Flood Impact Assessment of Climate Change on Zhengwen River basin

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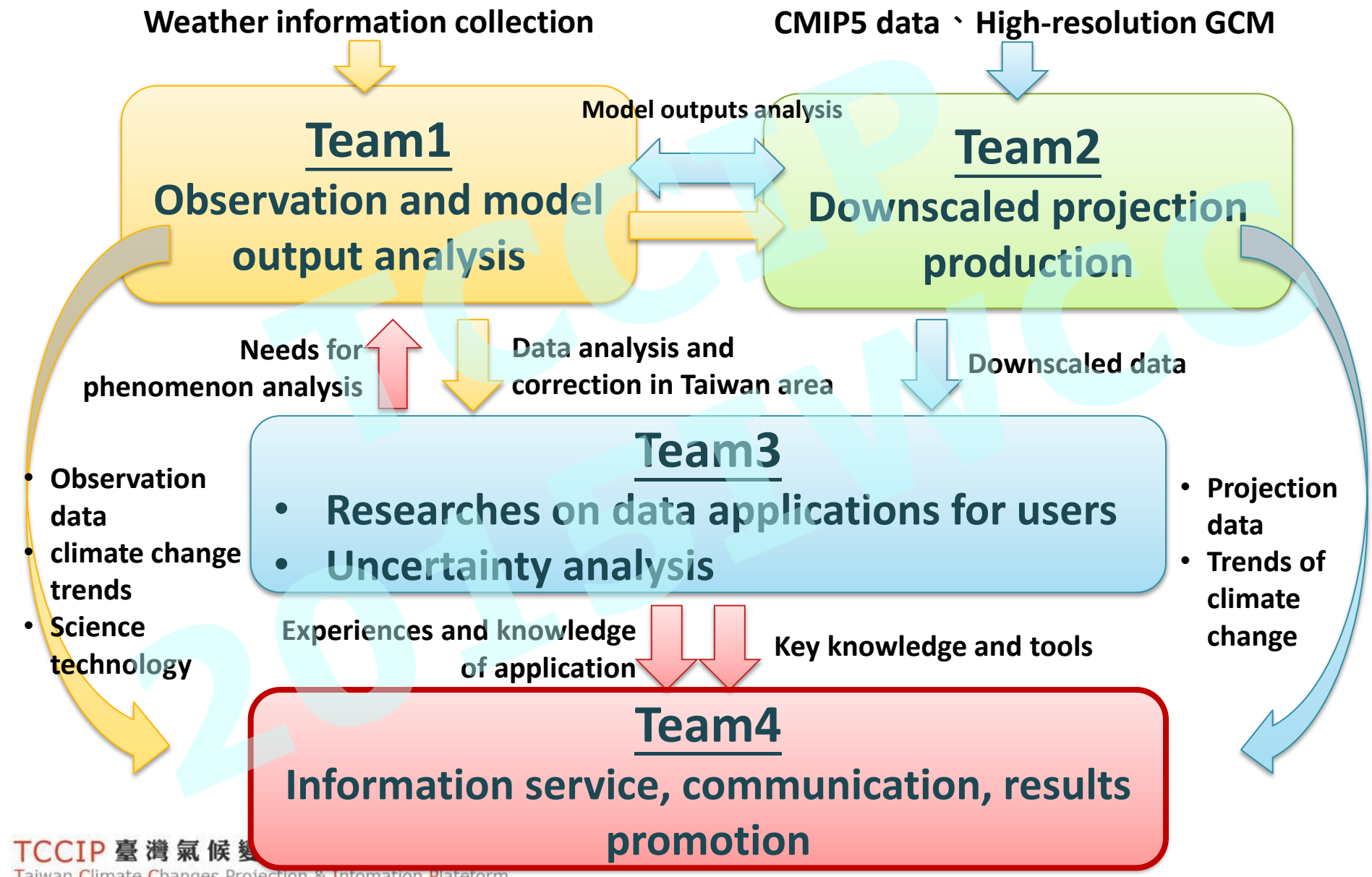
TCCIP Project Structure



About Taiwan

- Area: 36,193 km^2
- Population: 23 million
- Density: 644/km^2(17th)
- GDP: 2,2000 US (39th)
- HDI: 0.89 (23rd)
- Developed country

(**Wikipedia**)

