The disaster impact assessment of comprehensive river basin under extreme climate scenario

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Typhoons, floods, landslides and debris flows

Typhoon

Landslide

Flood

Debris flow

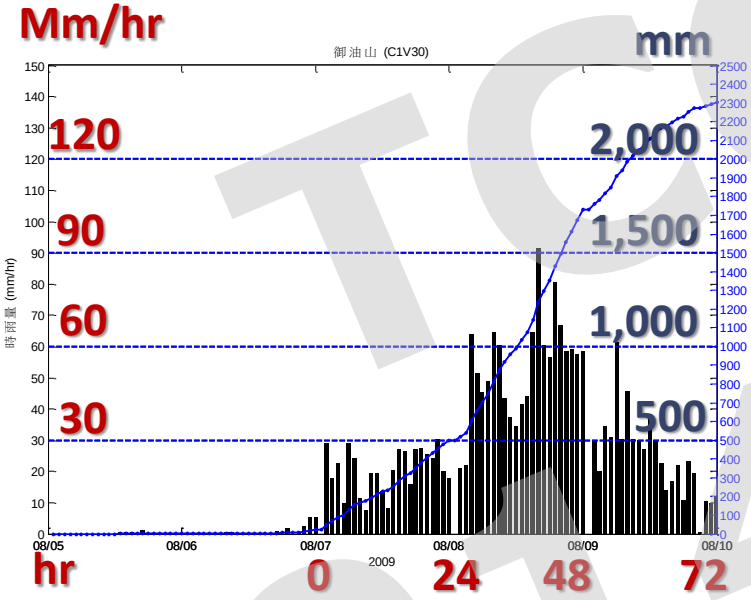

Things go different under extreme weather condition

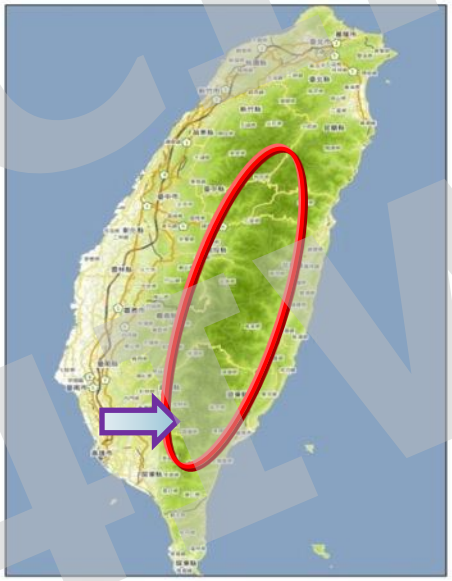
High intensity and long duration rainfall by Typhoon Morakot

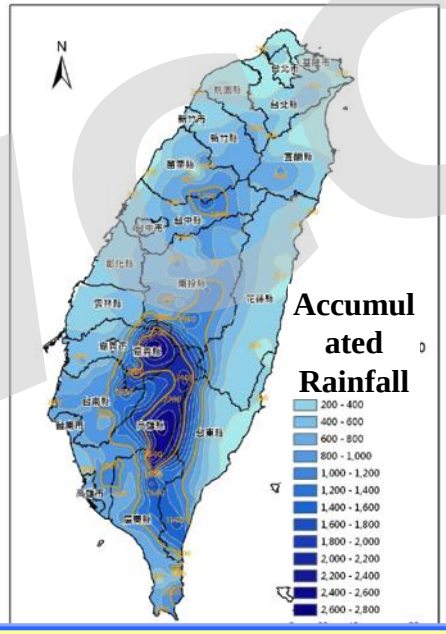

Long duration of heavy rainfall

Complex topography

Extreme rainfall

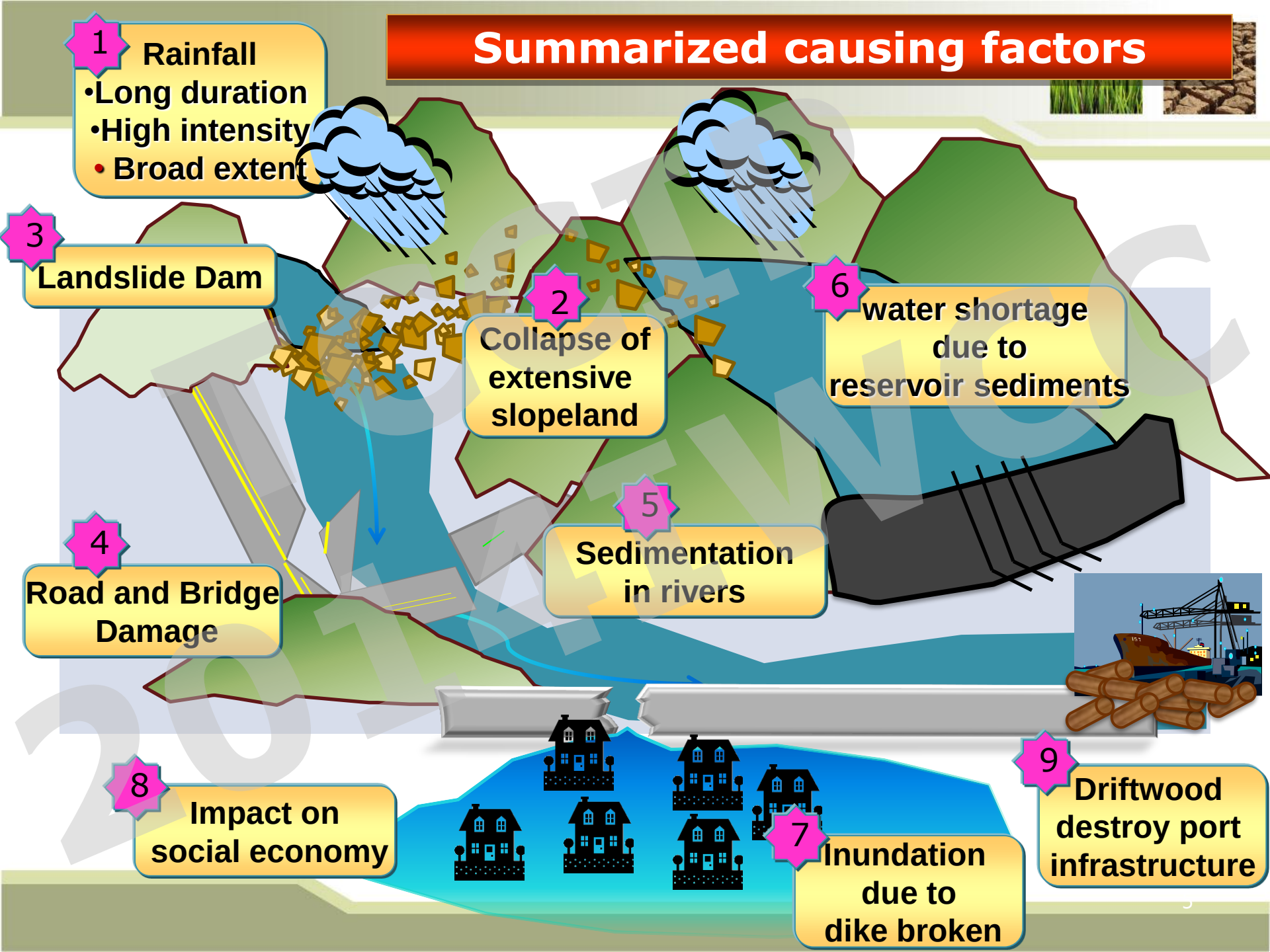






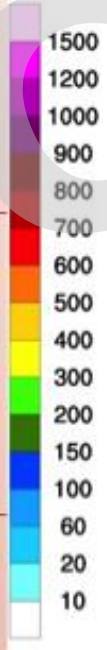
- Heavy rainfall(50-60 mm/hr) lasts for over 24 hours.
- **Topography :** Area of Taiwan is about 36,000 Km^2, ***over 70% in slope land***.
- **High intensity of rain :** *Extreme rainfall concentrated mainly in mountain areas.*

Summarized causing factors



Southern Taiwan will be more precipitation in the future


	Dan-Sui river	Da-Jia river	Jhuoshuei river	Zengwun river	Kaoping river
1979-2003	561.24 mm	511.19 mm	420.87 mm	345.12 mm	462.25 mm
2015-2039	424.75 mm	472.56 mm	458.69 mm	374.87 mm	425.03 mm
2075-2099	448.76 mm	598.17 mm	593.21 mm	607.13 mm	720.10 mm



The average rainfall from top 10 typhoons for 5 large basins

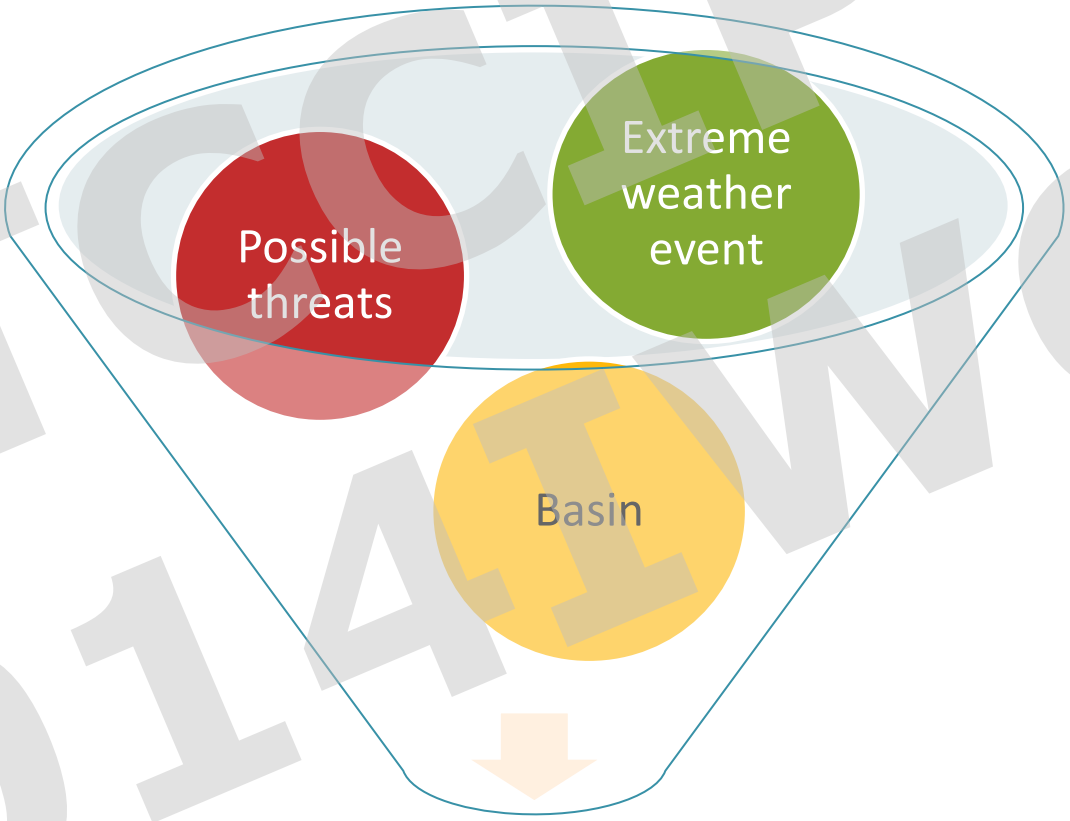
The river discharge assessment: Tseng-wen river basin

	TOP1	TOP2	TOP3	TOP4	TOP5	TOP6	TOP7	TOP8	TOP9	TOP10
Base	13531.38	7719.586	3156.794	3780.836	5441.979	3387.93	3856.473	1311.433	3507.61	2343.363
Near future	11782.82	11349.87	6750.627	7840.786	3367.139	5758.54	7926.844	4445.437	2353.962	4801.892
End of the century	18891.62	15937.19	11805.61	10783.4	12125.96	11170.08	10710.55	7011.56	5973.875	7021.806

Design discharge: 9890cms)

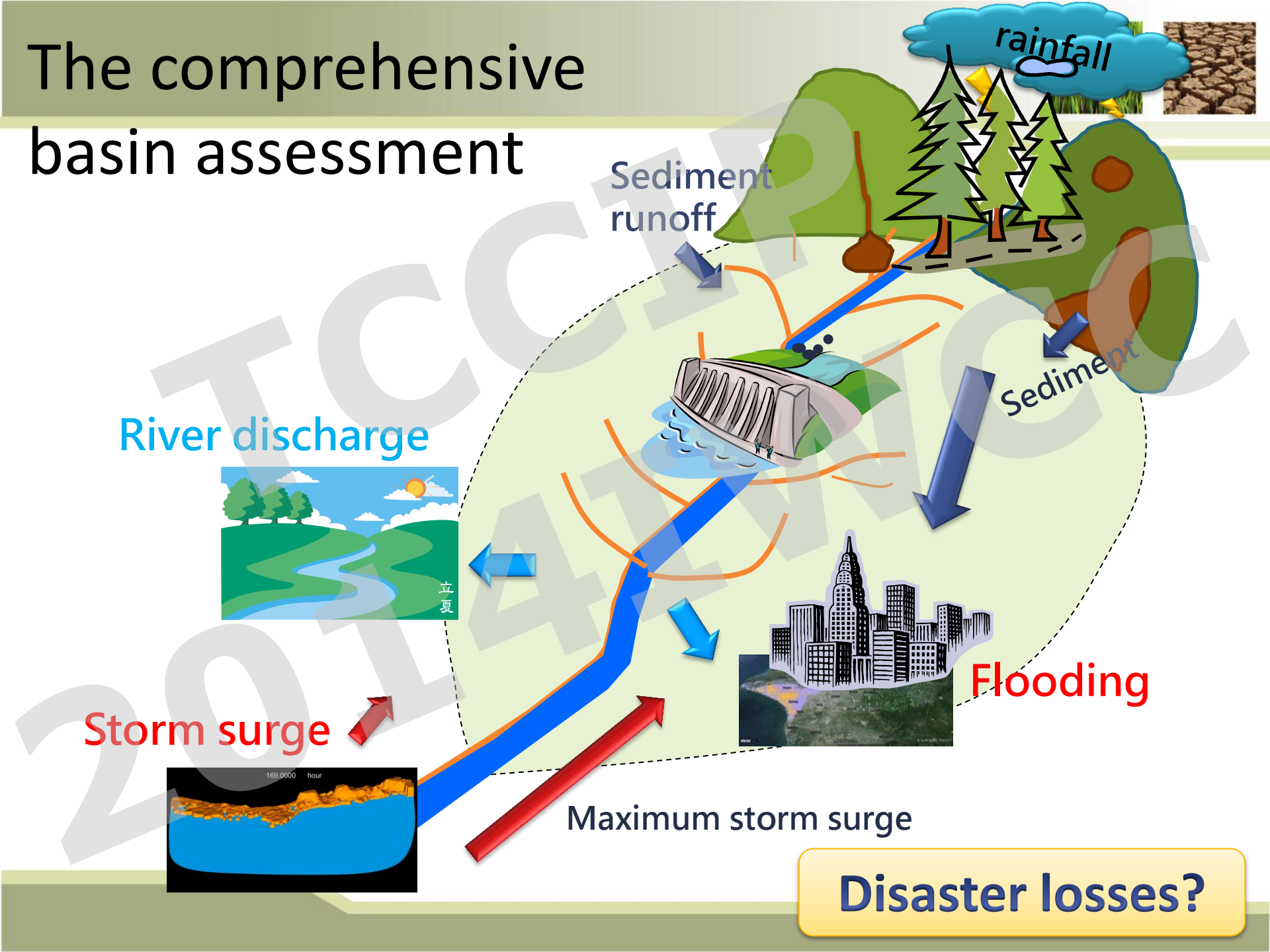
The analysis on extreme weather event shows that

