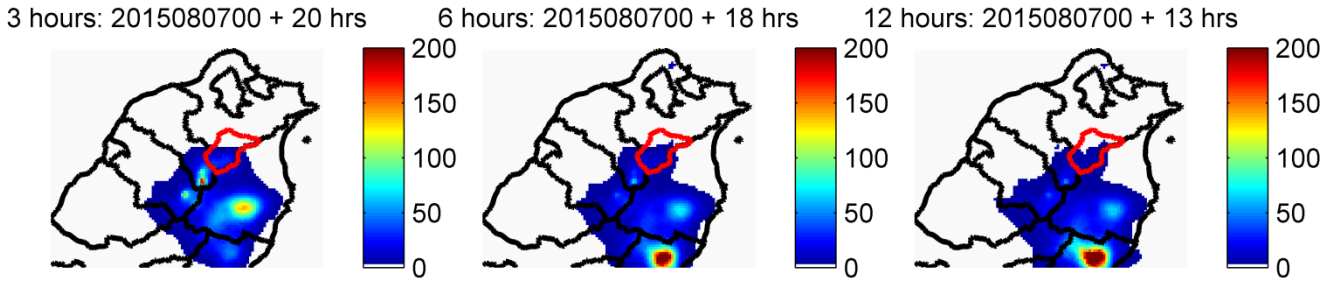
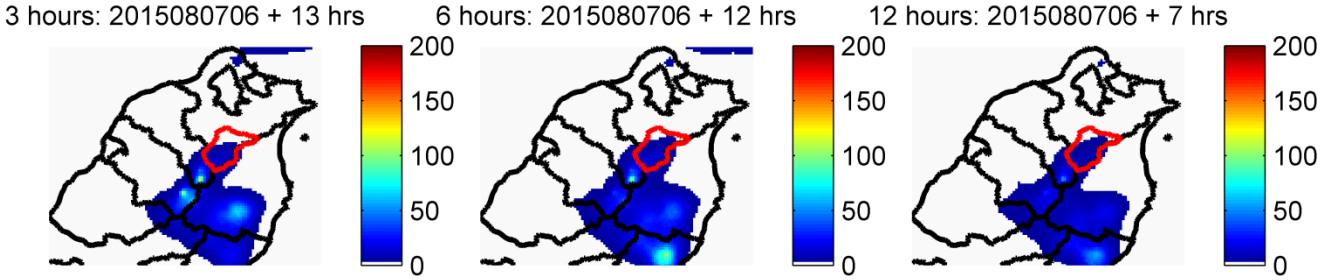


Ensemble Rainfall Frequency Forecasts (M06)

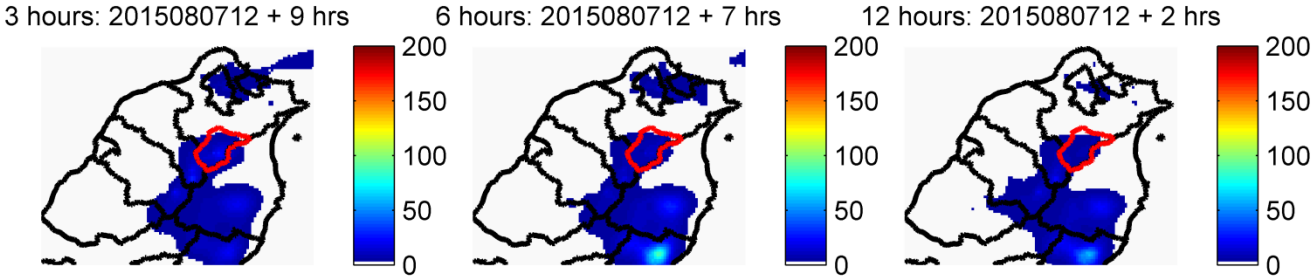
08/07 00:00 UTC



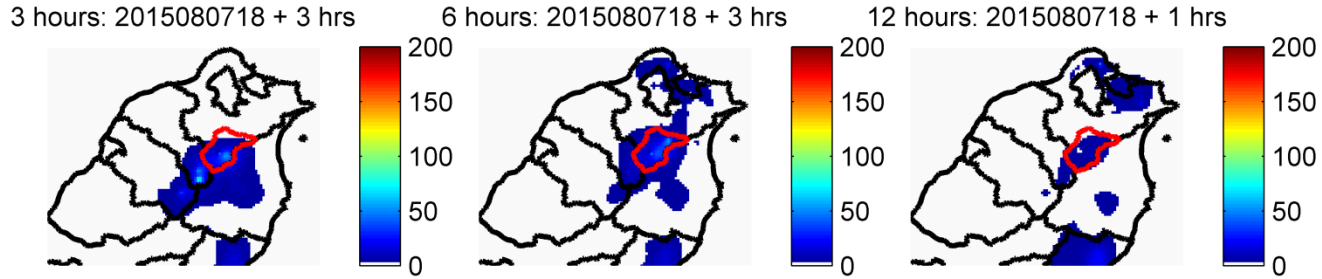
08/07 06:00 UTC



08/07 12:00 UTC

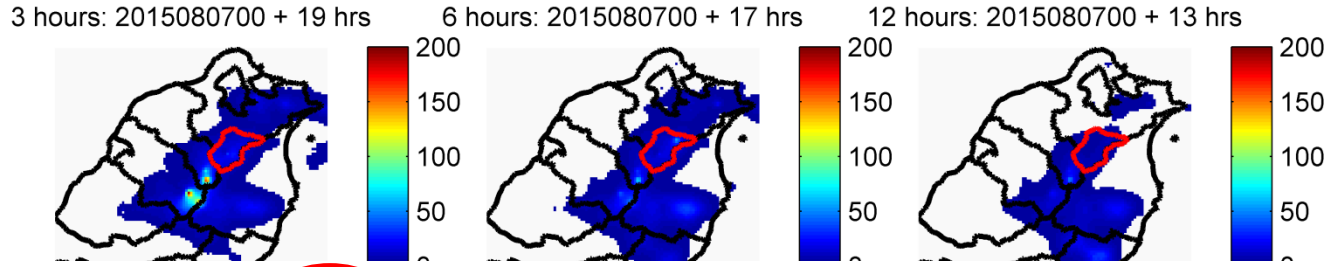


08/07 18:00 UTC

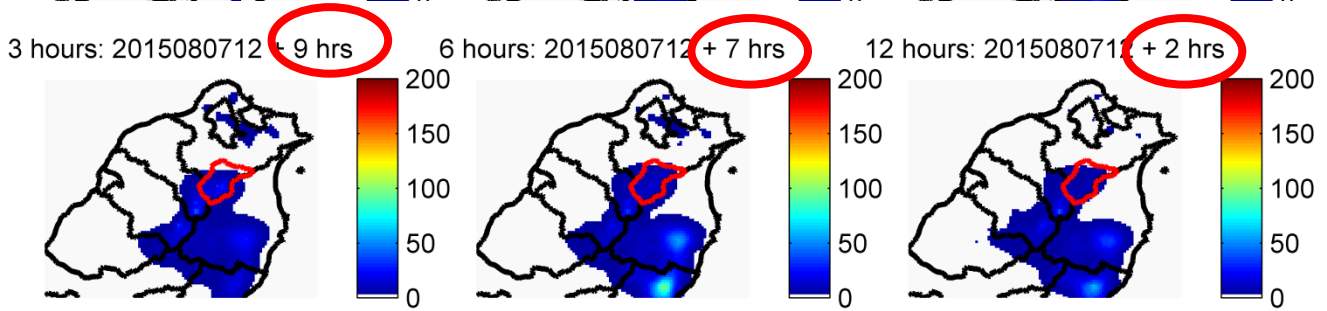


Ensemble Rainfall Frequency Forecasts (M07)

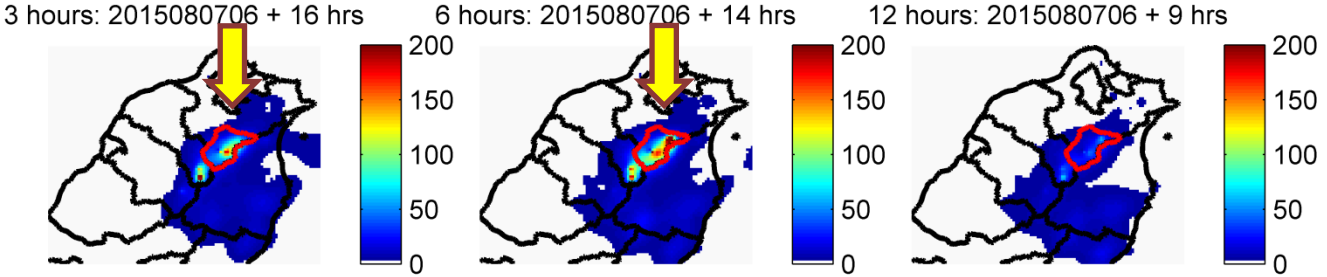
08/07 00:00 UTC



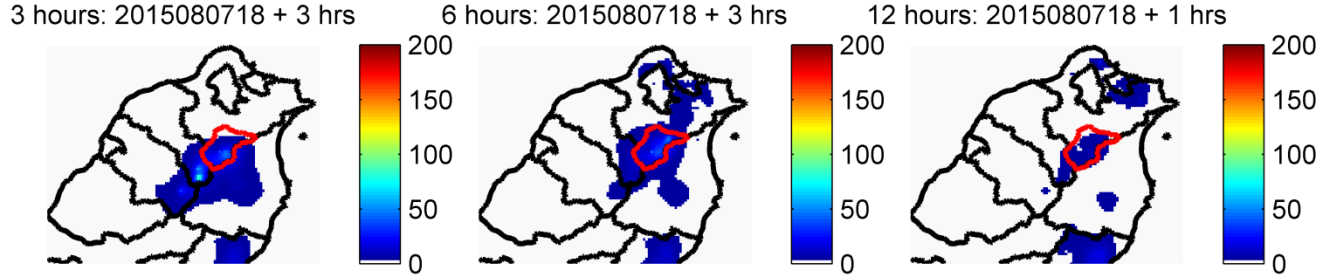
08/07 06:00 UTC



08/07 12:00 UTC

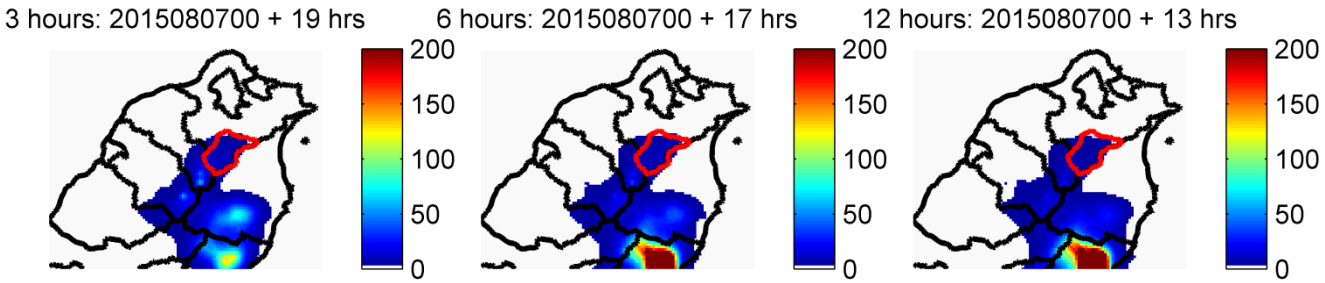


08/07 18:00 UTC



Ensemble Rainfall Frequency Forecasts (M08)