Complex terrain

- **Larger part of mountain area (70%)**
- **Short river, swift current, steep slopeland, alluvial plain**

(**East rift valley :** Photo by Tourism Bureau, Taiwan)

Long coastline

- **Taiwan has a coastline of 1,566.3 km**
- **Coastal inundation, storm surge, erosion**

(**Kenting :** Photo by Tourism Bureau, Taiwan)

Highly urbanization

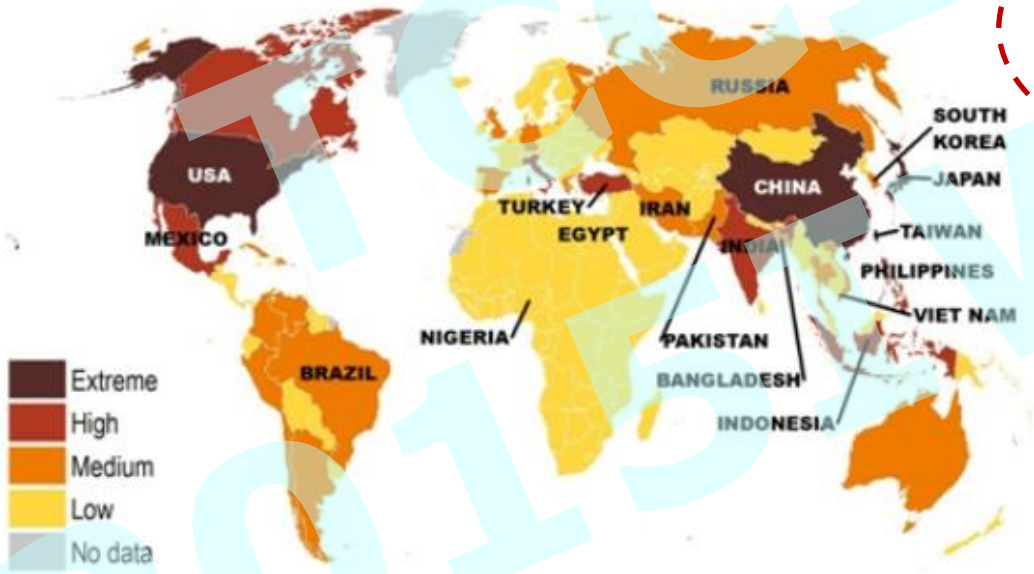
- **Populations of 5 major cities are over 2 millions in Taiwan.**

(**Taipei 101:** Photo by Tourism Bureau, Taiwan)