The frequency of exceeding design discharge will increase

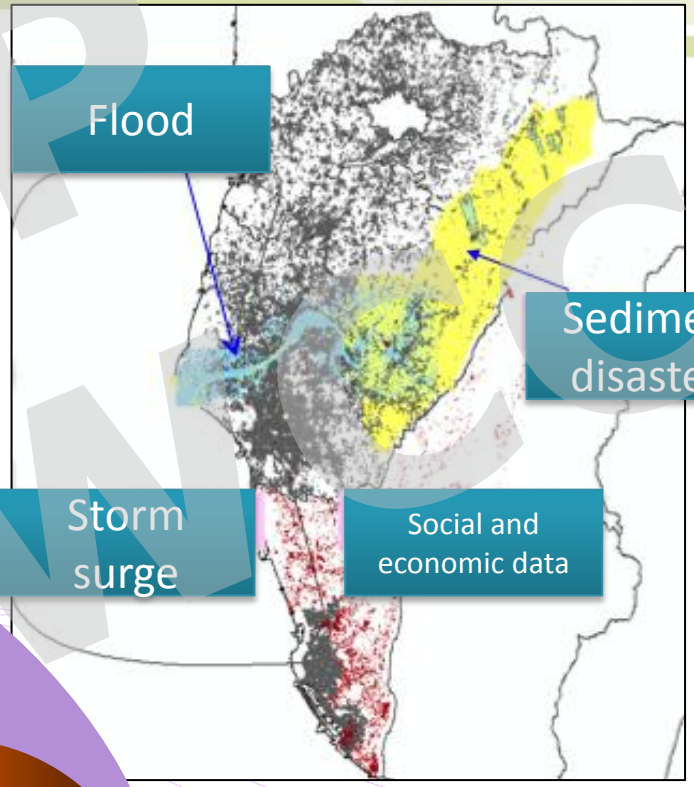


How much impact will occur?

The comprehensive basin assessment



ASSESS EXTREMELY DISASTER IMPACT in Tseng-Wen Basin



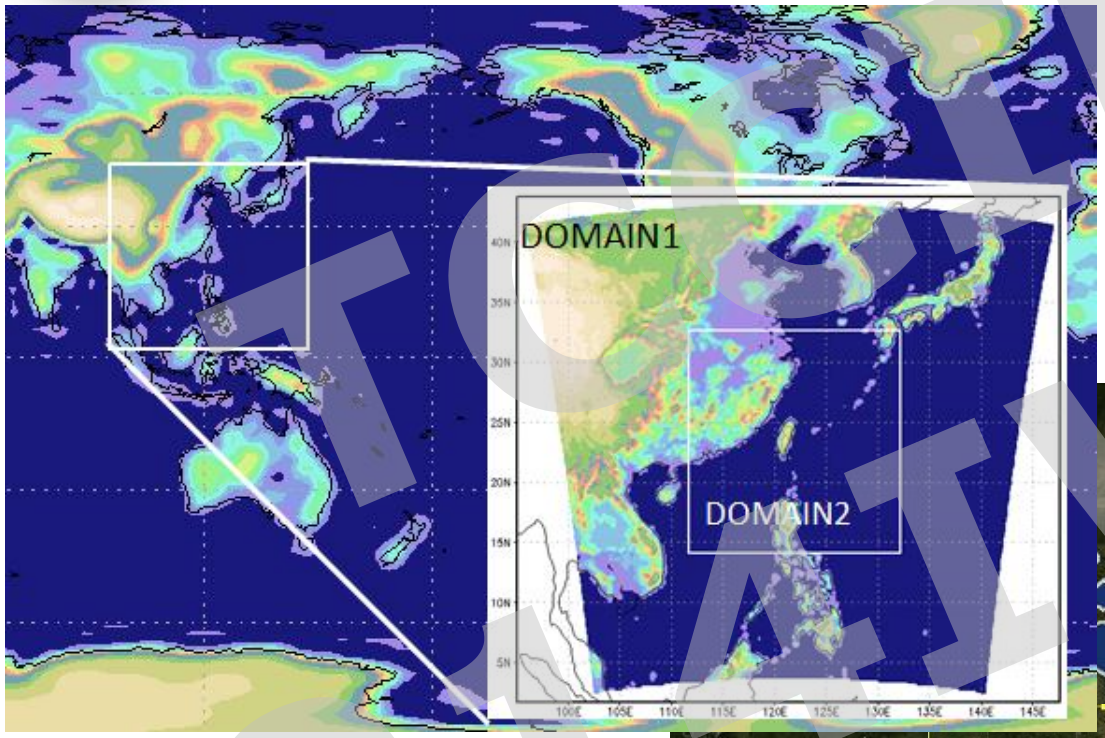
Worst case

Simulation
Sediment disasters
Flood
Coastal disasters

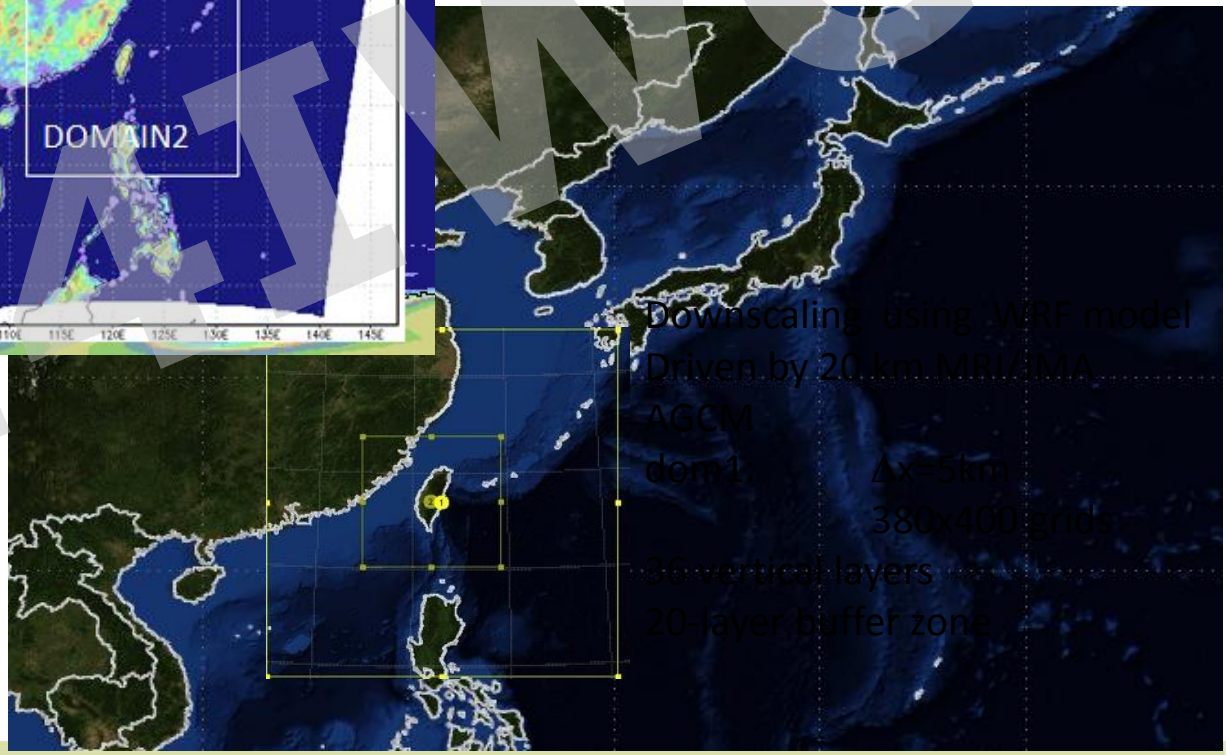
Impact Assessment

PROCESS

Dynamical Downscaling

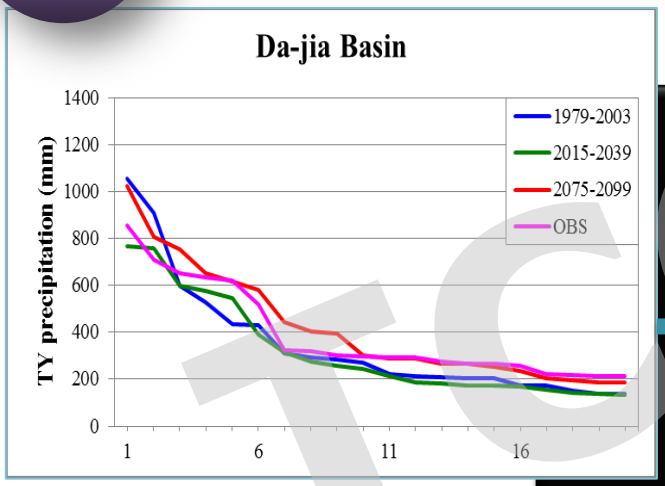
MRI-WRF-5km

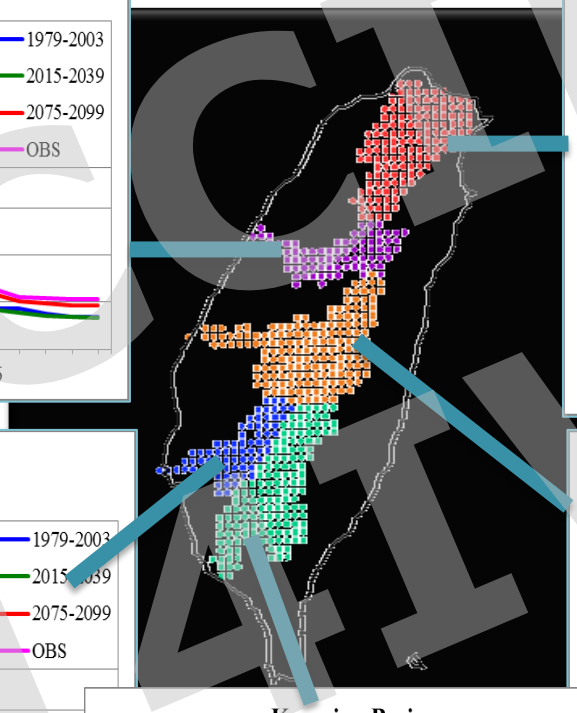


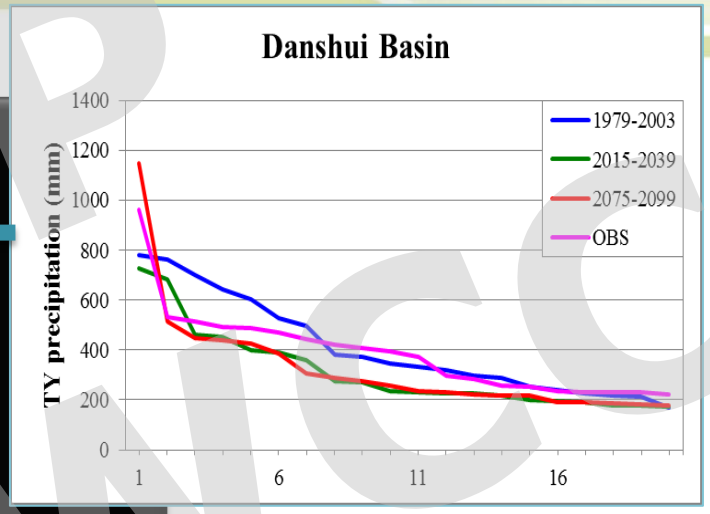
Downscaling using WRF model
Driven by 20 km MRI/JMA AGCM
dom1 Δx=5km
380x400 grids
36 vertical layers
20-layer buffer zone

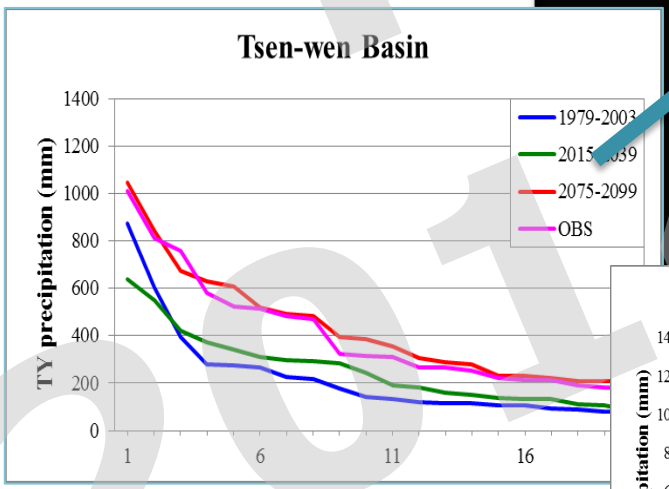
Extreme Typhoons

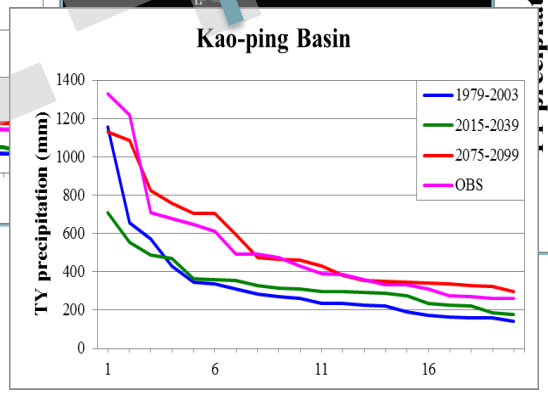
Selection of Extreme Typhoon as the WORST case