08/07 00:00 UTC



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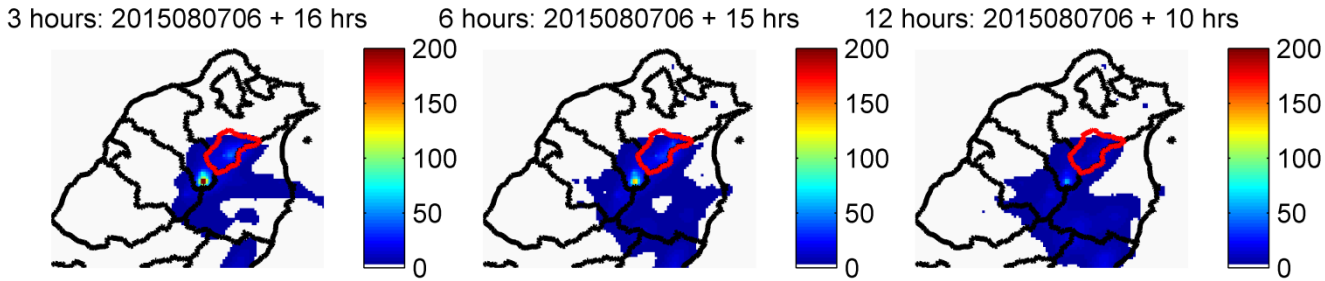
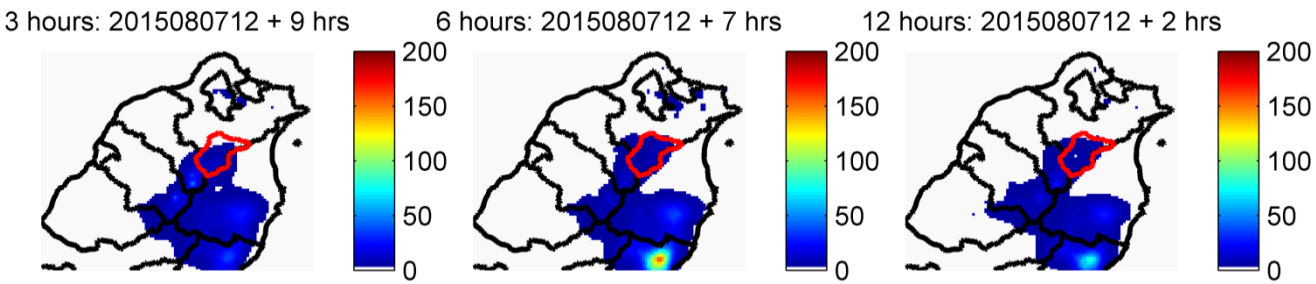
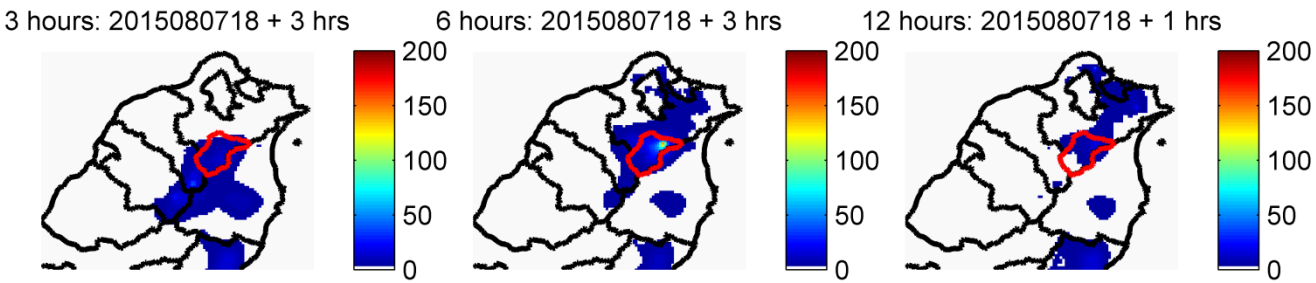


08/07 12:00 UTC

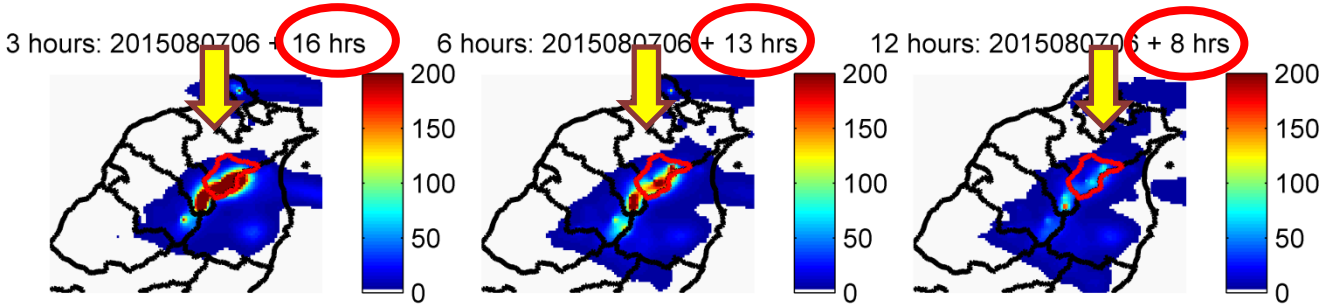


08/07 18:00 UTC



Ensemble Rainfall Frequency Forecasts (M09)

08/07 00:00 UTC



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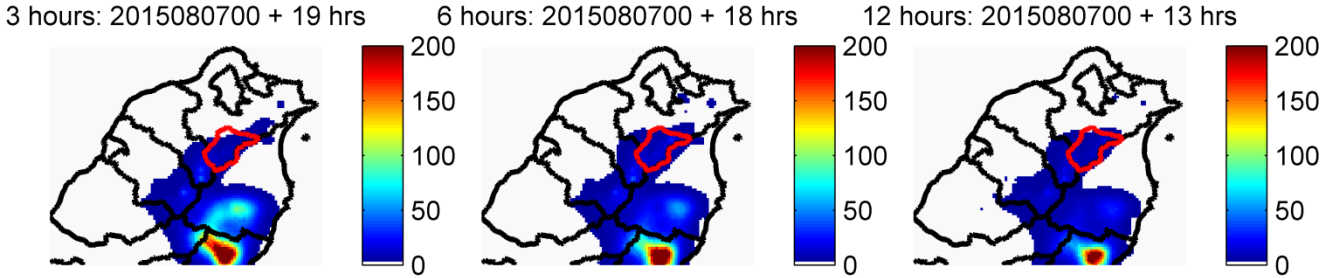

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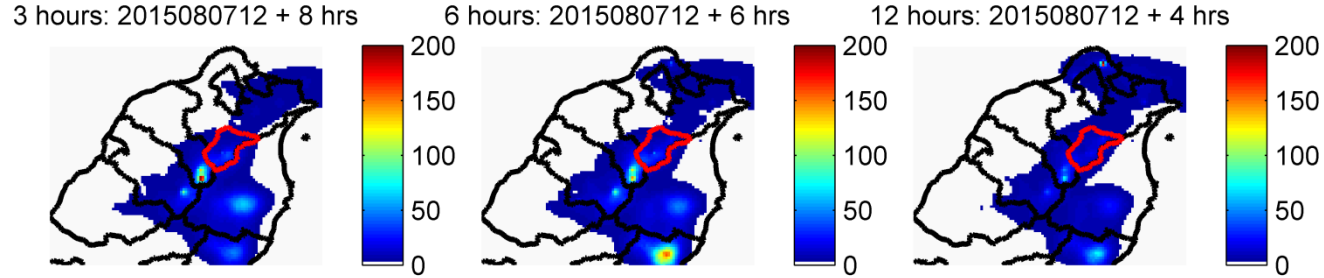

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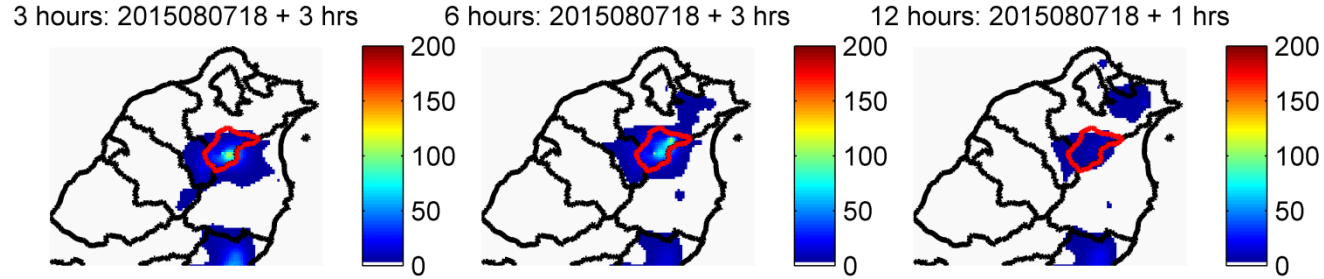
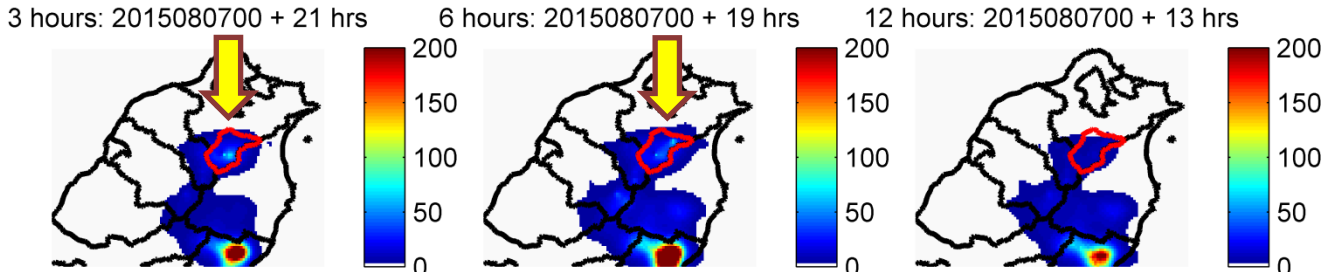


Ensemble Rainfall Frequency Forecasts (M13)

08/07 00:00 UTC



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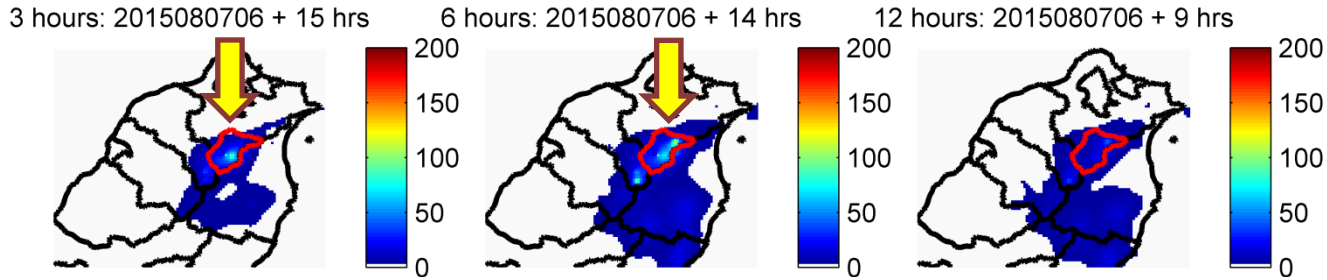

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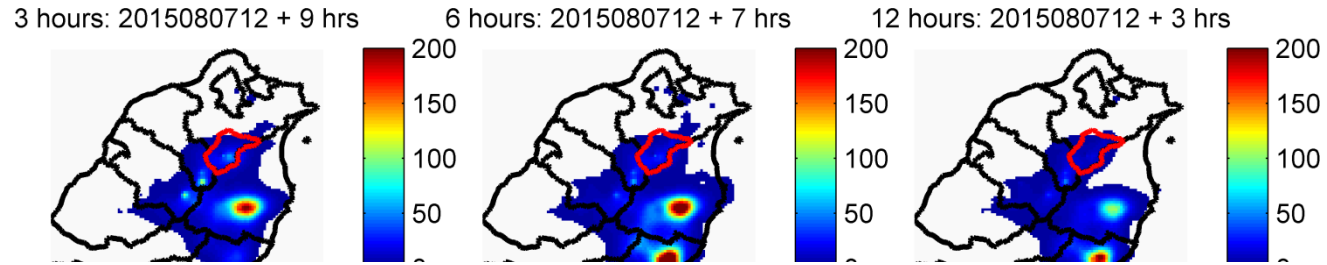