Highly economic loss risk for natural disasters

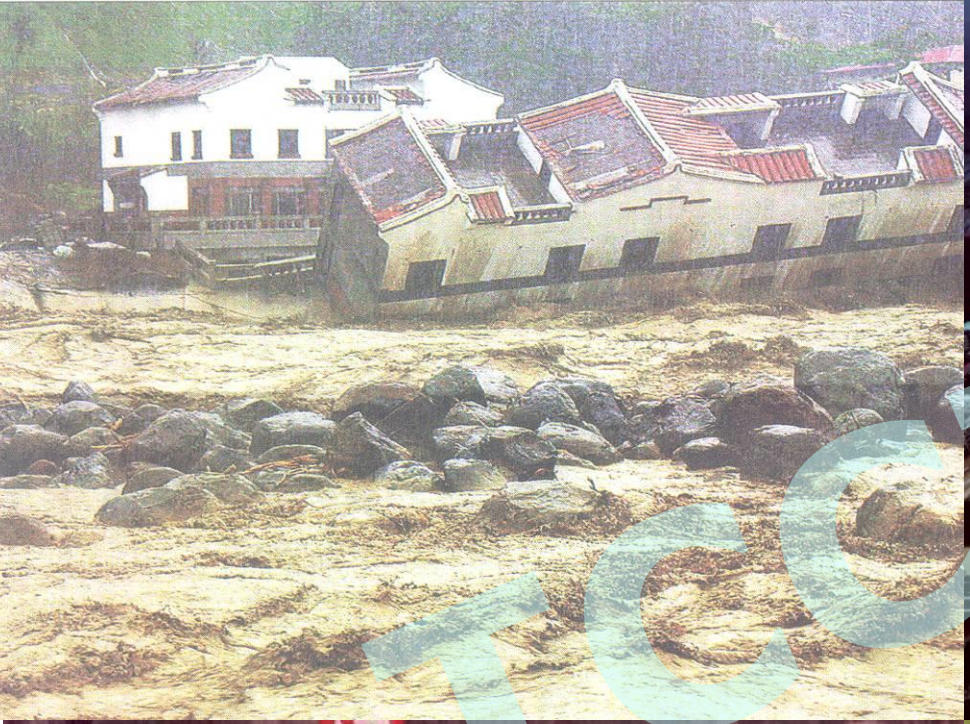
Absolute Economic Exposure Index 2011

maplecroft



- **USA**, **Japan**, **China** and **Taiwan** have the greatest economic output exposed to natural hazards
- However, the emerging economies of **Mexico**, **India**, **Philippines**, **Turkey** and **Indonesia** also have significant economic output exposed to major natural hazards

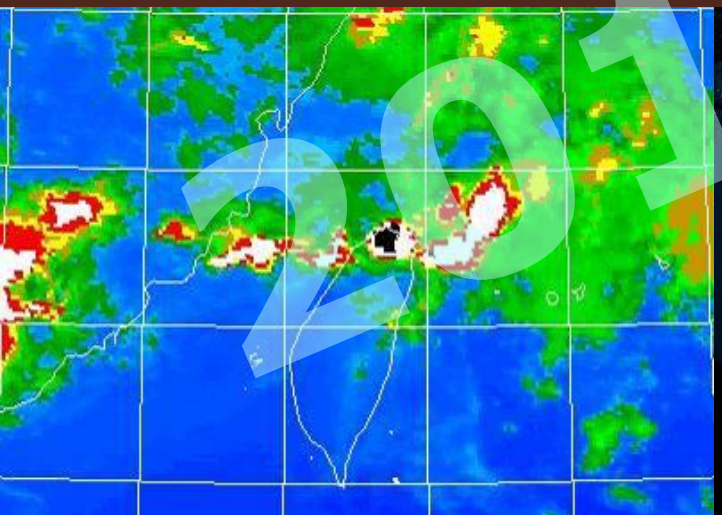
Despite significant economic growth, many of the emerging economies have yet to develop a resilience to the natural hazard risk they face