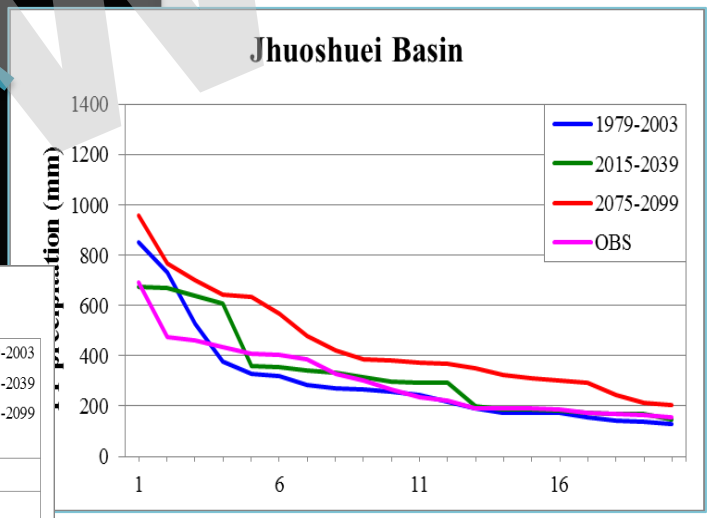






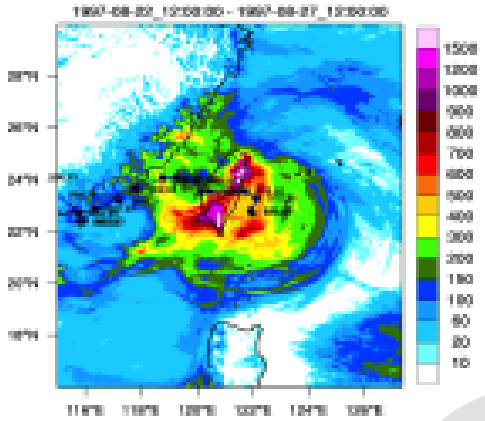


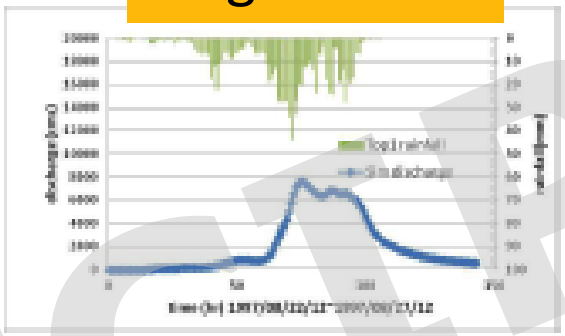


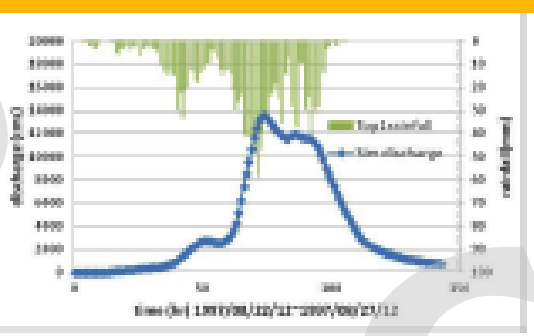


Original data

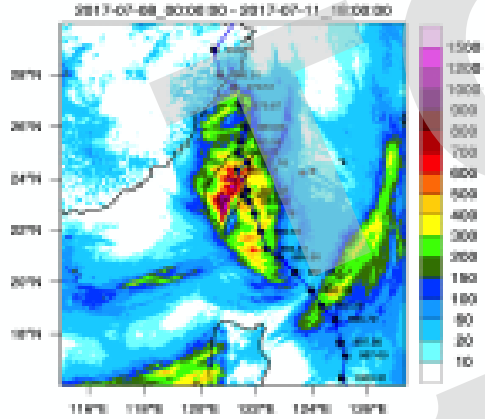
After Bias Correction

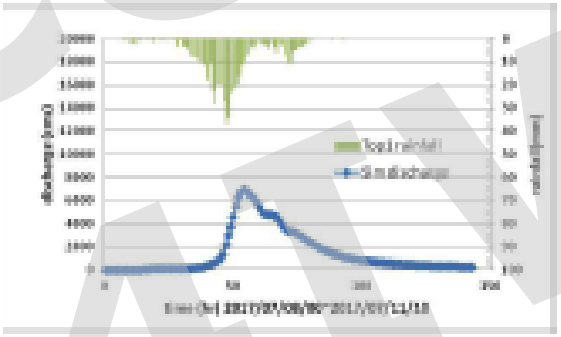


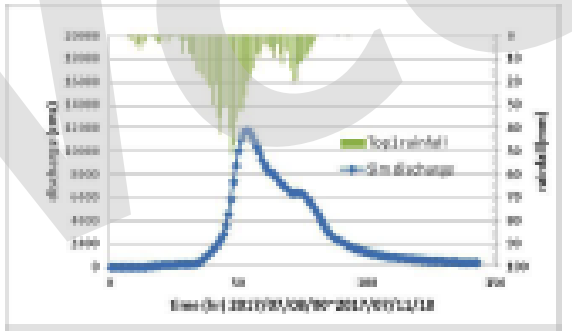




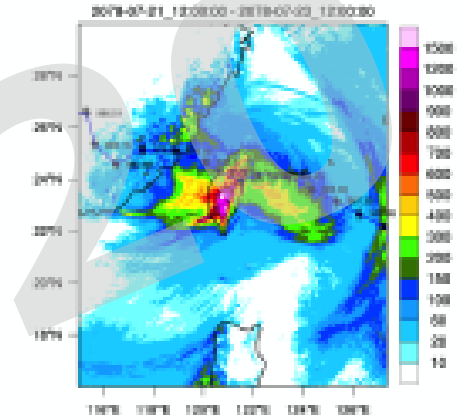
Base time

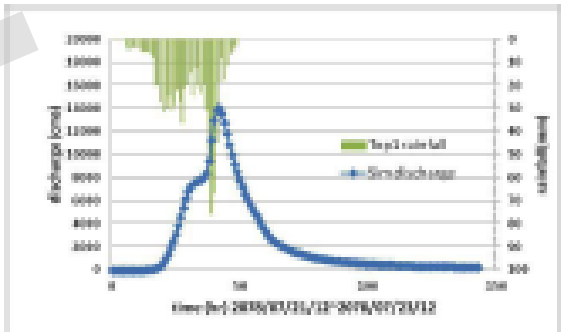


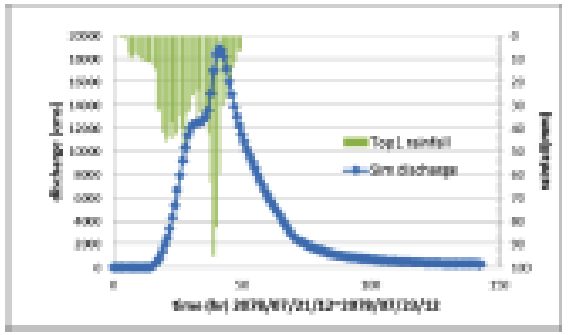




Near future







The end of century

Extreme Typhoons

The WORST case for impact assessment

Dynamical Downscaling Data

Typhoon Track

Wind Field

Pressure Field

Hourly Rainfall

River discharge

Event Return period

Daily Rainfall

Coastal Inundation simulation

Flood Inundation simulation

Sediment disaster simulation

Sediment disasters analysis process


Landslide susceptibility by TRIGRS

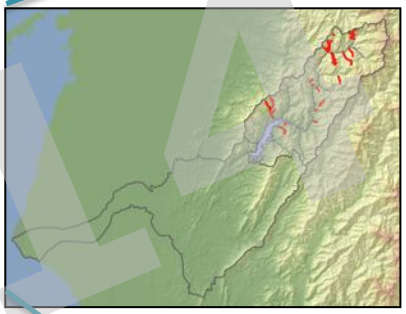
Landslide occurrence threshold

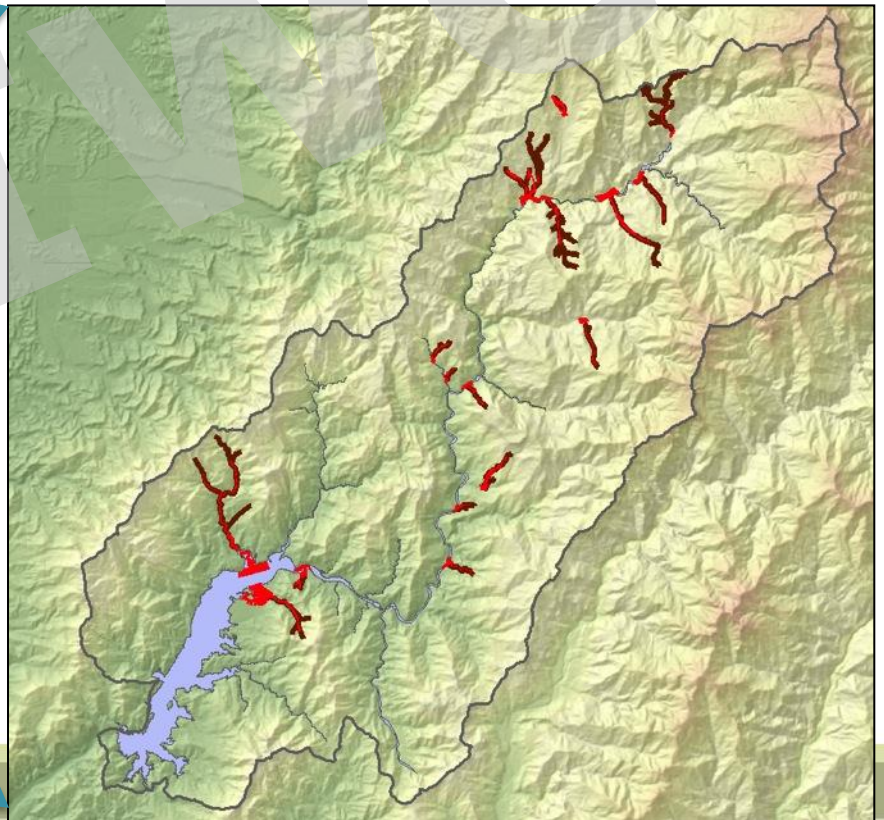
Debris flow sub-catchment classification

Debris flow simulation by Flo-2D

Sediment volume estimation

- The process aims to estimate the sediment amount and the disaster impact generates by extreme weather scenario.
- Assumption: The sediment generates will enter the Tseng-Wen reservoir
- Landslide: Sub-basin at upstream of Tseng-Wen reservoir
- Debris flow: 17 torrents defined as with debris flow potential





Sediment disasters analysis process

Landslide susceptibility by TRIGRS

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Landslide occurrence threshold

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Debris flow sub-catchment classification

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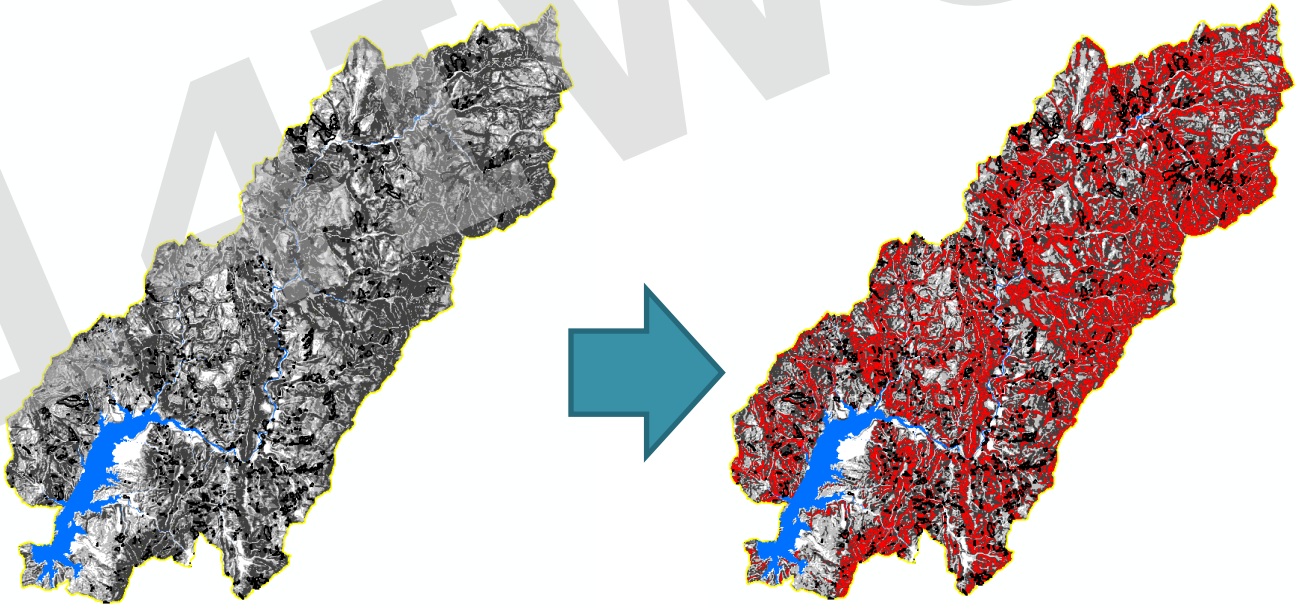
Debris flow simulation by Flo-2D

↓

Sediment volume estimation

- Landslide susceptibility is represent by Safety Factor (FS) of each grid-cell.
- The hourly rainfall of the typhoon event is as the input data.
- The landslide occurrence threshold is determined by matching with the historical landslide data after typhoon Morakot and rainfall event in 2011.