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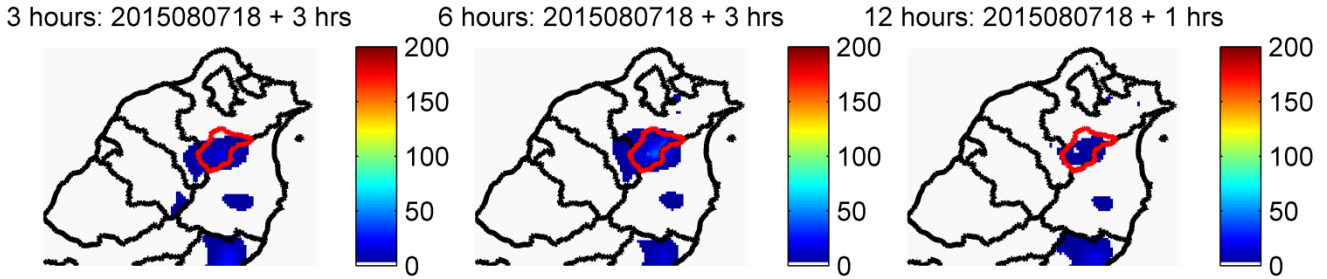
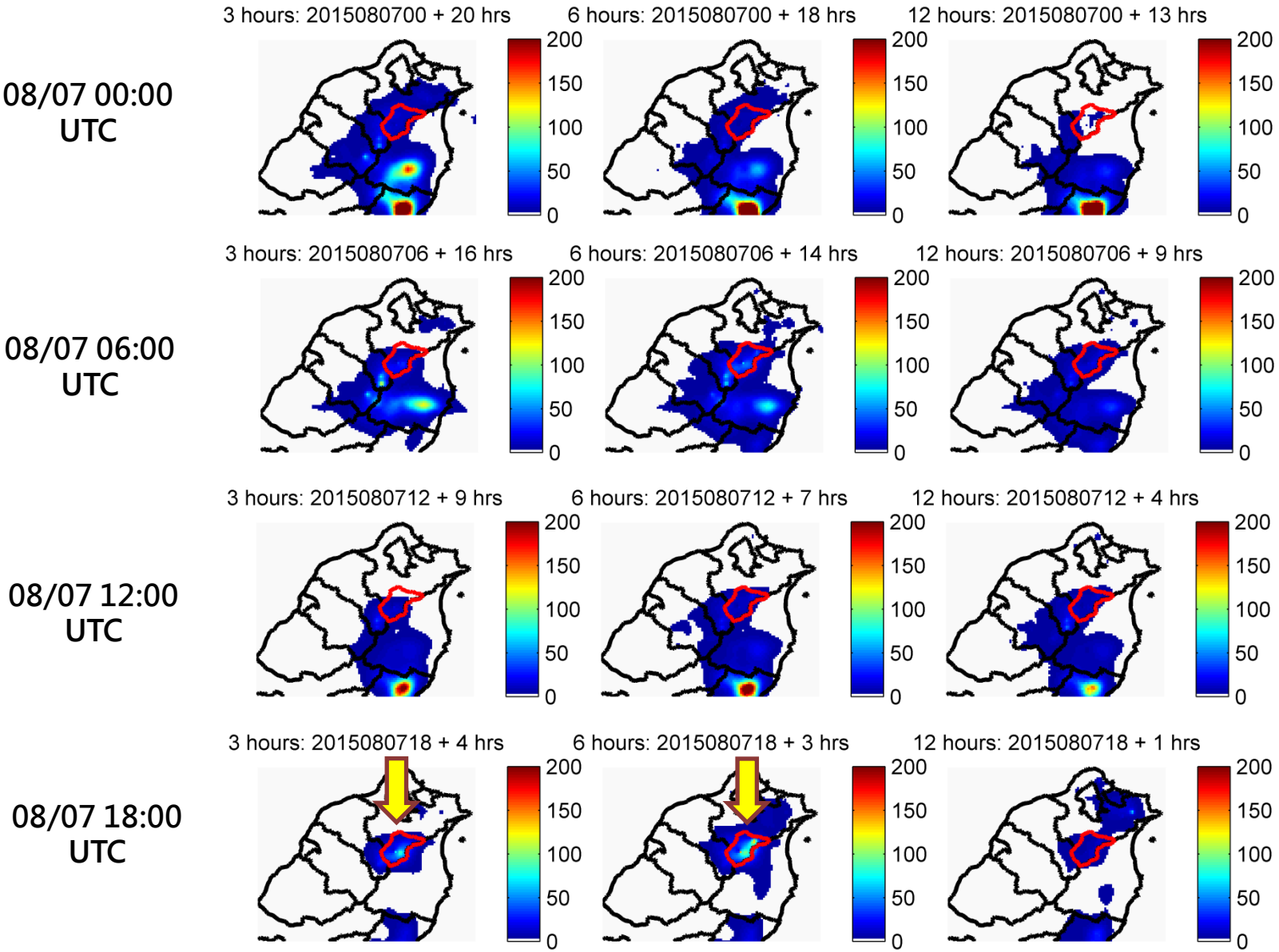


Ensemble Rainfall Frequency Forecasts (M14)



Ensemble Rainfall Frequency Forecasts (M15)

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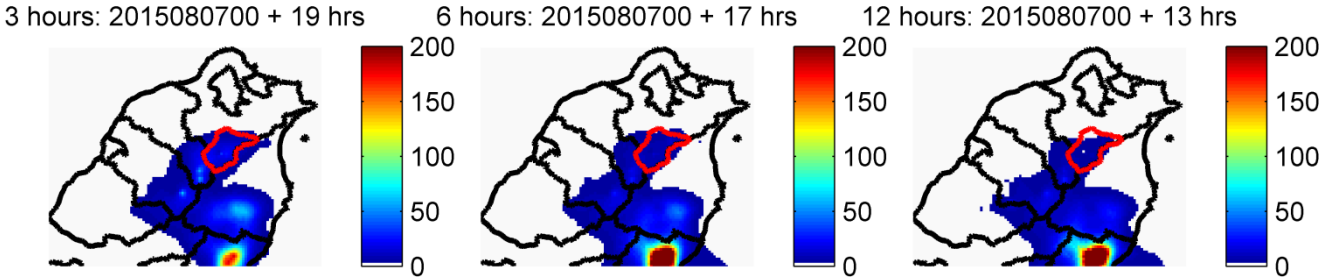

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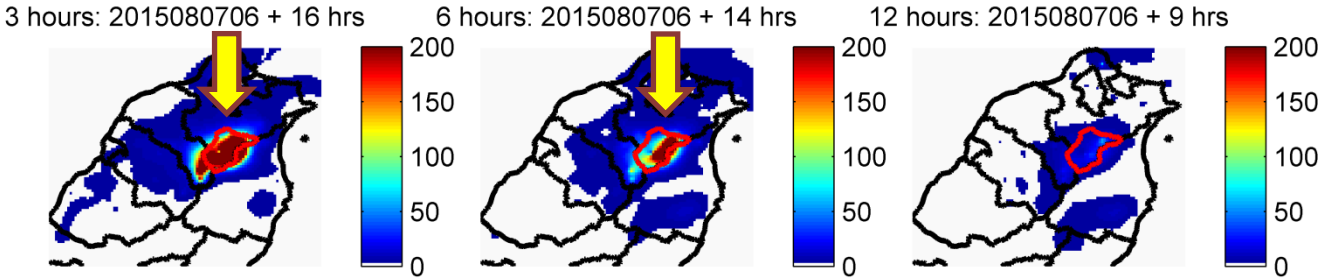

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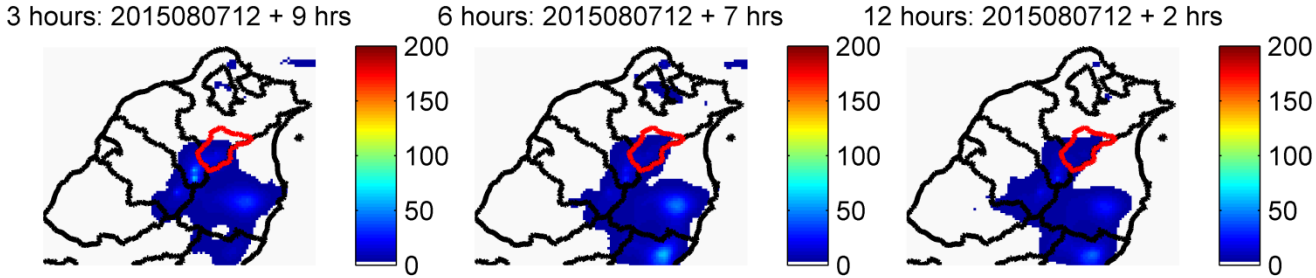

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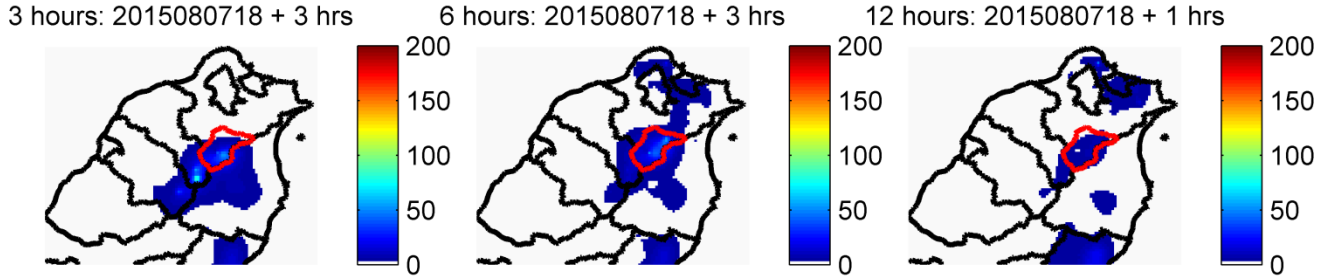
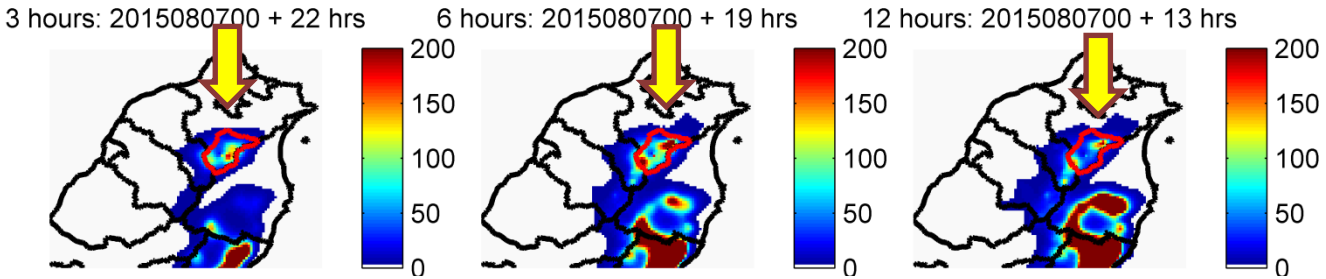


Ensemble Rainfall Frequency Forecasts (M17)

08/07 00:00 UTC



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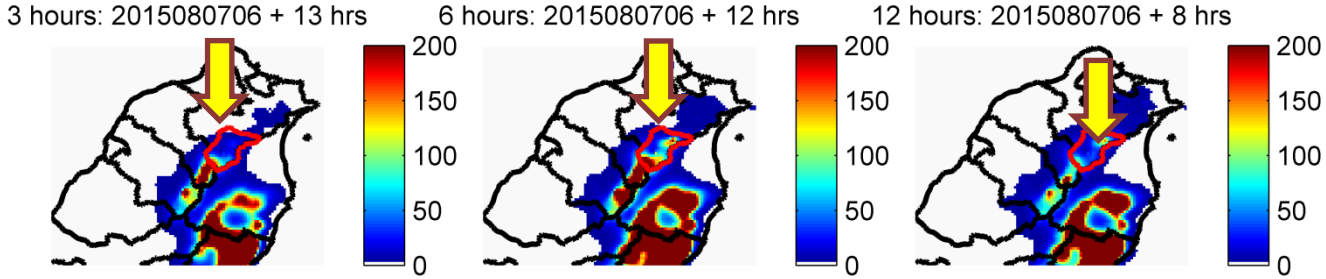

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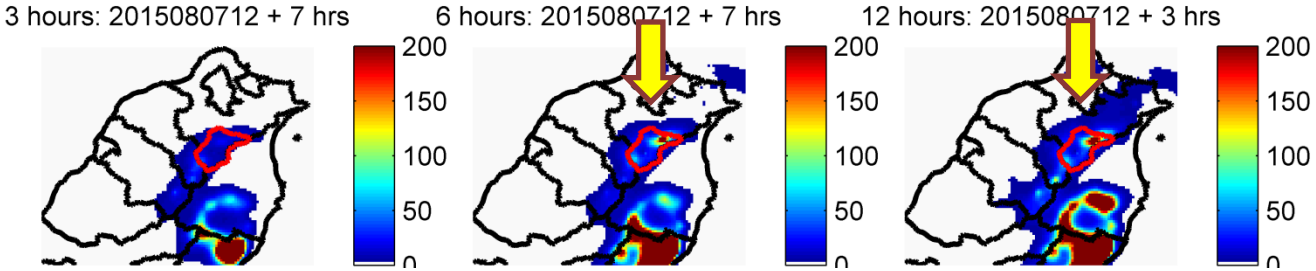