3 Major Climate/Weather Hazards in Taiwan

Typhoon

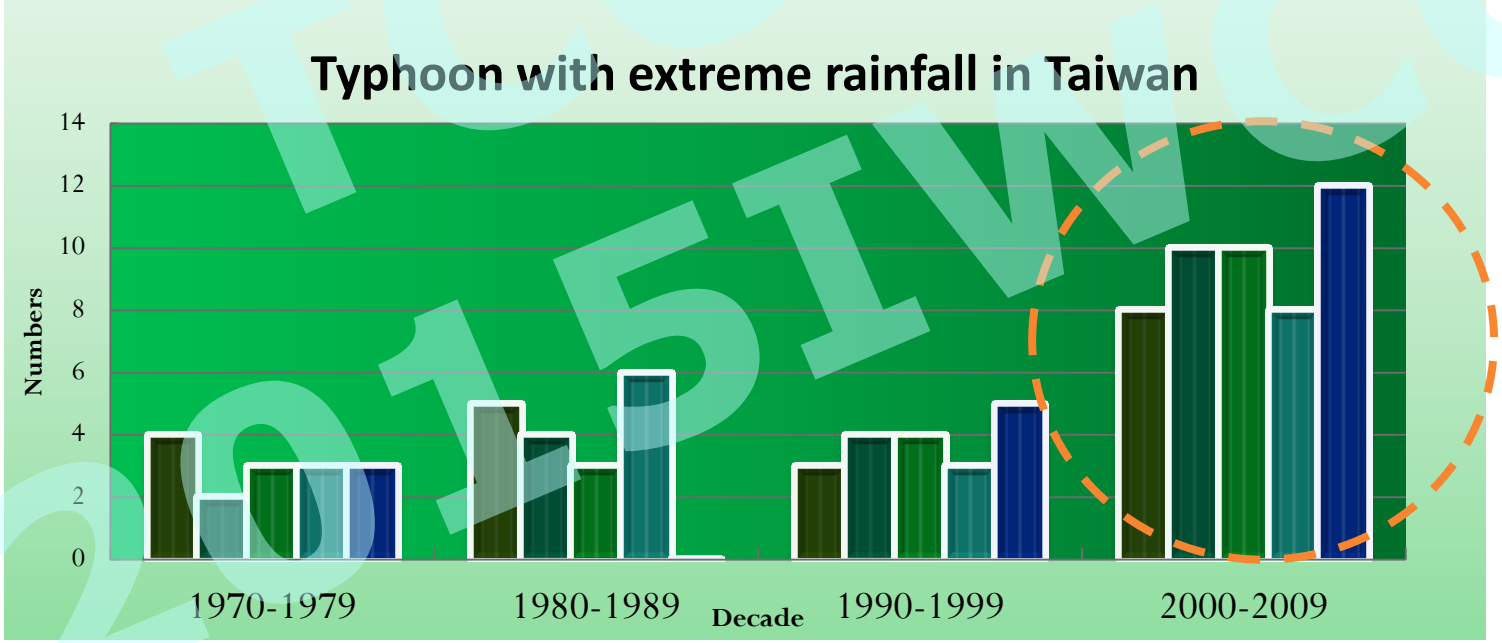
Mei-Yu



Seasonal monsoon

Typhoon with extreme rainfall

- **The increase of extreme events is evident in recent 10 years.**