FS distribution before typhoon event

FS distribution after typhoon event (61hr)

Sediment disasters analysis process


Landslide susceptibility by TRIGRS

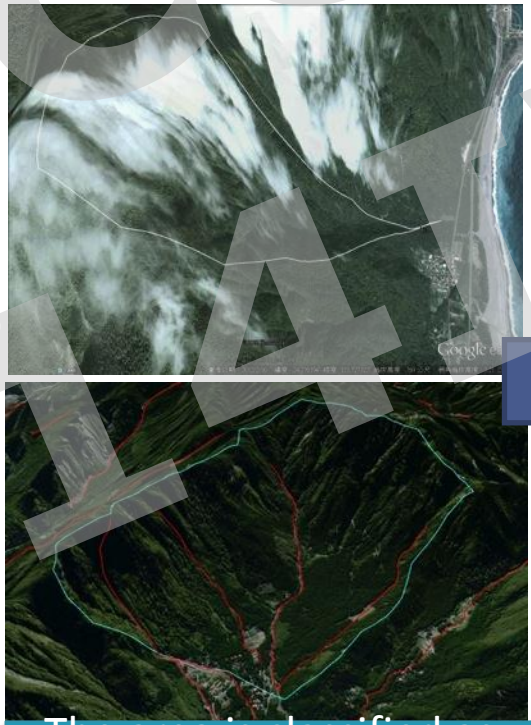
Landslide occurrence threshold

Debris flow sub-catchment classification

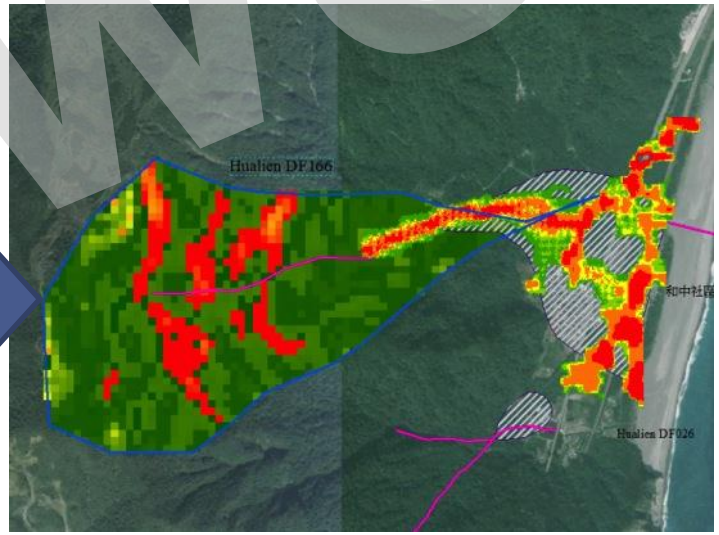
Debris flow simulation by Flo-2D

Sediment volume estimation

- Debris flow sub-catchment is the area where the debris flow material comes from. The landslide susceptibility analysis result is overlaid with the classified range to estimate the sediment volume for debris flow.
- This step is made by aerial photographs and images in Google earth.



The area is classified as the place to trigger debris flow



The range covers with results of landslide susceptibility analysis

Sediment disasters analysis process


Landslide susceptibility by TRIGRS

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Landslide occurrence threshold

↓

Debris flow sub-catchment classification

↓

Debris flow simulation by Flo-2D

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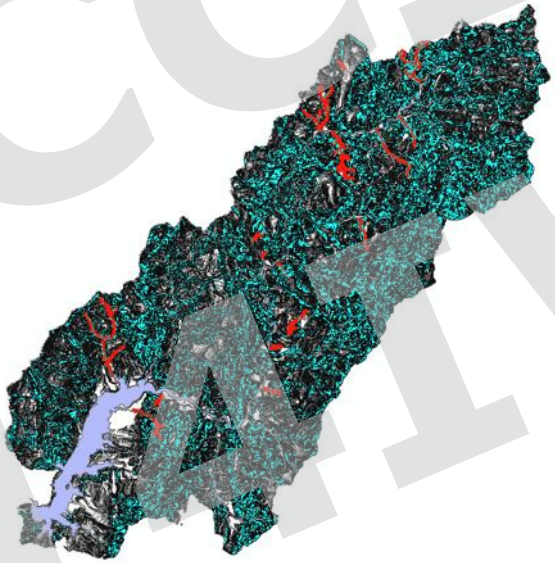
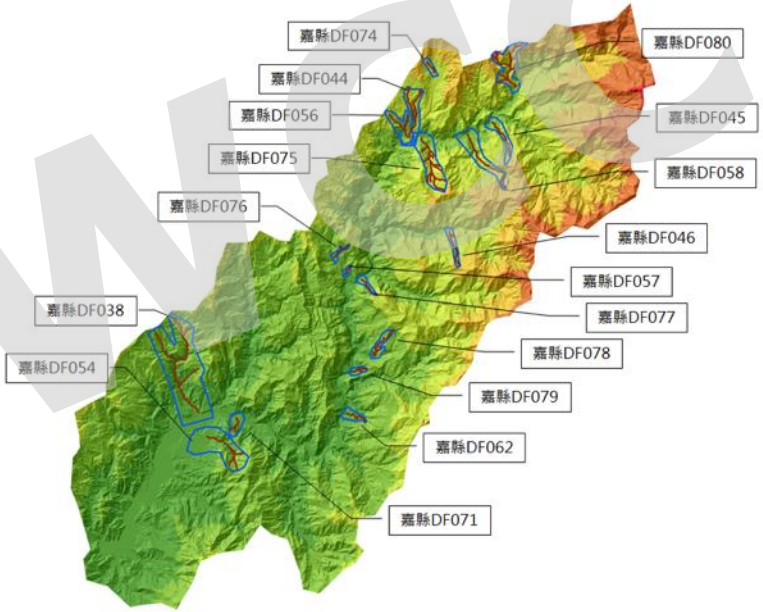
Sediment volume estimation

- The sediment volume estimation includes debris flow and landslide. The sediment volume of landslide is 74,326,000m^3 and of debris flow is 14,730,000m^3.





The sediment volume of landslide is 74,326,000m^3

The sediment volume of debris flow is 14,730,000m^3

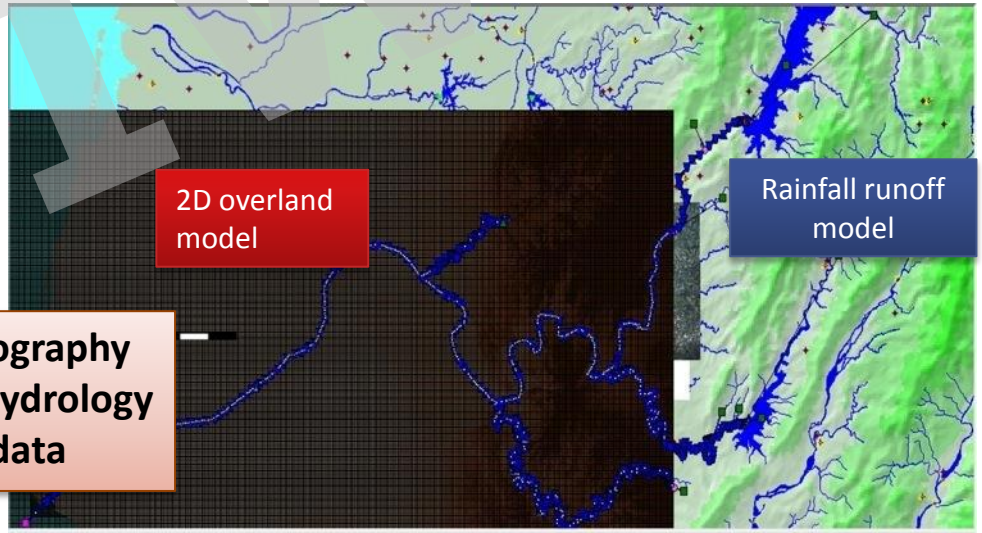
The total sediment volume from the sub-basin in the upstream area is 89,056,000m^3. But the number is still less than the sediment amount generated after typhoon Morakot (91.080,000m^3).

Flood inundation analysis process


2-D flood inundation analysis is carried out by SOBEK model.

- Boundary conditions: Discharge and water level by 1-D flood simulation for river channel and the tide level by FVCOM for downstream part.
- Spatial resolution: 90m
- Temporal resolution: Hour

- Upstream area: Rainfall runoff model
- Middle and downstream area: 2D overland model



WRF dynamic downscaling: Rainfall data of the TOP 1 typhoon (BC)

FVCOM

SOBEK model
Rainfall runoff module, river channel module, flood module

Topography and hydrology data

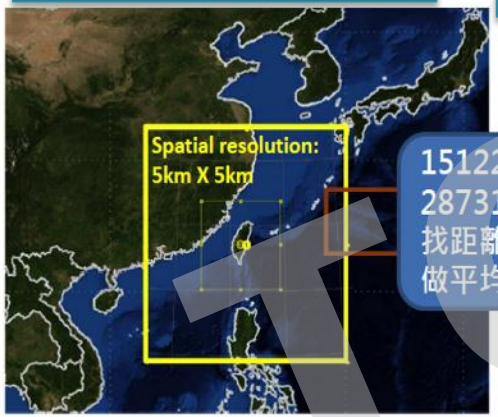
Flooding depth and area

Tide data

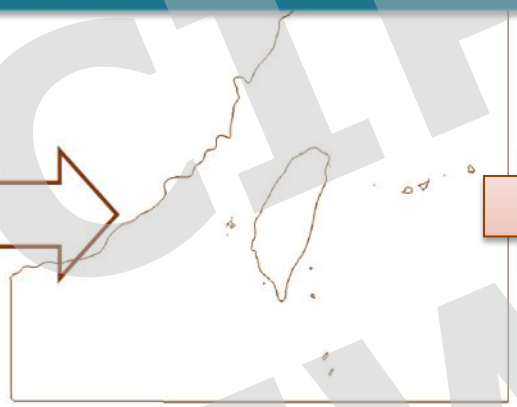

Data selection

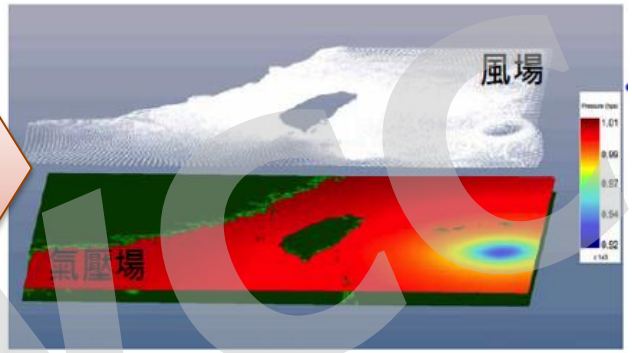
Storm surge height is calculated from dynamic downscaling data