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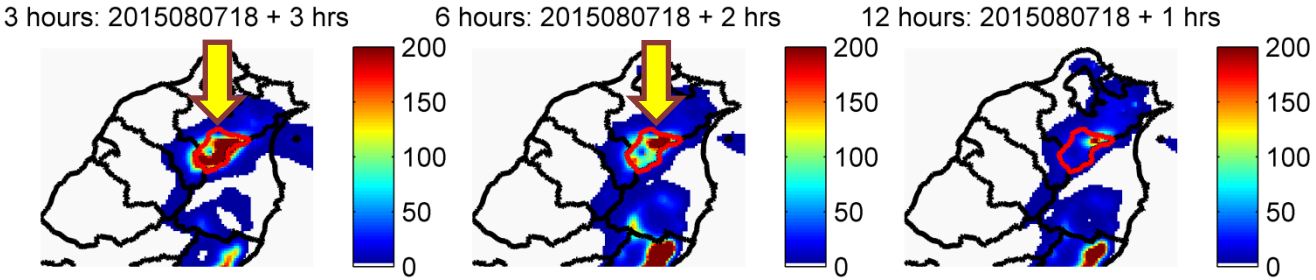

Ensemble Rainfall Frequency Forecasts (M18)

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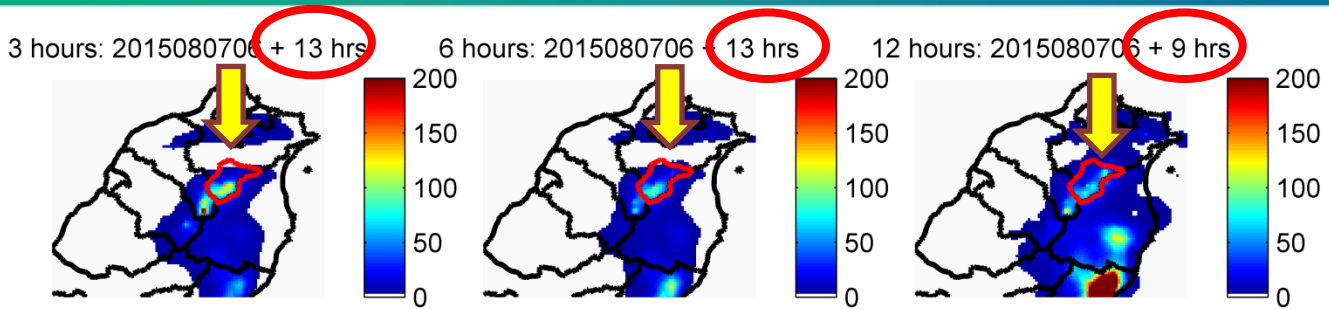

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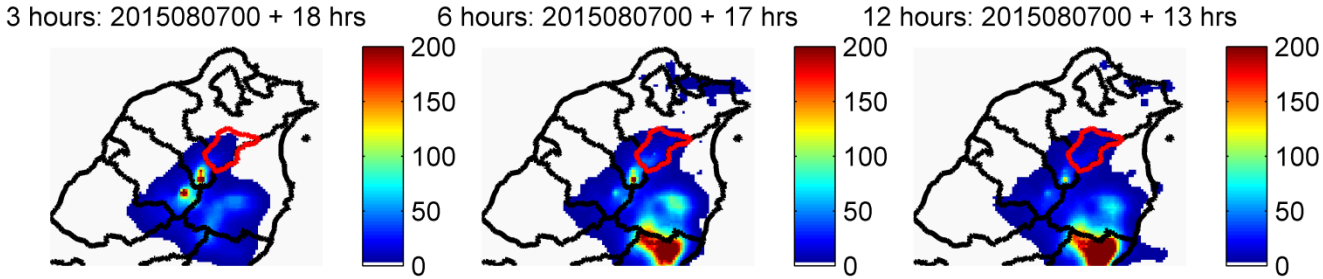

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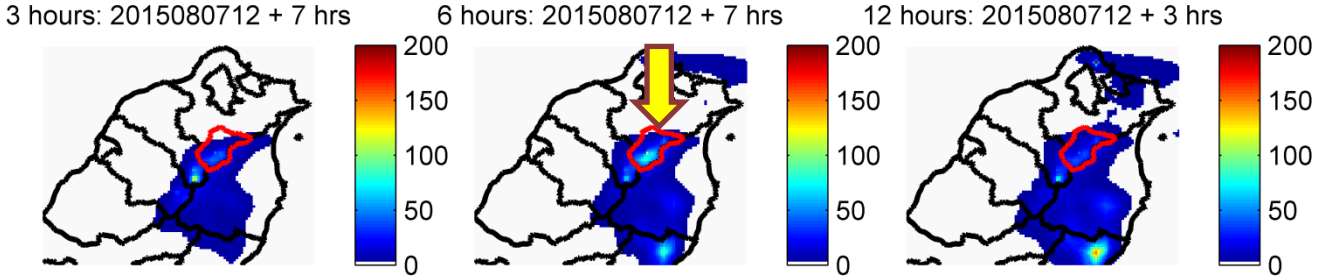

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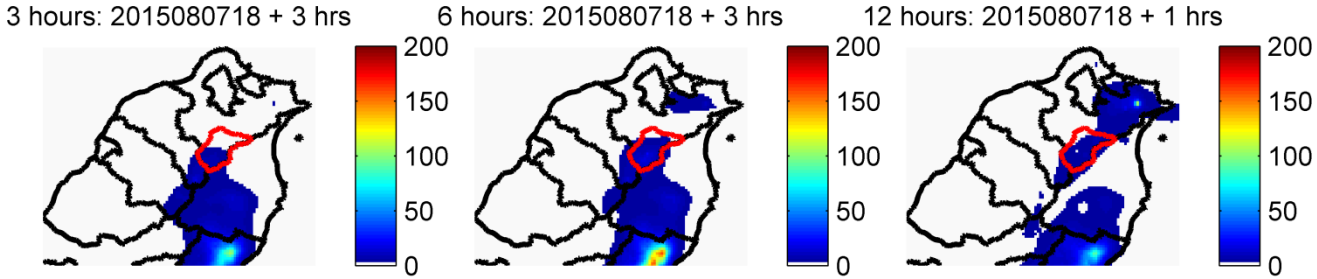
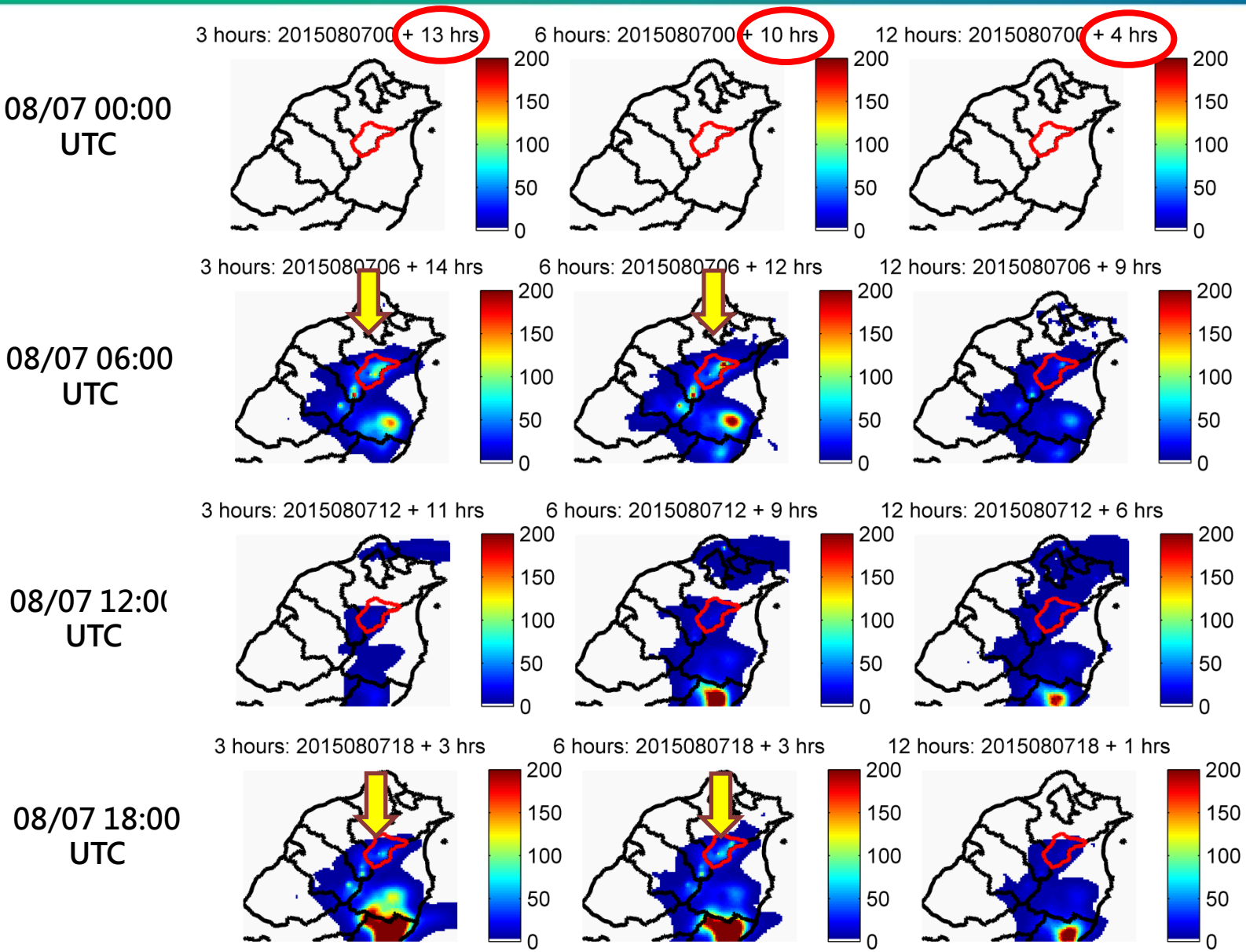


Ensemble Rainfall Frequency Forecasts (M23)



Ensemble Rainfall Frequency Forecasts (M26)

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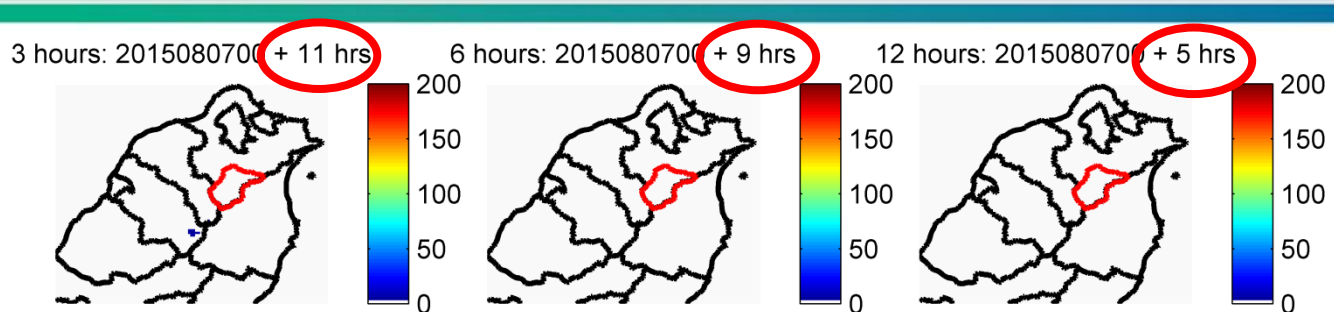

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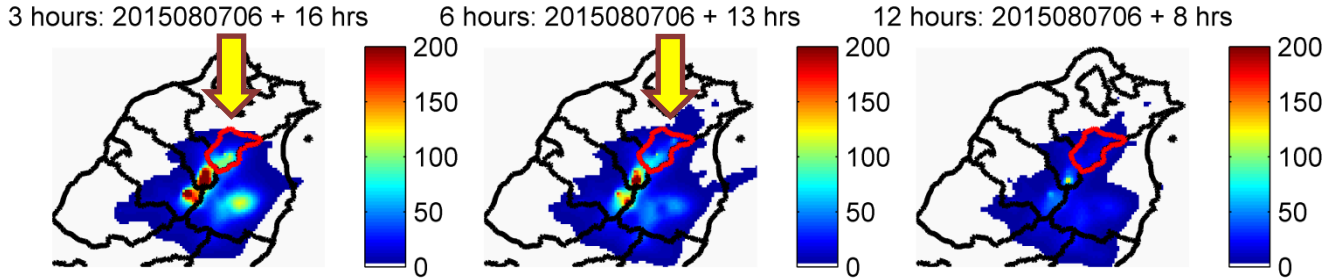