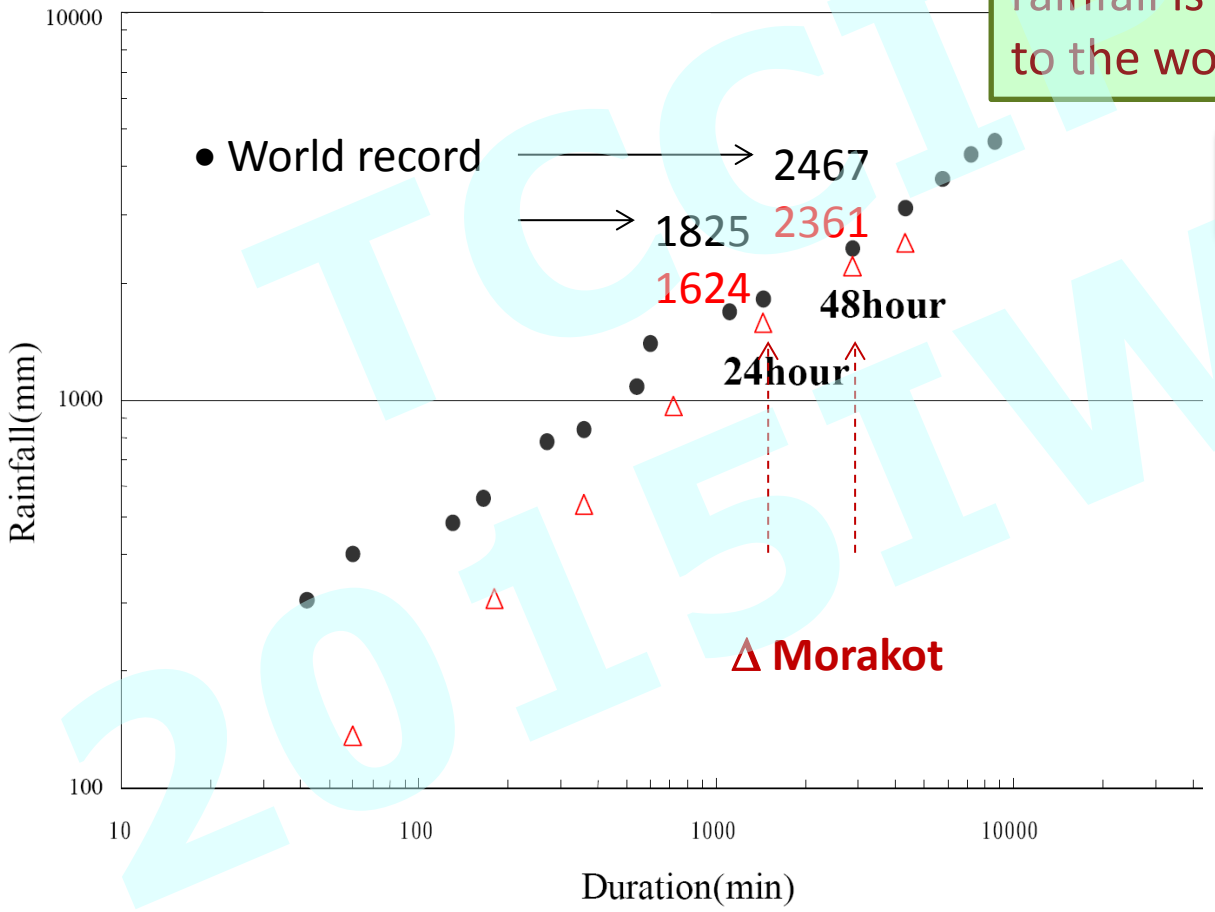


Top 20 events(195 total) was chosen by 5 extreme rainfall indices

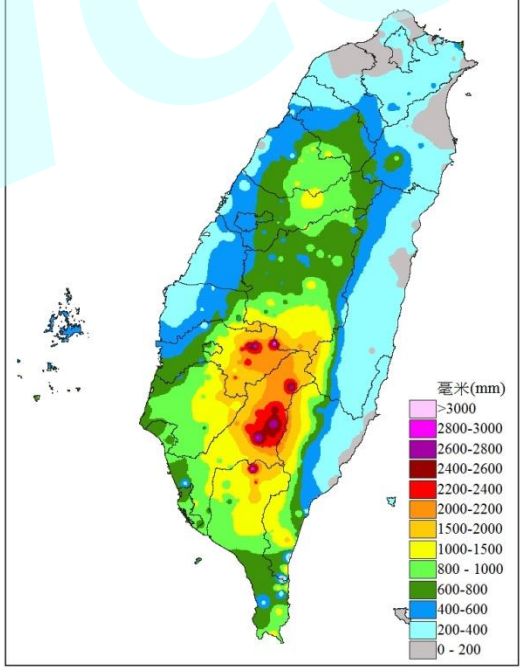
More and More Extreme Events in Taiwan?