Generate the wind field and pressure field

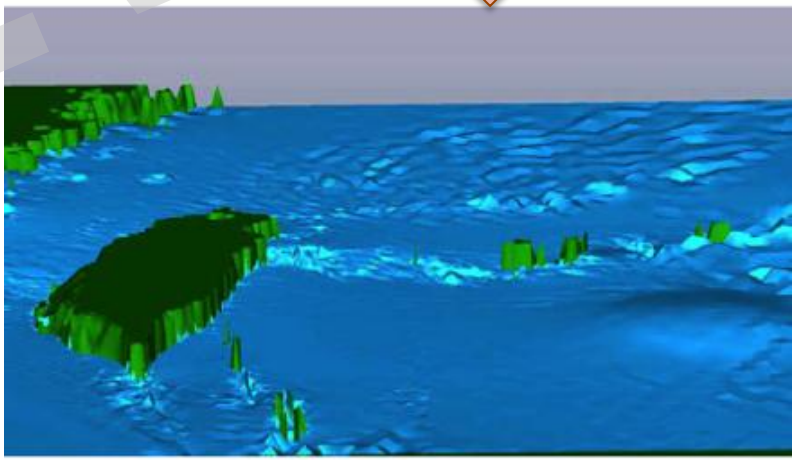


151221nds to
28731nds
找距離最小的4點
做平均



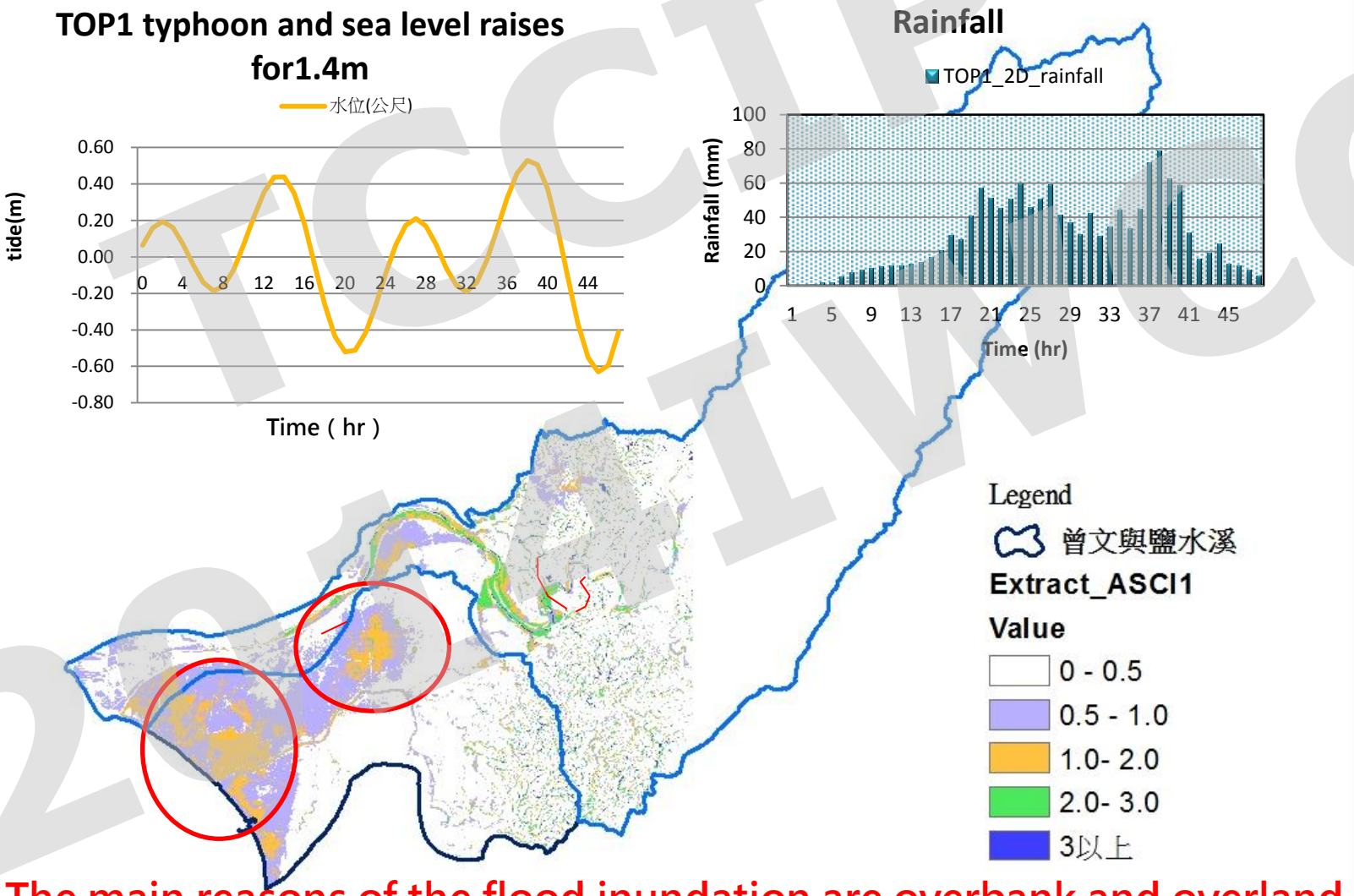


TOP1 typhoon and sea level raises for1.4m



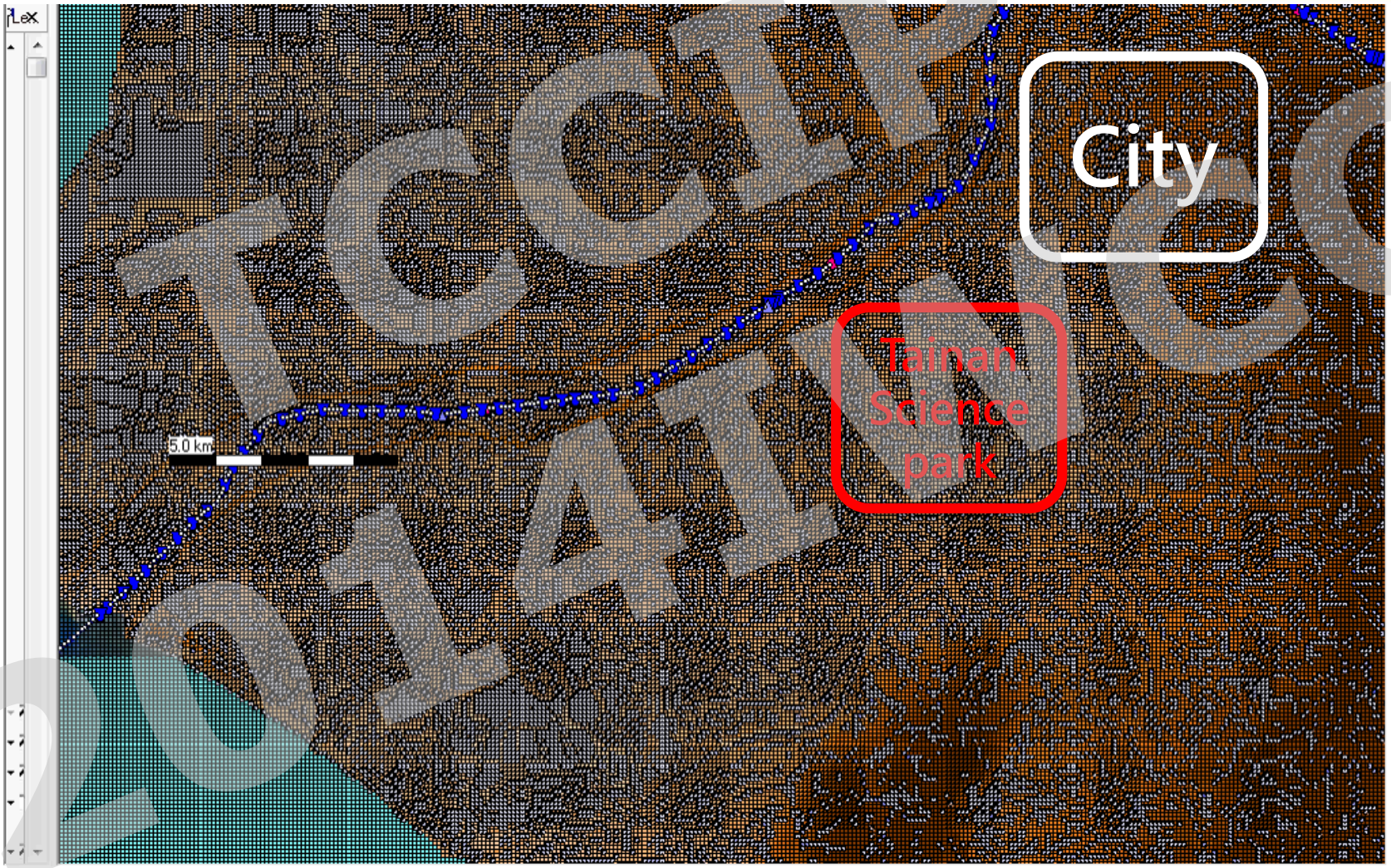
The storm surge simulation

Flood inundation analysis result (1/2)

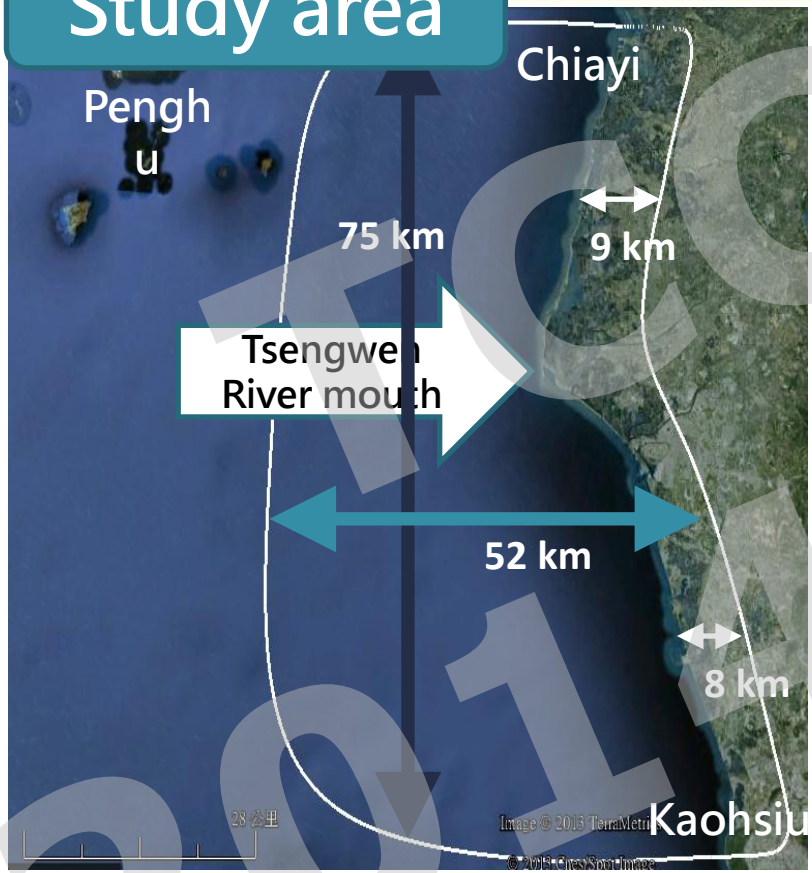
- The main reasons of the flood inundation are overbank and overland flow. The main impact area is at the cities in the downstream area

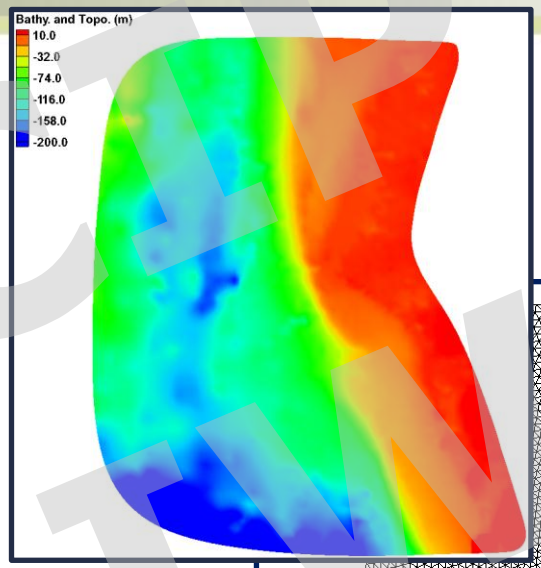
Flood inundation analysis result (2/2)