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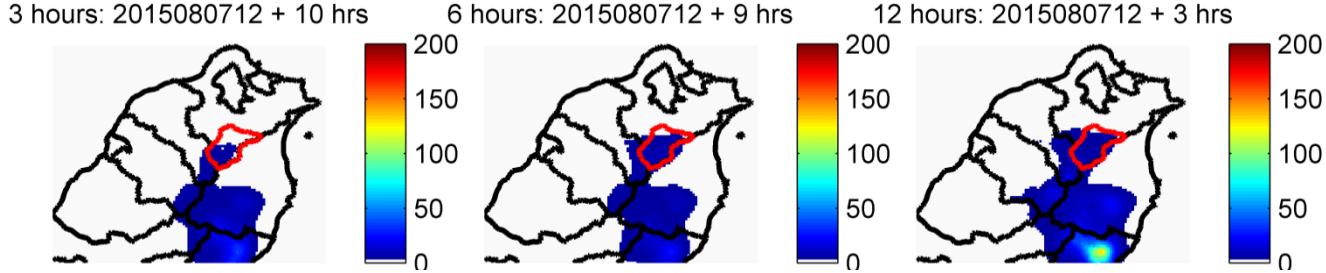

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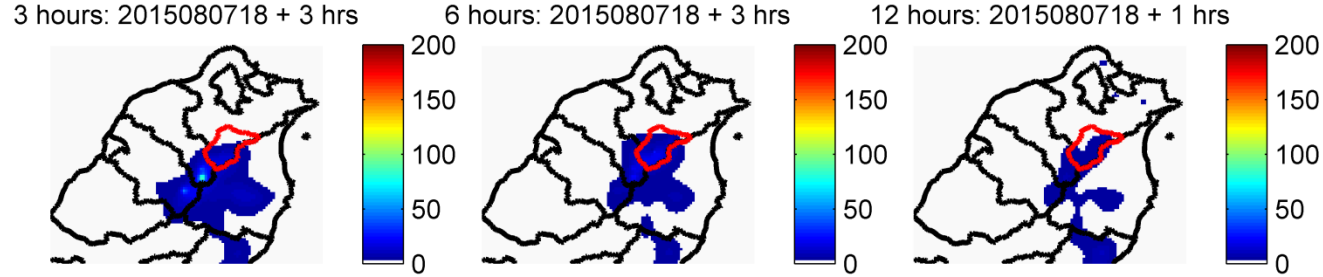
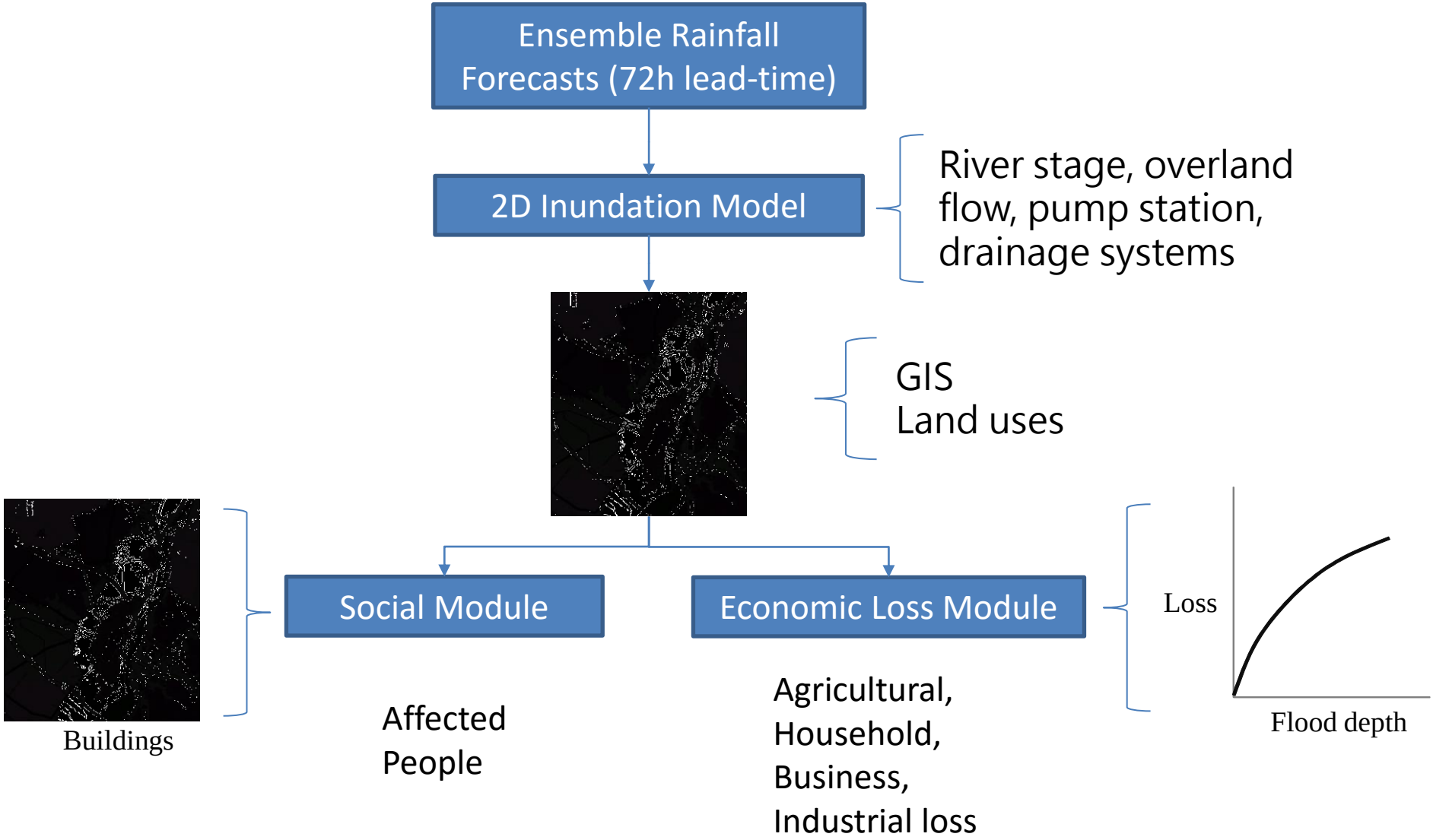


Contingency Table for Frequency Analysis

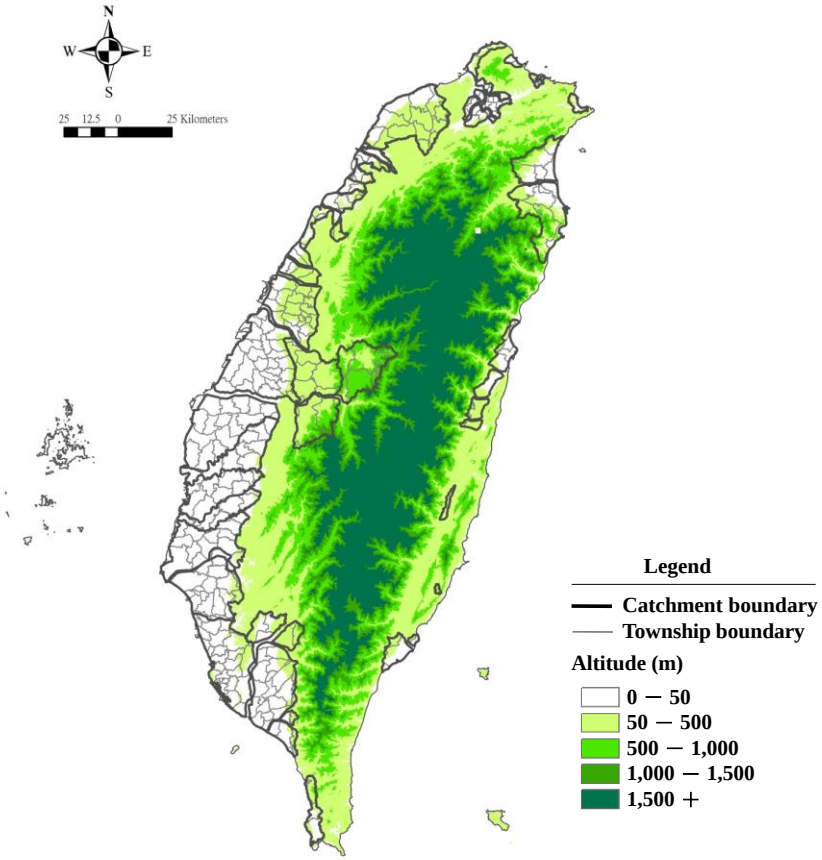
Member	Consistency	Efficiency
M01	+	+ +
M02		+
M03		+
M04	+ +	+ +
M06	+ +	
M07		
M08	+ +	
M09		+
M13	+	+ +
M14	+	
M15		+
M17	+ +	+ +
M18		+
M23		+
M26		+