- **Typhoon Morakot (2009)**

24 to 48 hours accumulated rainfall is high enough to close to the world record

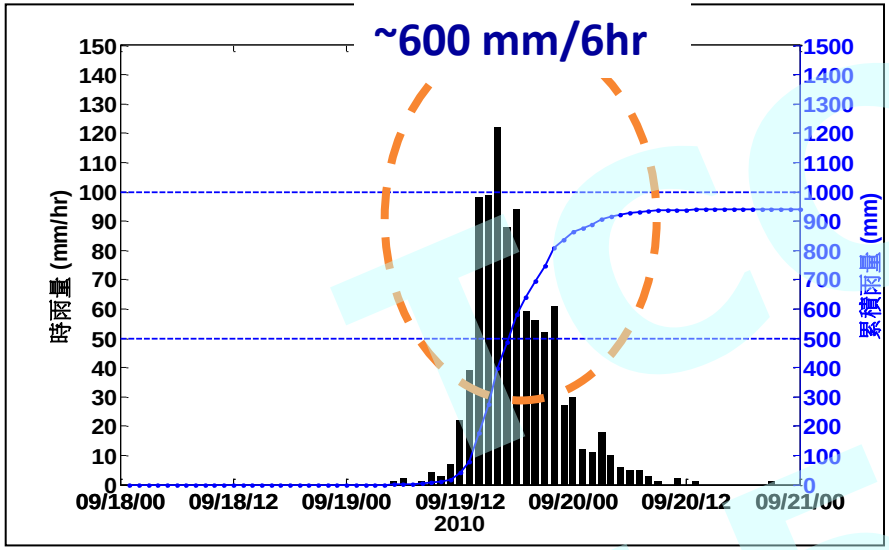


0805-0810 accumulated rainfall

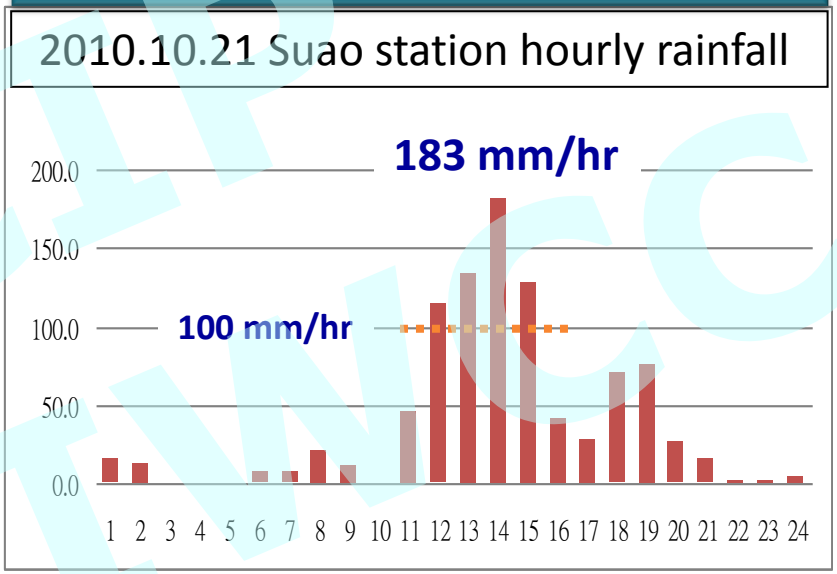


More and More Extreme Events in Taiwan ?

Typhoon Fanapi (2010)



Typhoon Megi (2010)



More and More Extreme Events in Taiwan ?

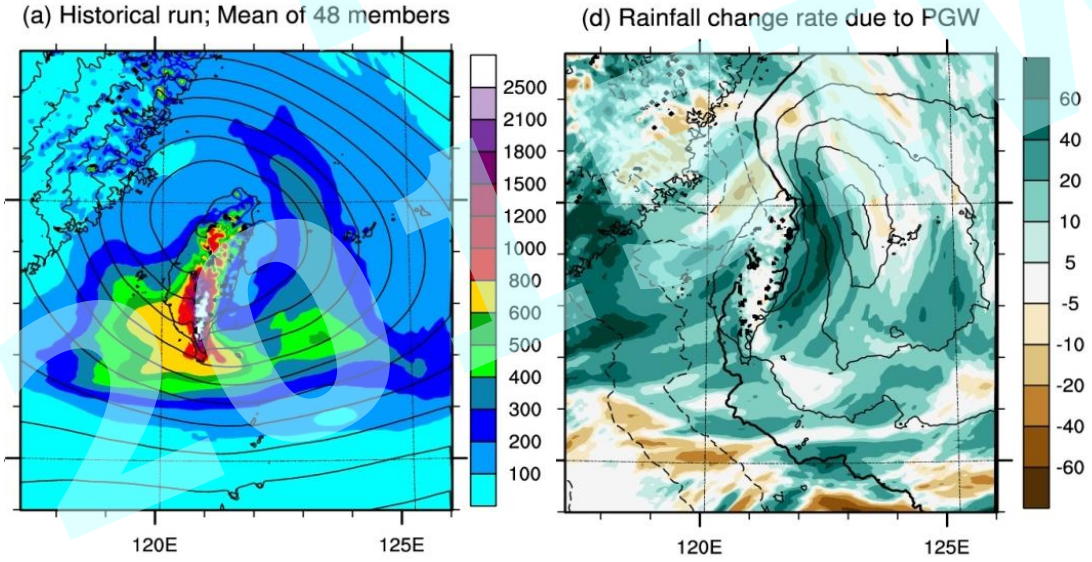
- There are some possible linkages between extreme rainfall and climate change, and we need more concrete study to identify the causing factors and ways for reduce future impact.

- In order to realize the possible trend and future scenario of climate change, Ministry of Science and Technology (MOST) launched "Taiwan Climate Change and Information Platform Project" (TCCIP) at 2010 to provide scientific support to decision makers.

Pseudo Global Warming Experiment for Historical Typhoons

Pseudo Global Warming Experiment for Historical Typhoons

- In case typhoon relocation still miss the worst case, a perfect storm from past is moved to global-warming environment to simulate as a substitute.
- Superposition circulations of future change and historical events
  - $C_{PGW} = C_{history} + (\overline{C}_{future} - \overline{C}_{present})$; $\overline{C}$: T、RH、U、V、Φ、SST
- Consider circulation change of MRI-AGCM3.2S in 2075-2099 A1B
- 2009 typhoon Morakot (top rainfall record ~3000 mm)