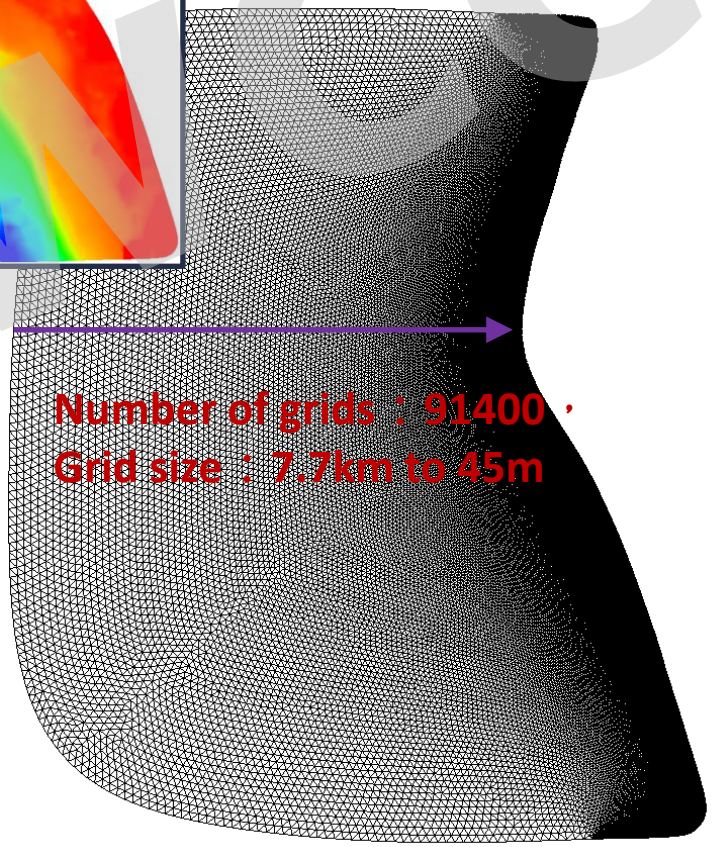


Coastal inundation analysis

Study area



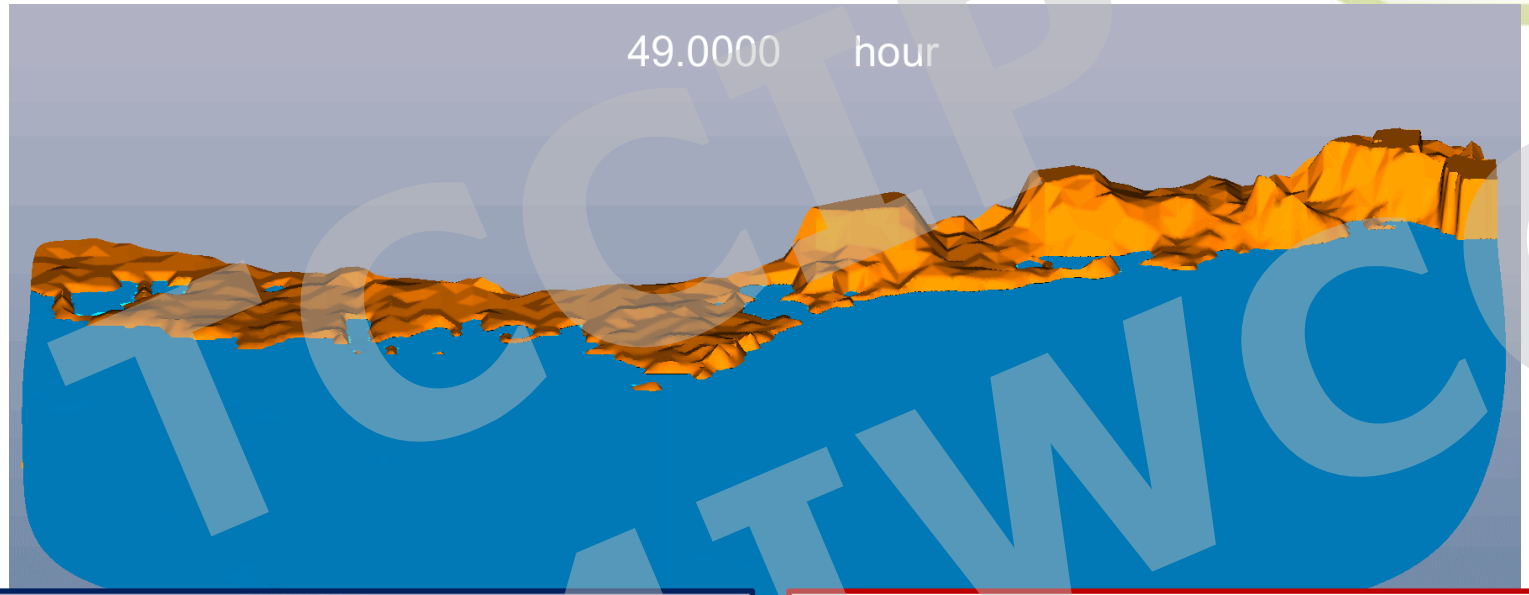


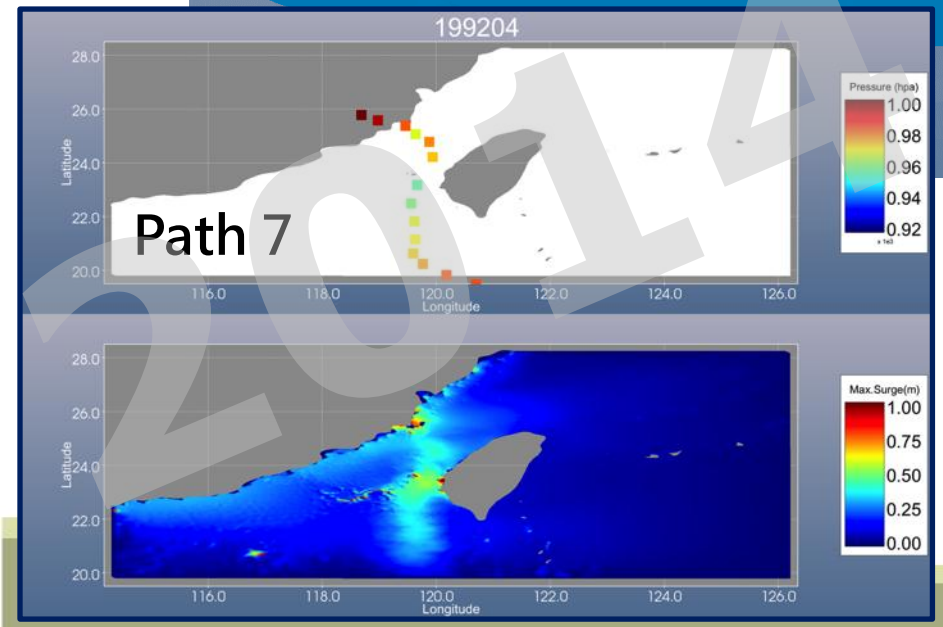


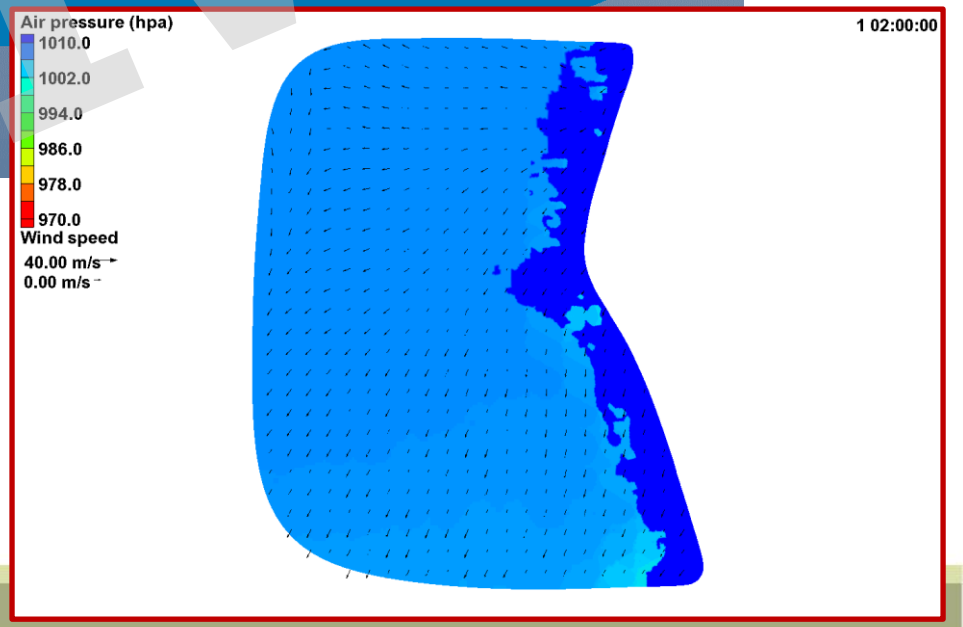
Unstructured grid and bathymetry (topography) for model

Coastal Inundation

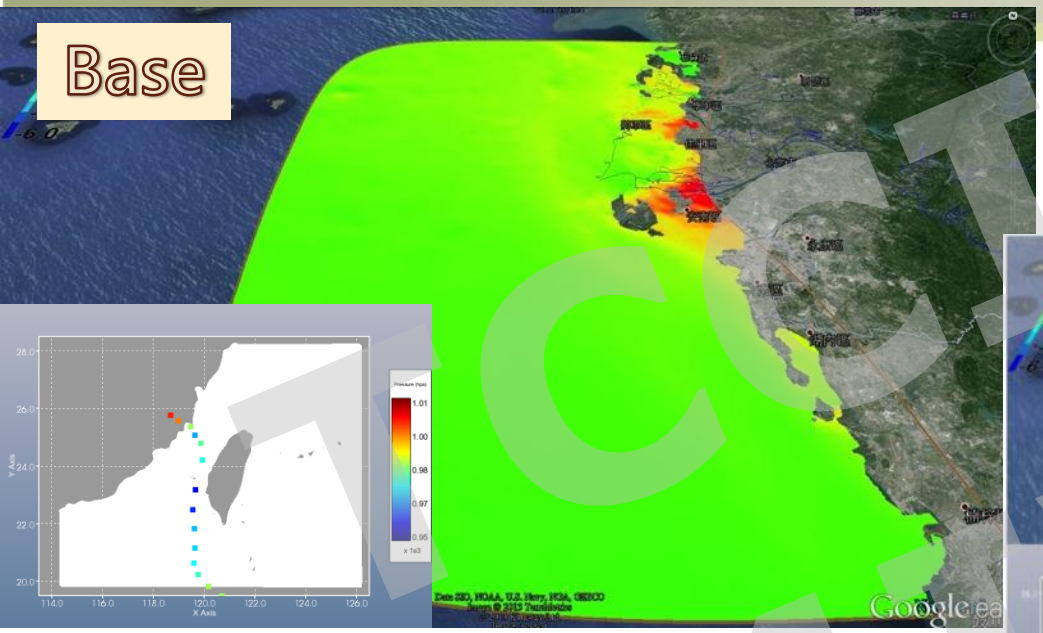
Dynamic downscaling (base)

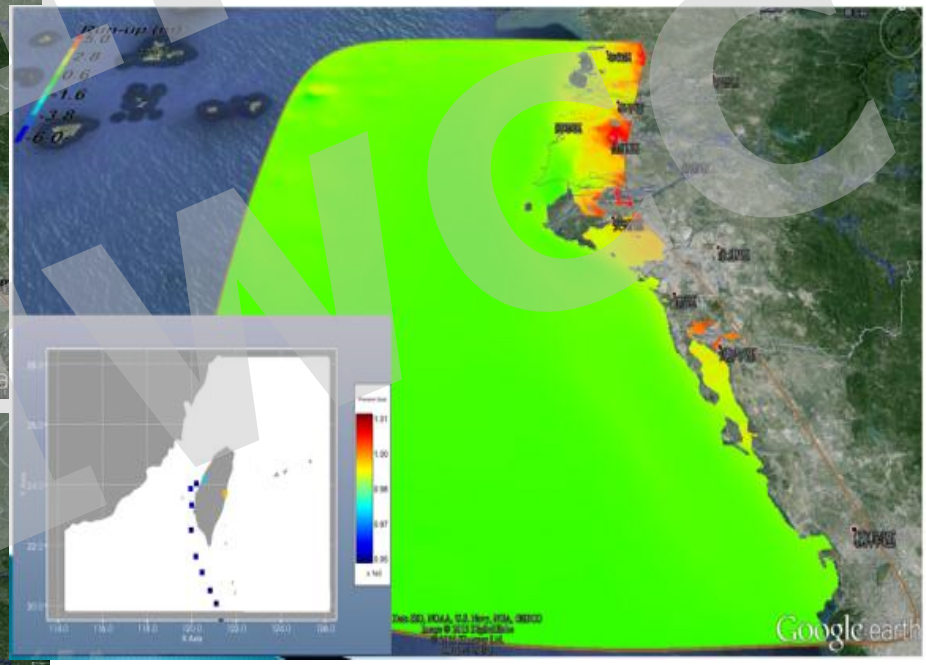


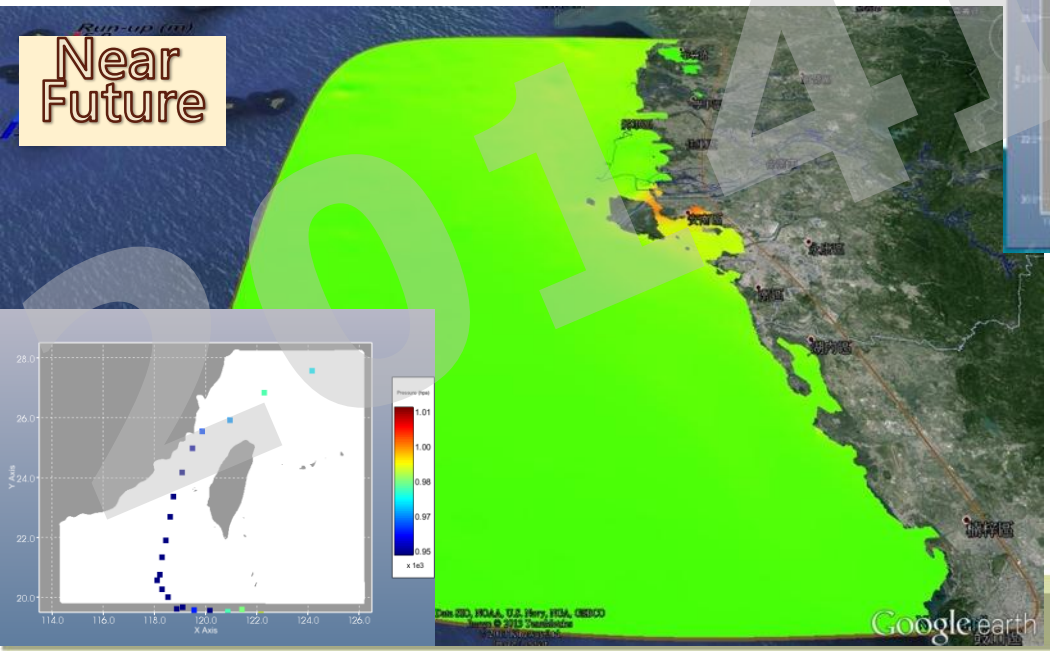




Distribution of Maximal Water Level

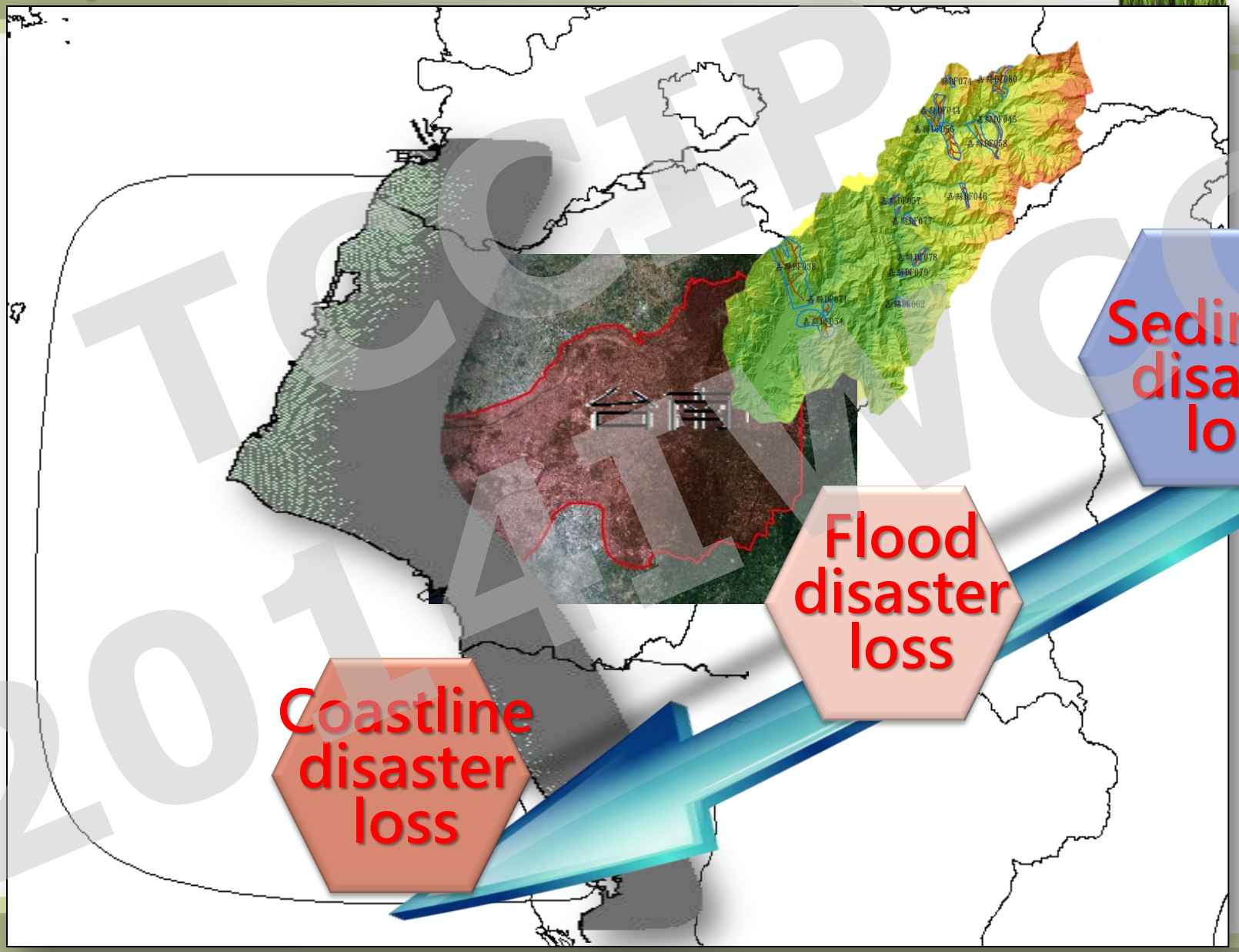






The end of century

Impact Assessment framework



Taiwan Typhoon Loss Assessment System

國家災害防救科技中心
臺灣颱洪災損評估系統
Taiwan Typhoon Loss Assessment System

View Virtual Machine Window

目前版本：v1.01

目前登入：李欣

淹水災害 | 坡地災害 | 資料下載

步驟1：請輸入此事件分析名稱 (必填)