Ensemble Impact Forecasts

Flowchart of Ensemble Flood/Social/Economic Impact Simulation



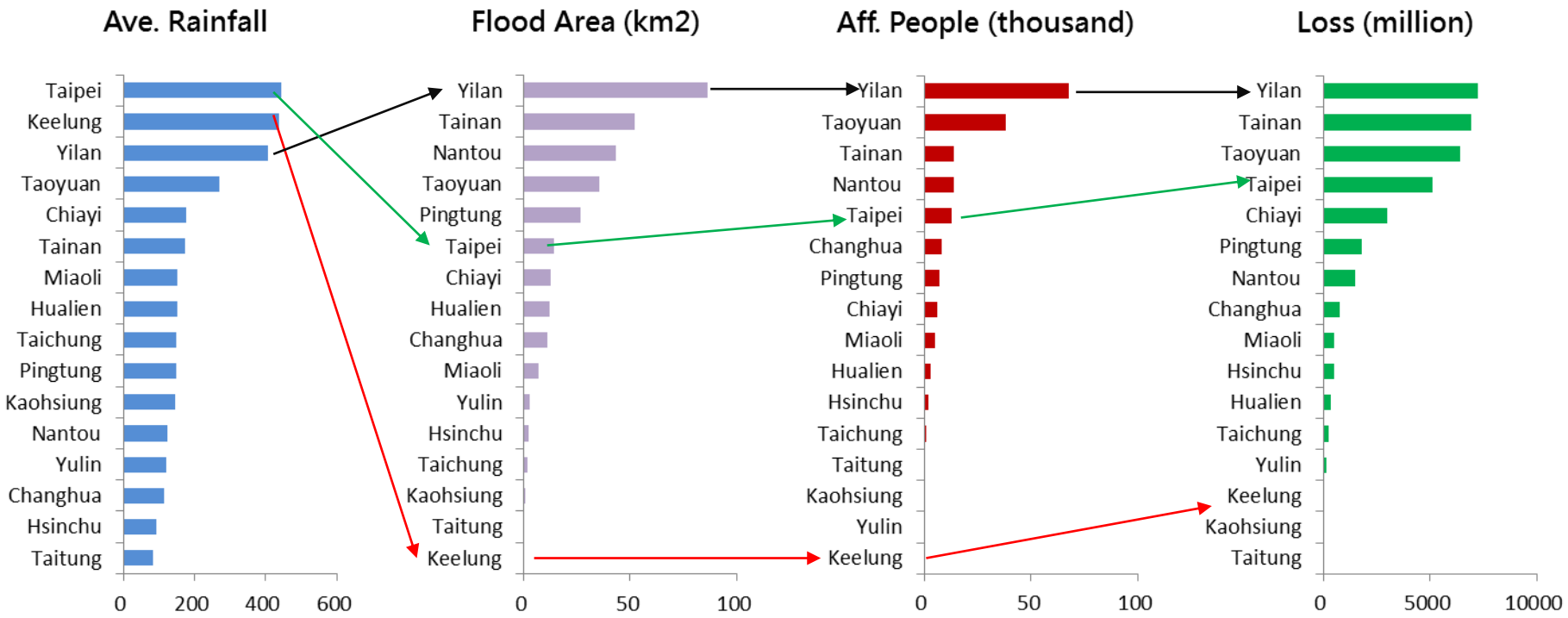
Real-time City Flooding Forecasts



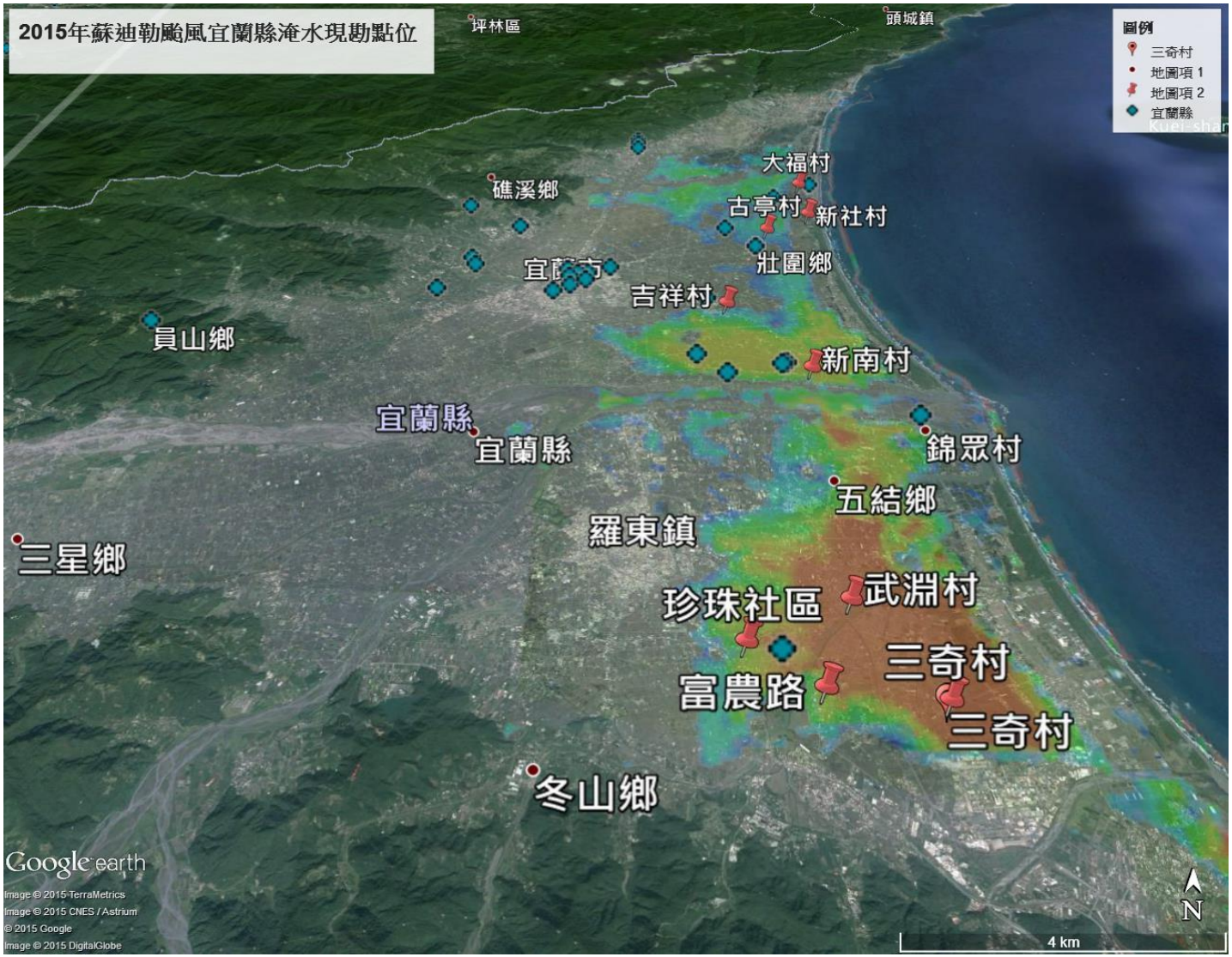
- 252 urbanized cities, divided into 51 catchments, mainly located in low-lying areas covering 30% of the total area and 90% of the population

High-speed flood simulation with the help of super computers and optimized job submission.

Flood vs Social vs Economic Impacts



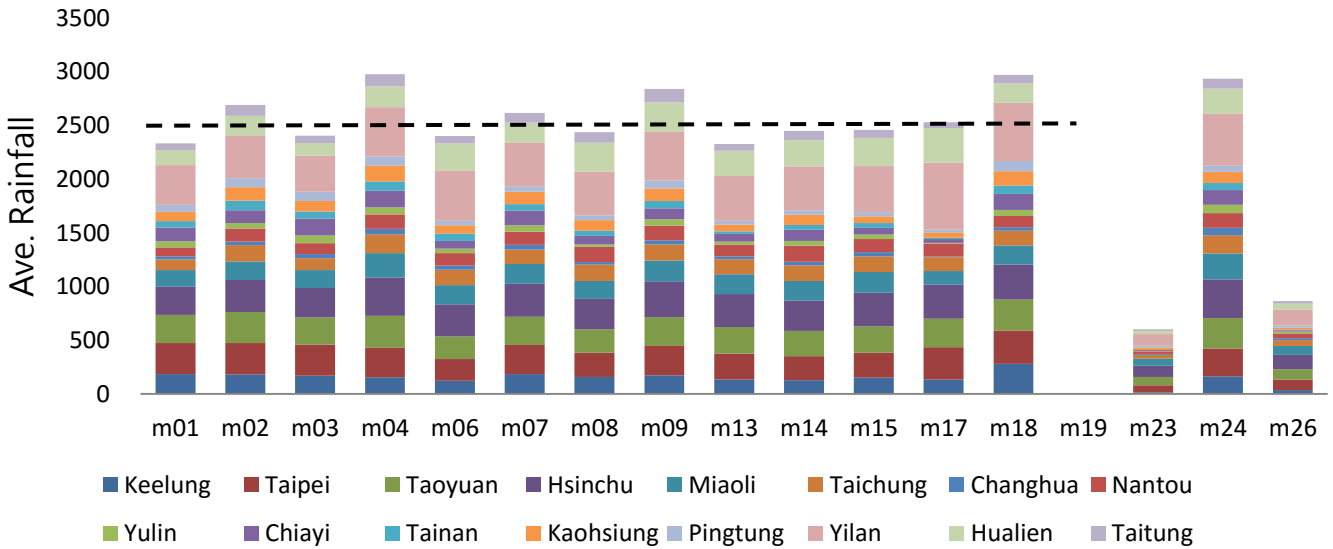
Flood Area in Yilan (QPESUMS)

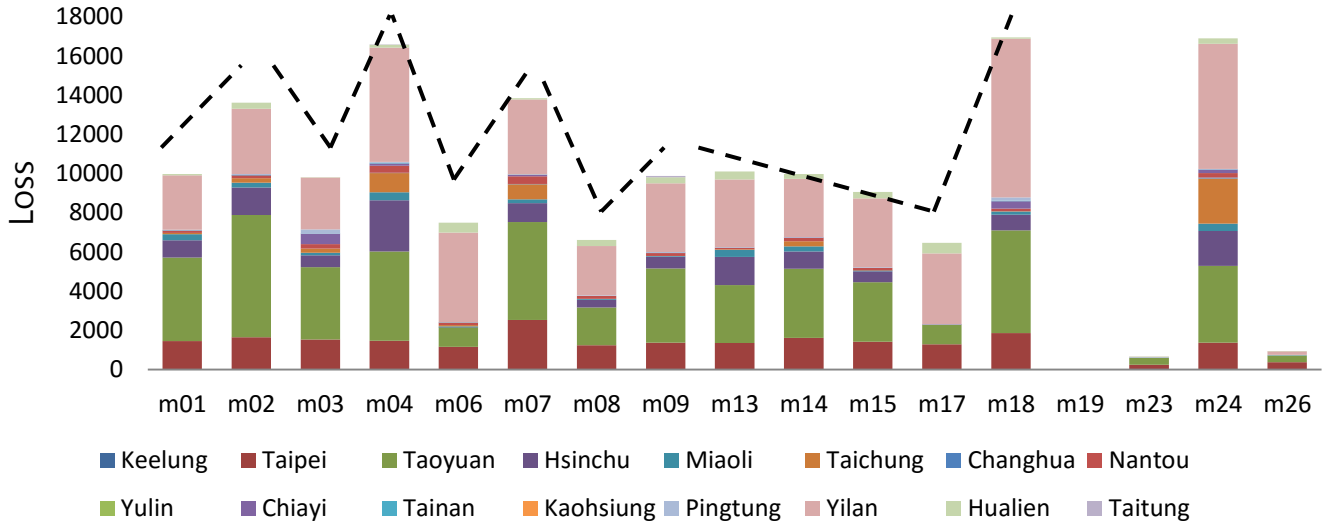


Colors: simulation

Points : investigation

Social/Economic Impact Forecasts are more Identified





Flood Assessment with the Help of Virtual Community

Rainstorm on 0614, 2015, Taipei

- Location : Da'an, Wenshan, Xinyi Districts
- Duration: 2015 / 06 / 14 Pm 2:00 - 5:00

Gongguan Rain guage
Max
131.5mm/h
190.5mm/3h

Daan

MRT Station

Wenshan

Xinyi

信義路 6段邊坡土石崩塌

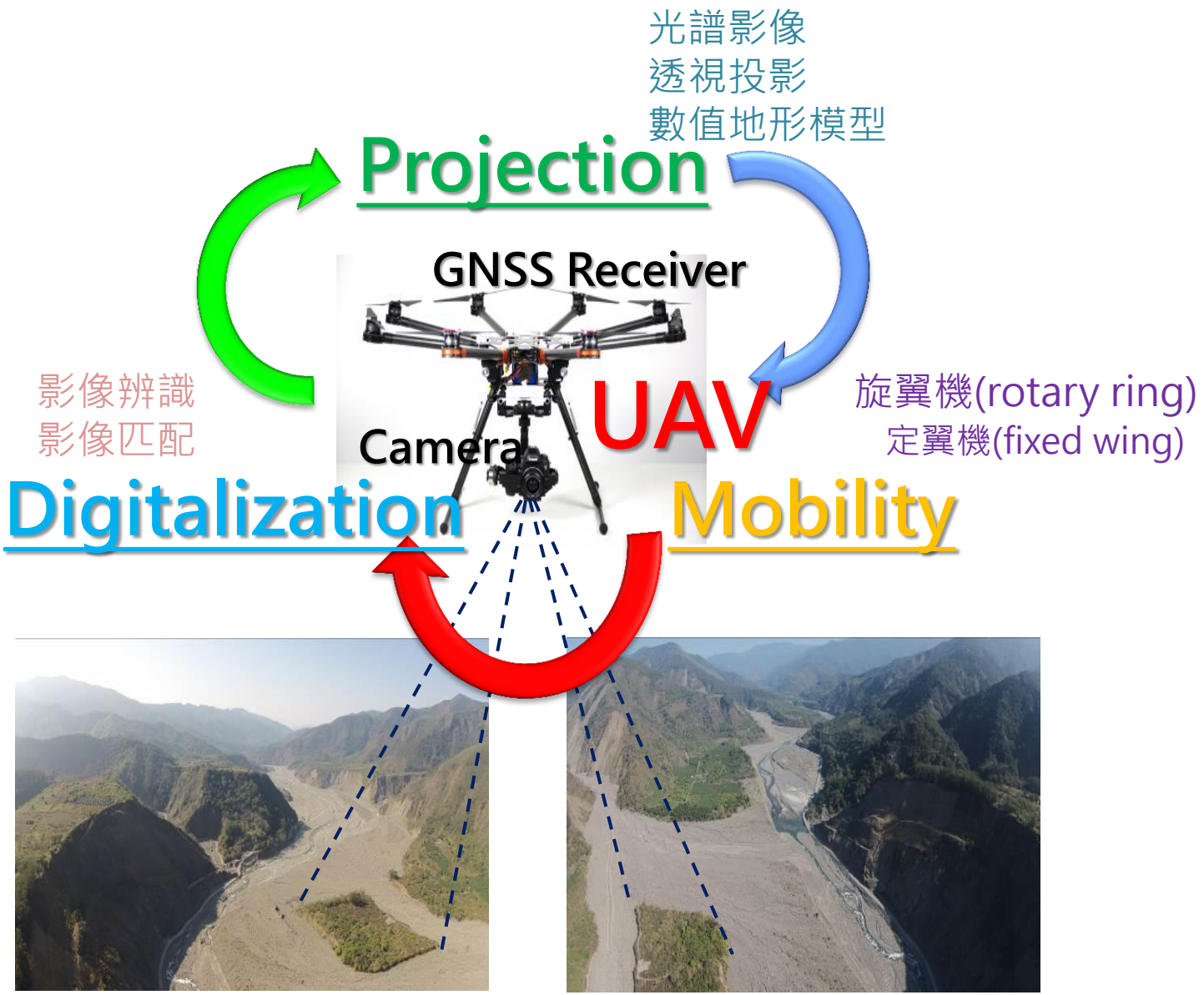
興隆路四段(來源:中國時報)