使用說明

請選擇年度： 2011

步驟2：上傳崩塌範圍檔案

使用說明

※限TWD97二度分帶座標系統之ShapeFile檔案

請選擇shp檔： 上傳 shp 檔

請選擇shx檔： 上傳 shx 檔

請選擇dbf檔： 上傳 dbf 檔

自訂掩埋深度： 3 (m) 清除資料 讀取欄位

請選擇掩埋深度欄位： (m) 確定

步驟3：選擇欲計算的鄉鎮

使用說明

請選擇鄉鎮：

※系統計算結果會以Email通知

請輸入您的Email(必填)：

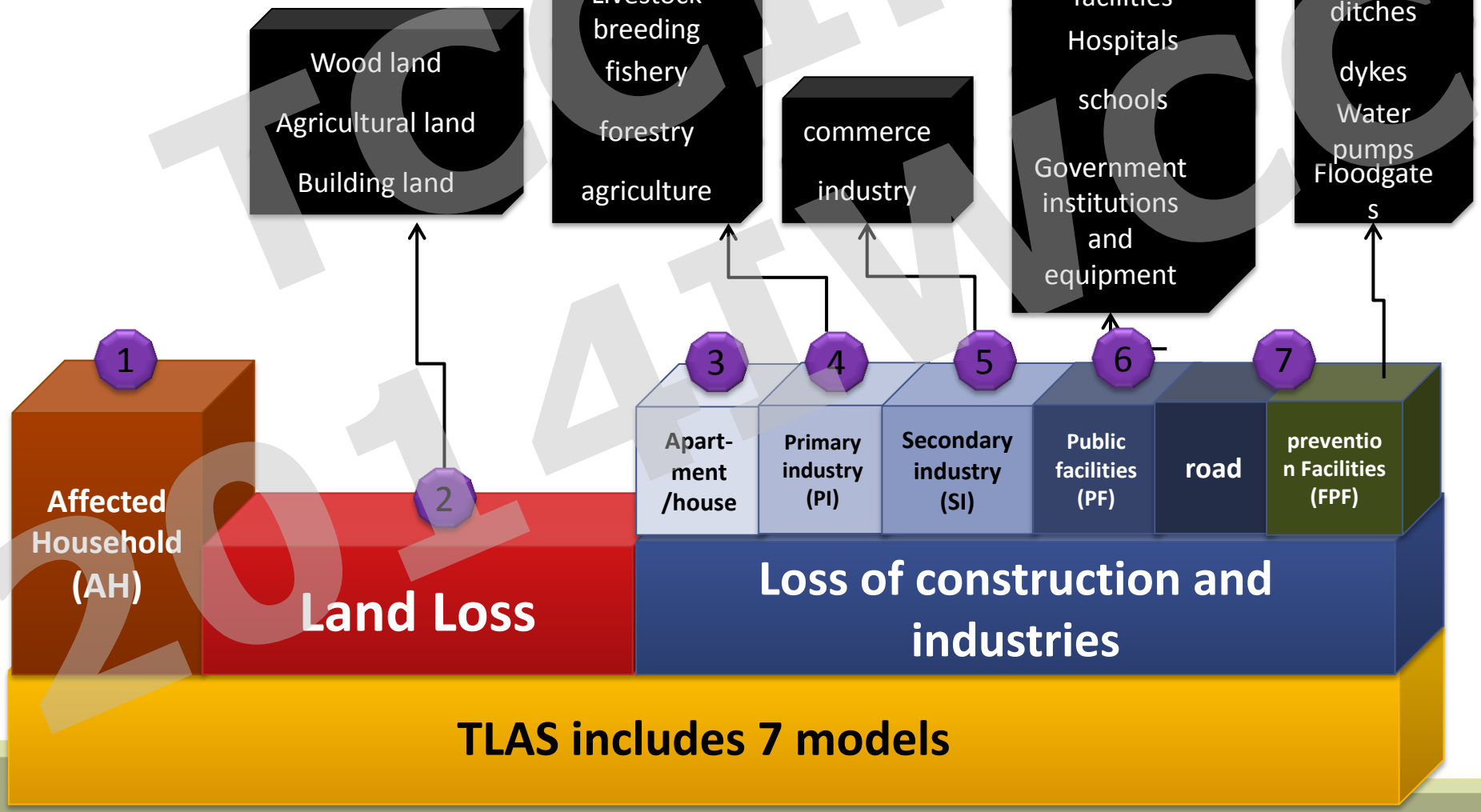
開始執行

比例尺：
1：2279802

目前座標：
WGS1984: X = 121.8255, Y = 25.4702
TWD97: X = 333010.8234, Y = 2818120.9059

NCDR

TLAS Taiwan Framework



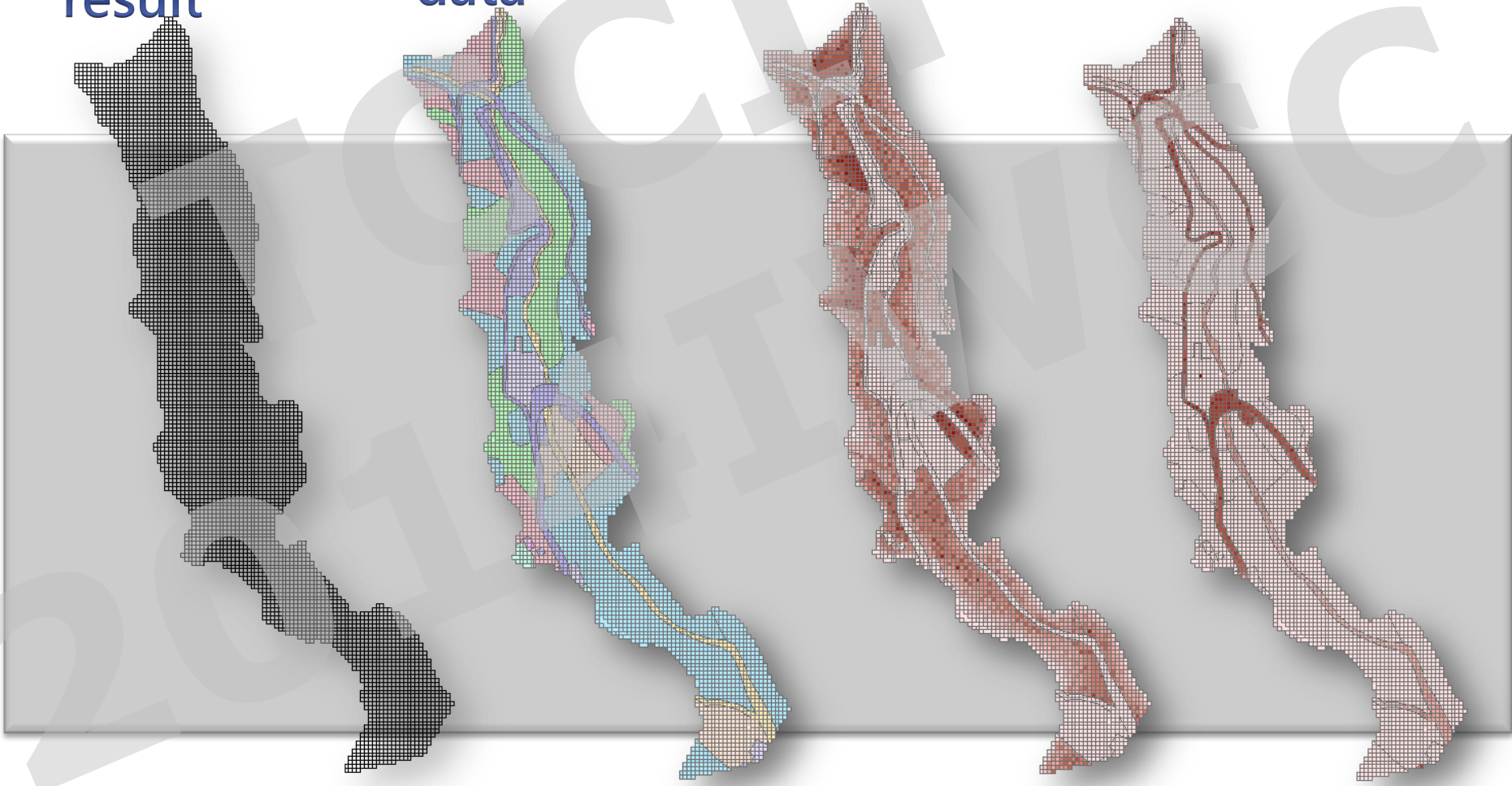
Impact assessment method

Simulation result

Land-use data

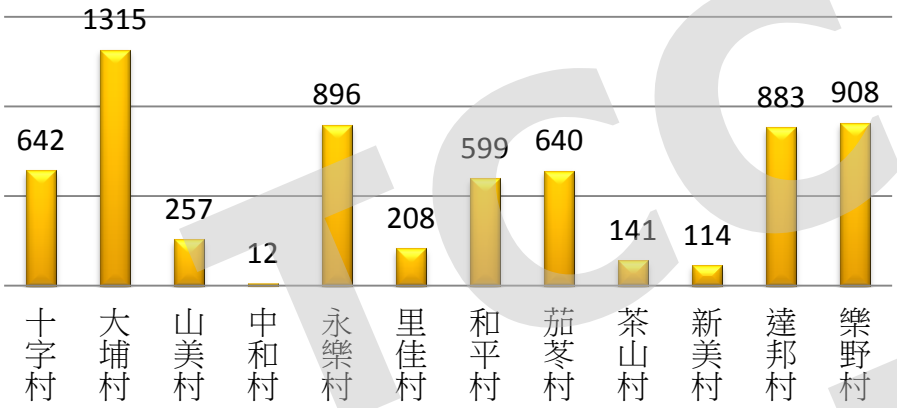
Land loss

Property loss

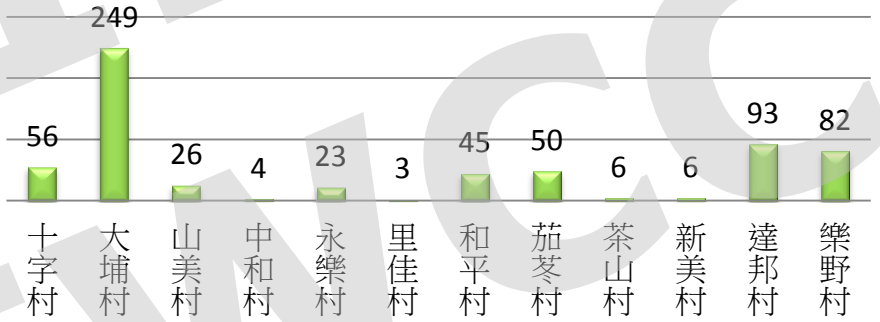


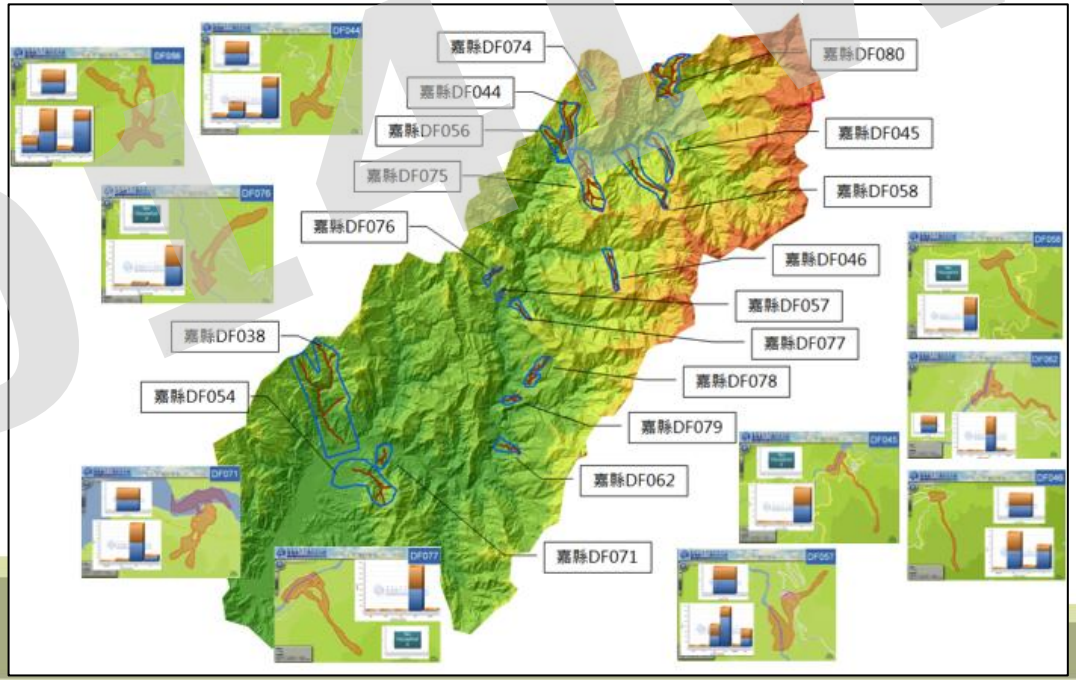
Impact Assessment (debris flows)

Property Loss (million NTD)



Influenced household





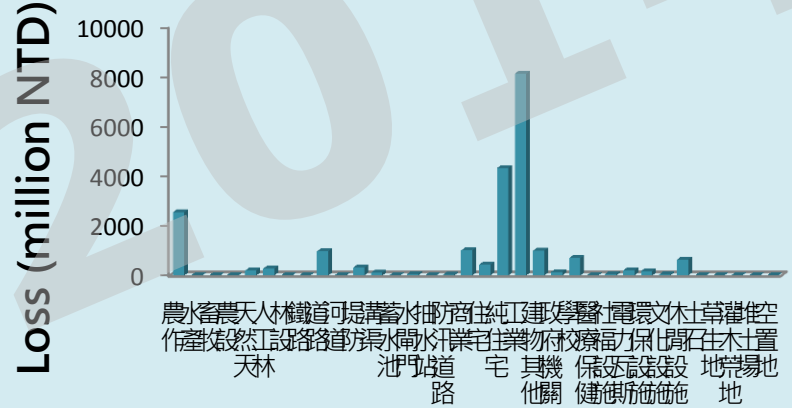
國家災害防救科技中心

臺灣颱洪災損評估系統

Taiwan Typhoon Loss Assessment System

Loss area of different land-use category

Flooding loss analysis

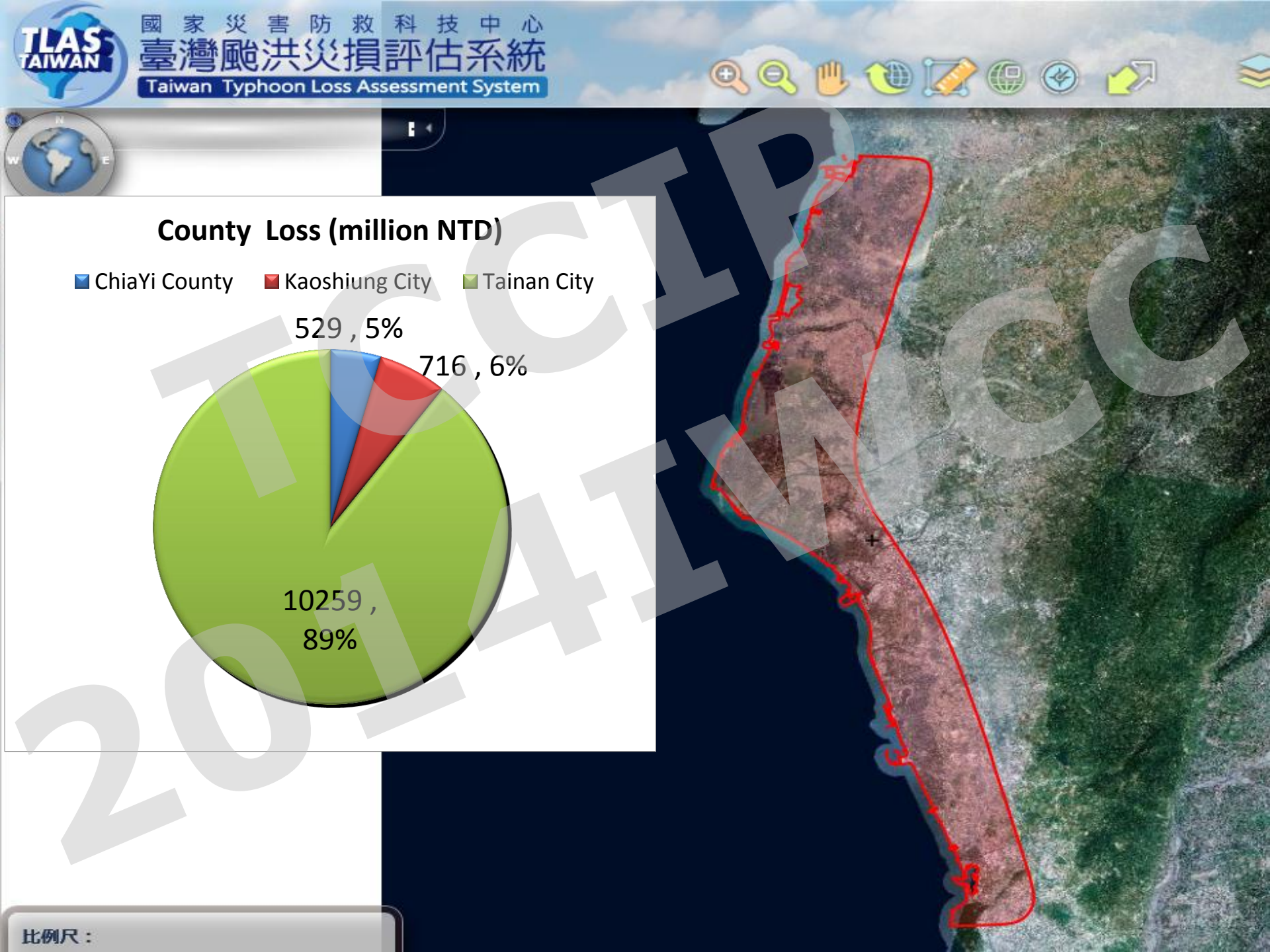


TWD97: X = 187342.2319, Y = 2549584.7177

國家災害防救科技中心

臺灣颱洪災損評估系統

Taiwan Typhoon Loss Assessment System



比例尺：

Conclusion


- The disaster impact assessment connect probable threats, extreme weather condition, and climate change data. The dynamical downscaling data should be used after BC.
- The disaster analysis of worst case scenario shows the disaster area will increase, including sediment, flood, and the coastline disasters.
- The impact assessment result gives us an idea of the probable disaster losses under the extreme weather condition.


Thanks for your attention

Outline


- Introduction:
- Methodology-

Sediment disasters analysis

Flood inundation analysis

Coastal inundation analysis

Disaster Impact Assessment

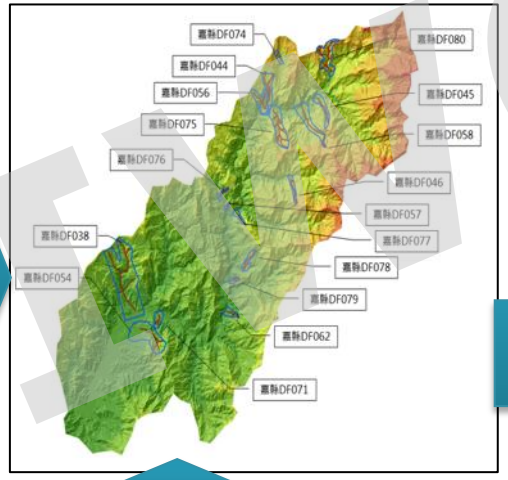
- Conclusion

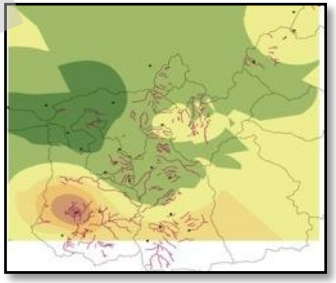
Sediment disasters analysis process

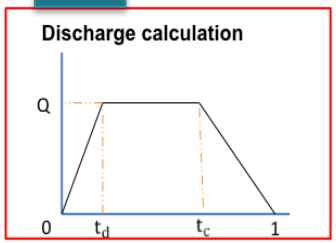

- Landslide susceptibility by TRIGRS
- Landslide occurrence threshold
- Debris flow sub-catchment classification
- Debris flow simulation by Flo-2D
- Sediment volume estimation

- Debris flow simulation is carried out by Flo-2D numerical simulation.
- Parameter dataset is established and hydrologic statistical analysis is proceed to estimate the magnitude of the extreme event.

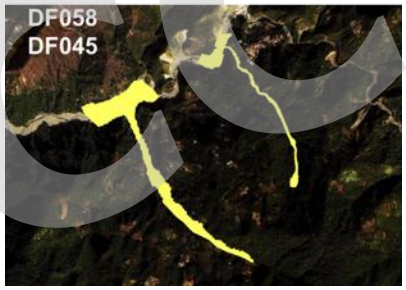
Parameter dataset

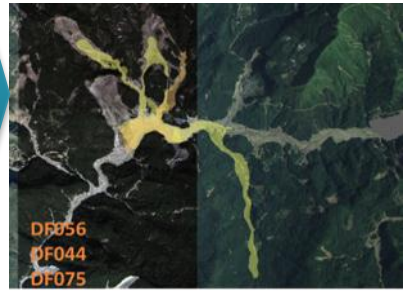




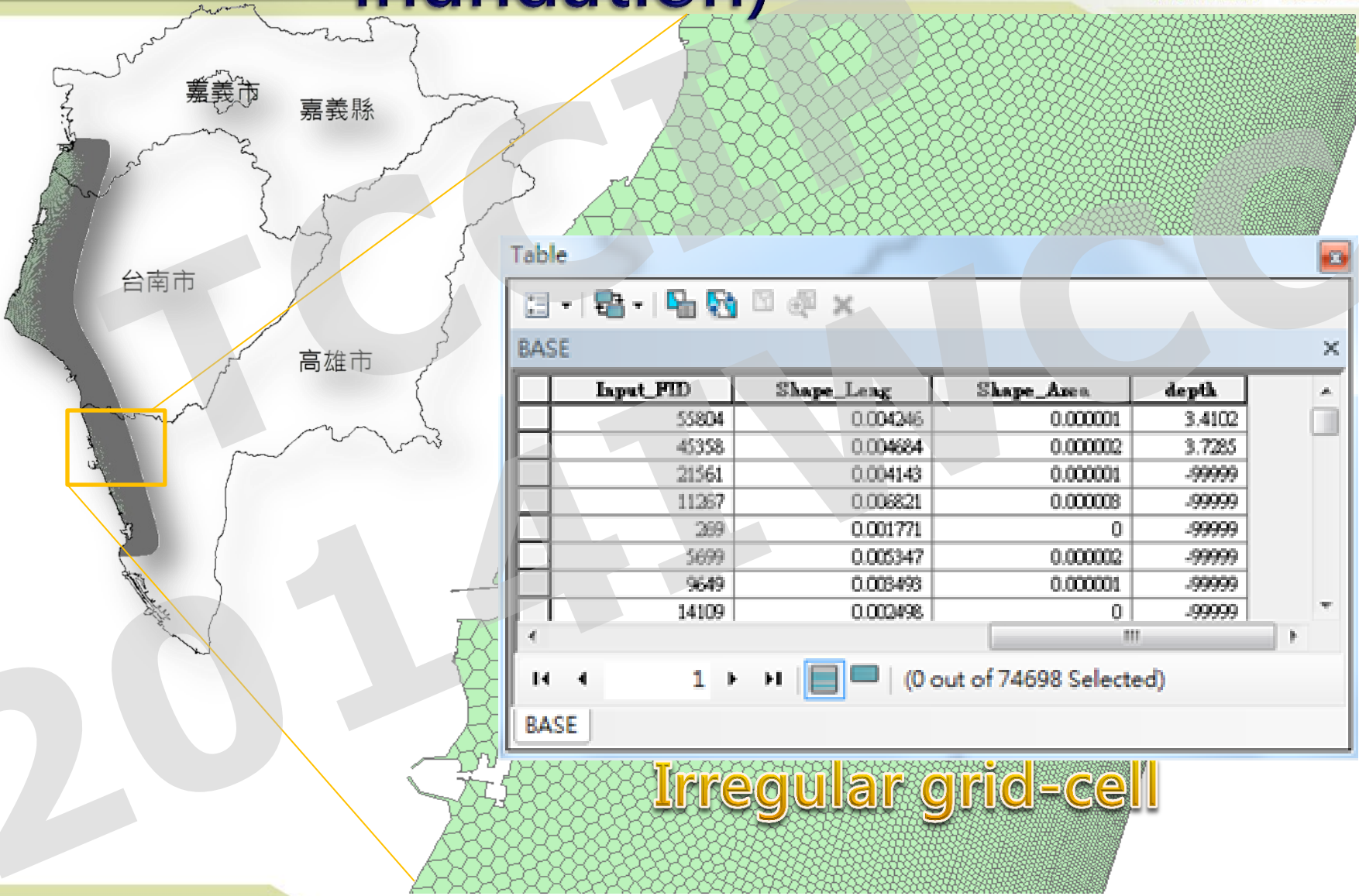


Hydrologic statistical analysis





Impact assessment (Coastal inundation)



Table

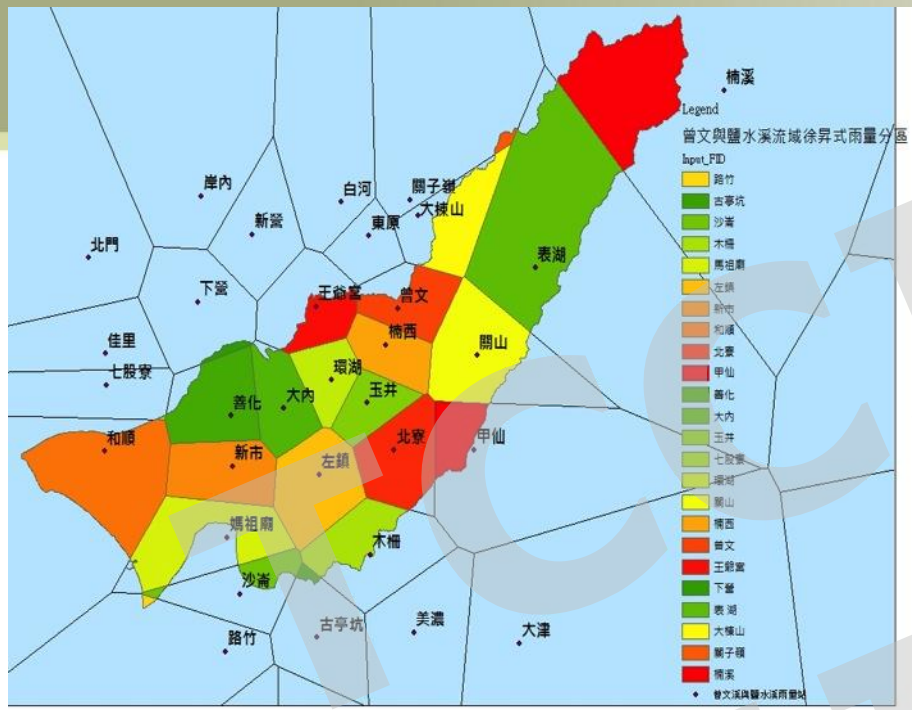
BASE

Input_FID	Shape_Leng	Shape_Area	depth
55804	0.004246	0.000001	3.4102
45358	0.004684	0.000002	3.7285
21561	0.004143	0.000001	-99999
11267	0.006821	0.000003	-99999
269	0.001771	0	-99999
3699	0.005347	0.000002	-99999
9649	0.003493	0.000001	-99999
14109	0.002498	0	-99999

1 (0 out of 74698 Selected)

BASE

Irregular grid-cell



Thiessen polygons method

Average rainfall