基隆路 台科大
(來源:自由時報)

Intersection of Keelung and Changxing Roads

Source : FaceBook
6/14 15:30

Construction of 3D Spacial Data



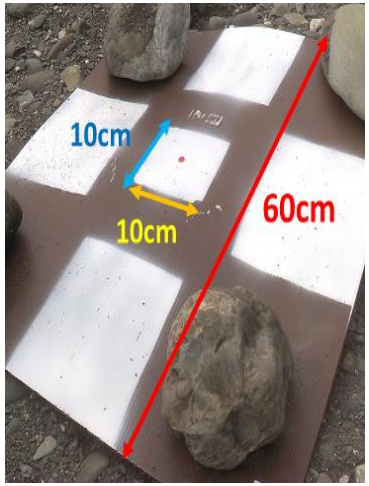
UAV Specification

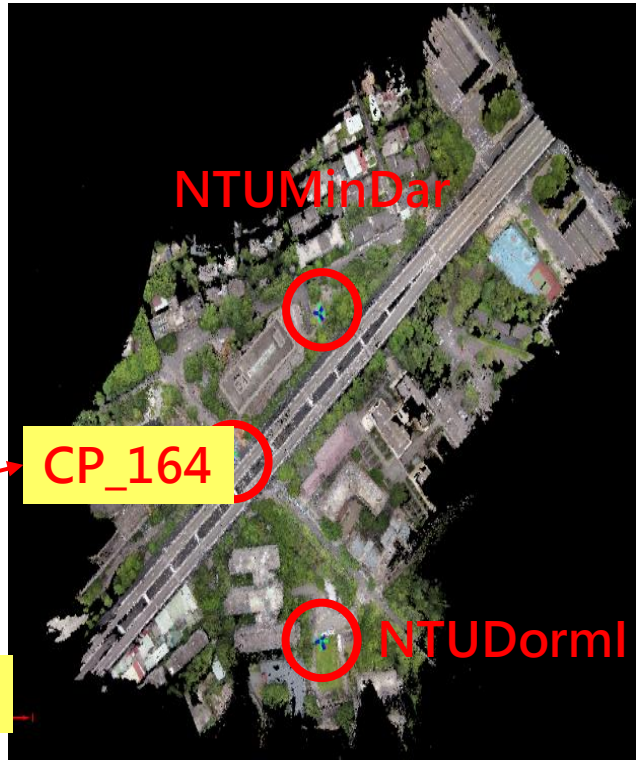
DJI Phantom 2 Vision+無人飛行載具

名稱	Phantom 2 Vsion +	最大飛行速度	15 m/s
重量	1242 g	最佳續航時間	17 min
軸距	350 mm	水平/垂直姿態角度	0~360/ -90~0 °
感光元件	1/2.3”	(俯)角度控制精度	±0.03 °
影像	4384*3288 [pix]	懸停精度(垂直/水平)	0.8/2.5 m

Control Points on the Ground

- 施測方法: UAV無人飛行載具
- 範圍:基隆路-長興街
- 控制點

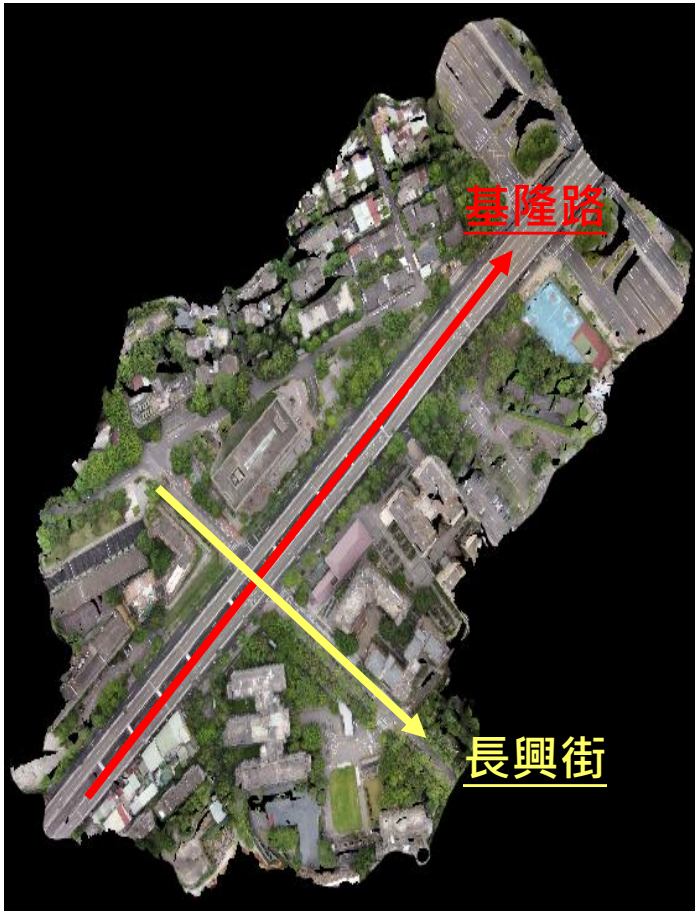


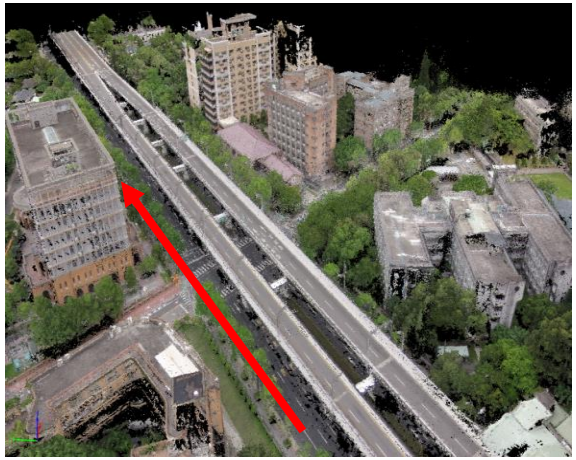


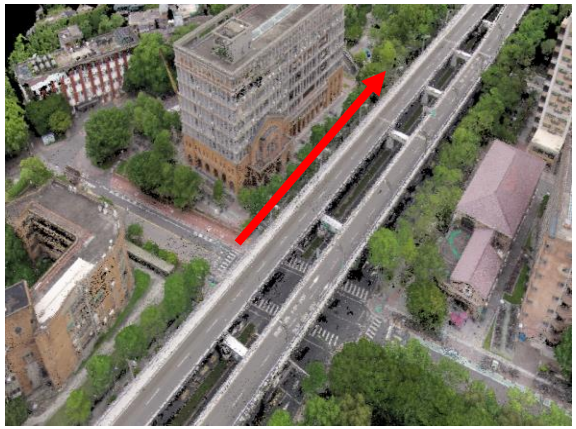
GCP Name	Accuracy XY/Z [m]	Error X [m]	Error Y [m]	Error Z [m]	Projection Error [pixel]	Verified/Marked
CP_164 (3D)	0.020/ 0.020	0.010	0.063	-0.008	1.289	71 / 71
NTUDormI (3D)	0.020/ 0.020	0.024	-0.043	-0.010	0.867	55 / 57
NearMinDar (3D)	0.020/ 0.020	-0.032	-0.039	0.001	0.931	60 / 60
Mean		0.000448	-0.006654	-0.005812		
Sigma		0.023676	0.049126	0.004959		
RMS Error		0.023681	0.049574	0.007640		

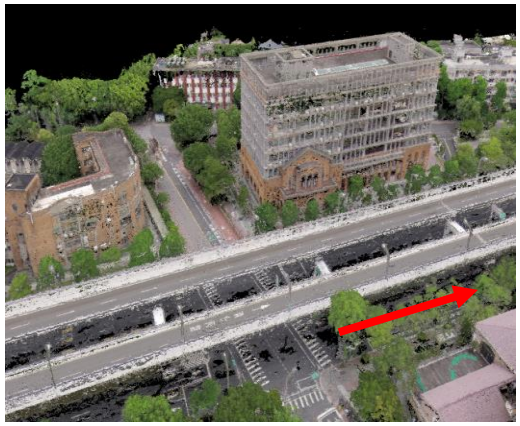
誤差<5公分

Flight Directions



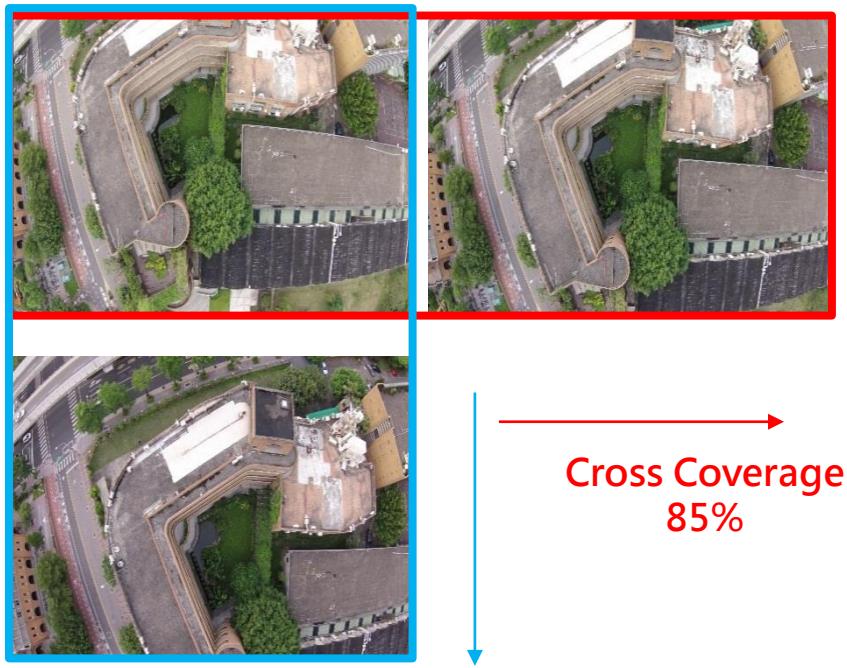




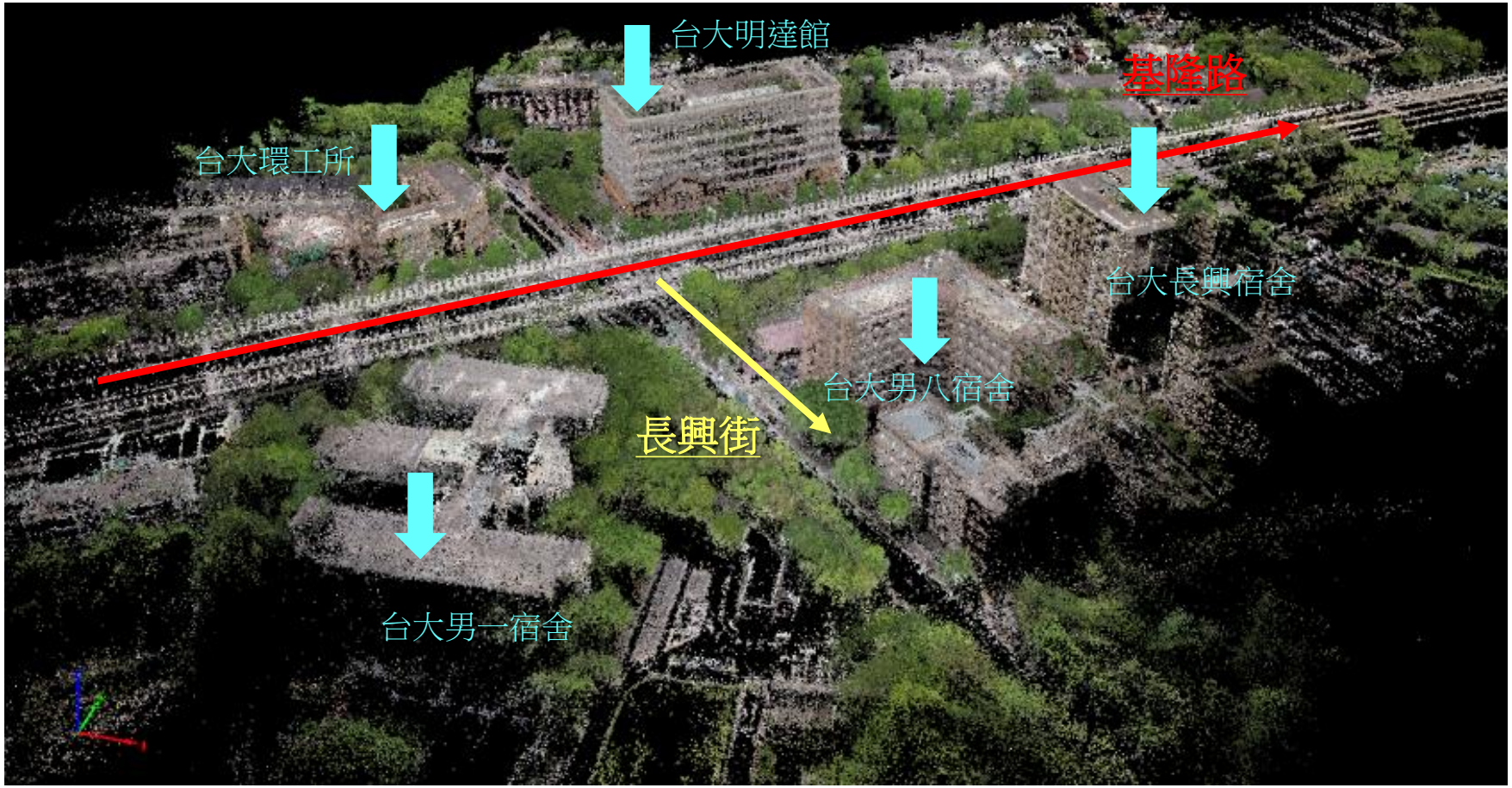


UAV Tracks

- 589 Photos



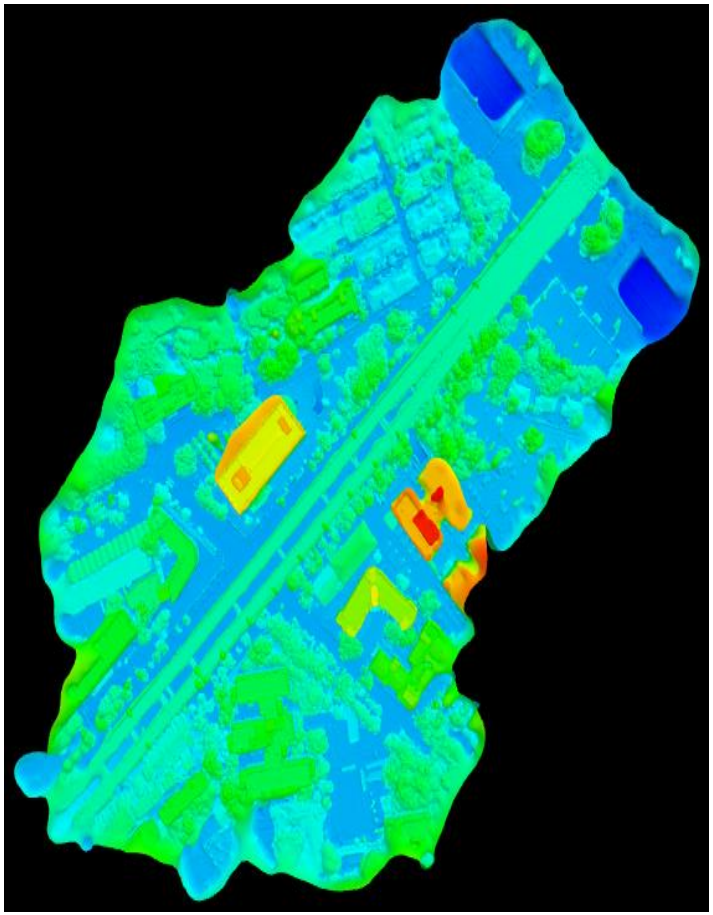
3D Point Cloud Data



Sophisticated DSM

- Average Ground Sampling Distance (GSD) : 2.84 cm / 1.11 in

正射影像



DSM

Flood Time Series for Rainstorm 0614

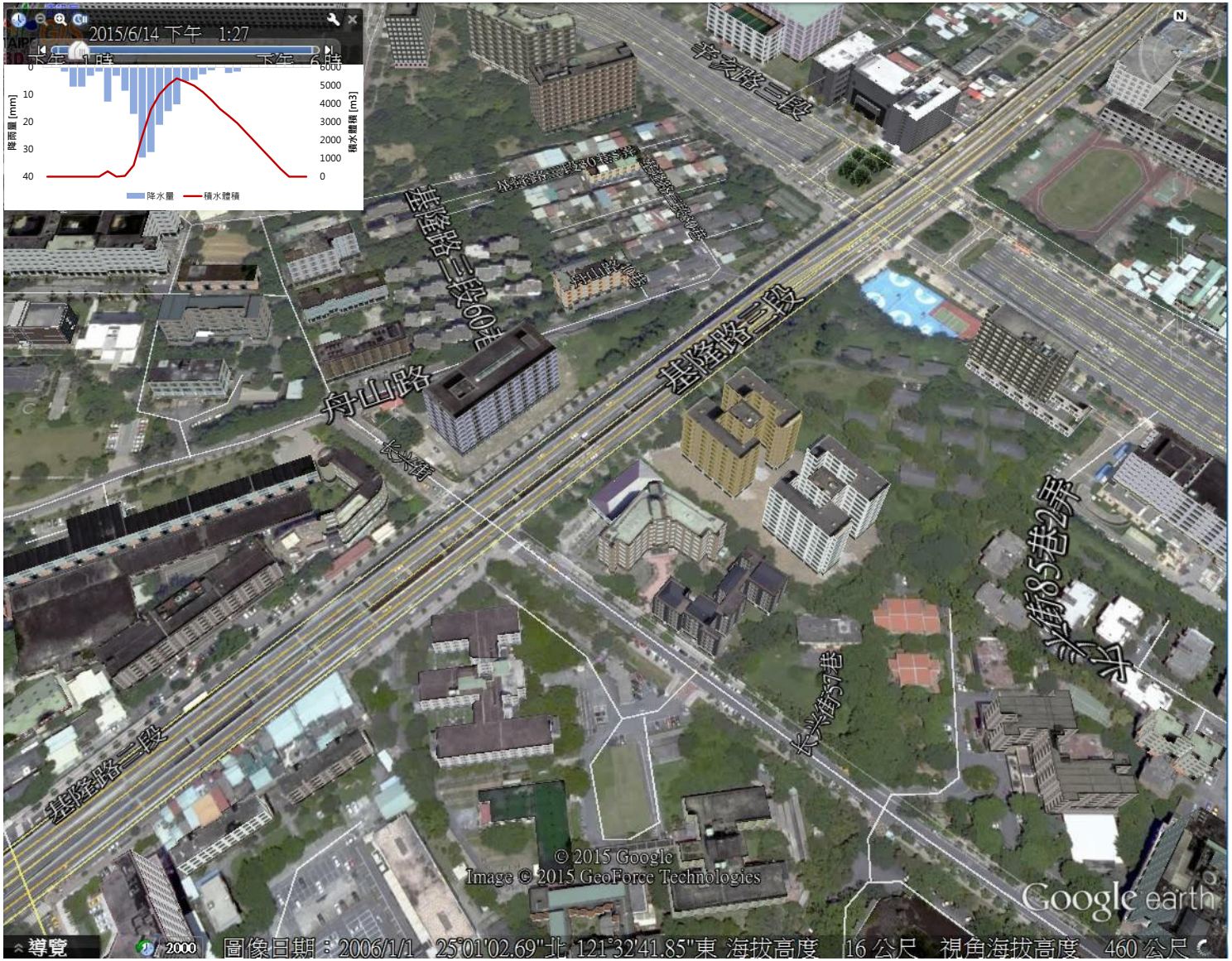
Rain started
Pm 1:20

Max rain
Pm 2:50

Max flood
Pm 3:30

Rain stop
Pm 4:40

Flood retreat
Pm 5:30

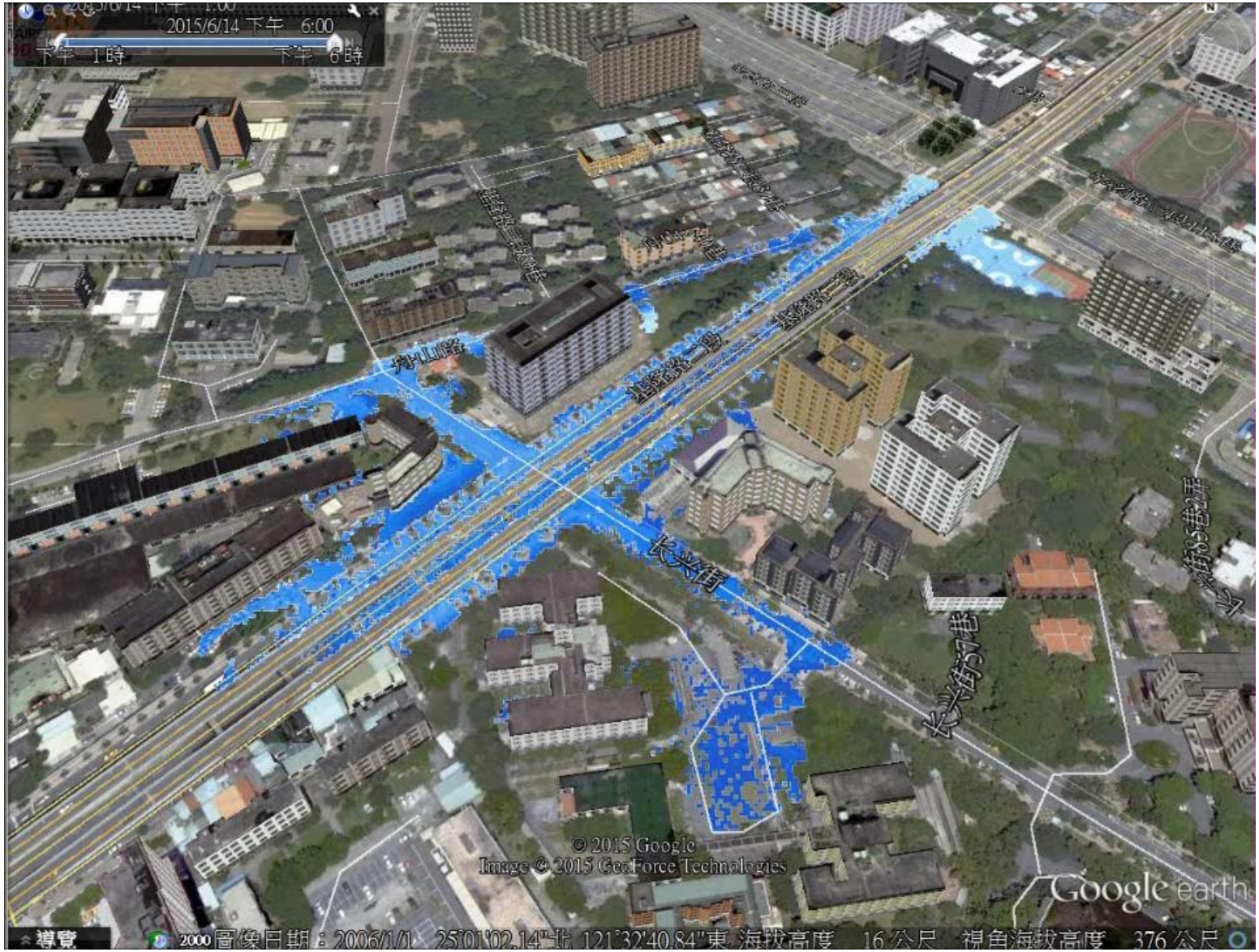


Rebuild Flood Scale in the Photo

The flood occurrence time is 15:10 by simulation, meaning the photo was taken in 20 mins before publication.

基隆路與長興街口
淹水深度0.4m (EL. 9.3m)

Flood Demonstration with 3D Building



Thank you