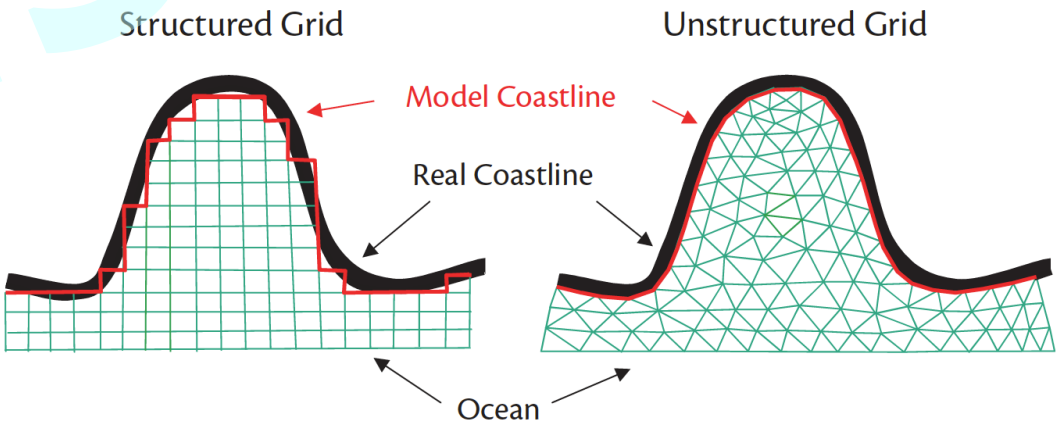


Precipitation change rate over Taiwan island can reach 40%.

Global warming may increase the impact by %?

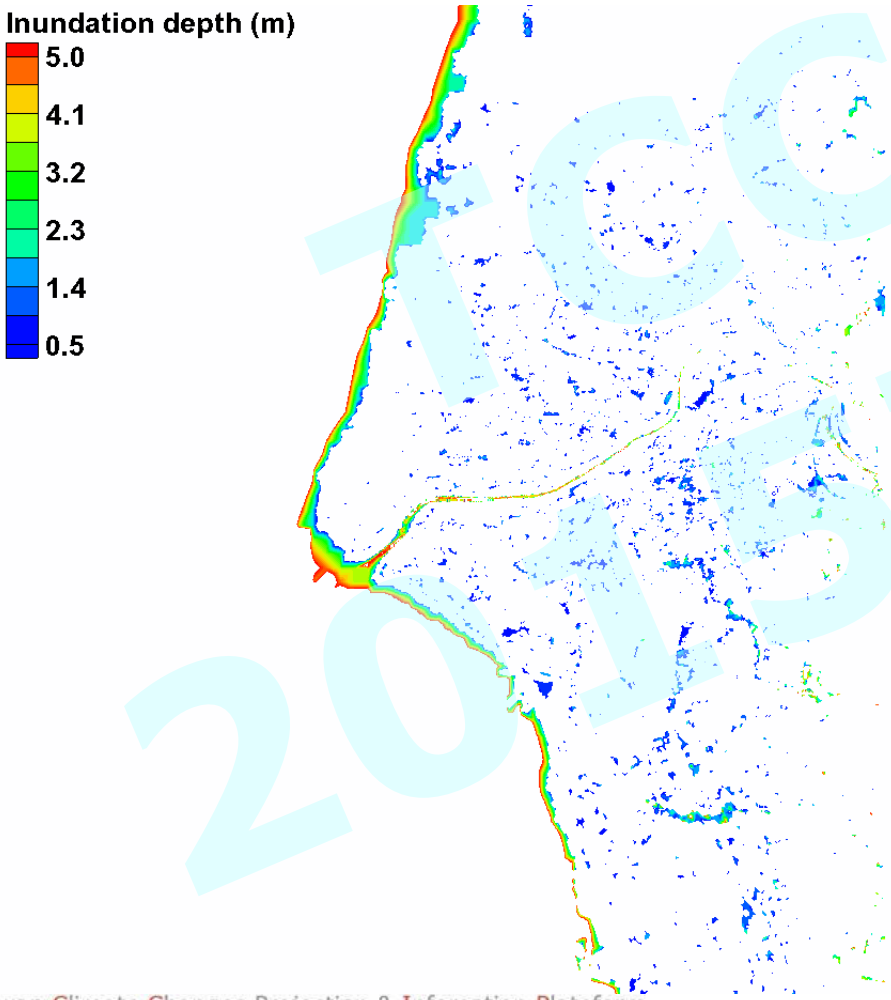
Inundation Model-FVCOM

- Solve the Primitive Equations : Provide high-accuracy Simulation for Fluid.
- Parallel Computing: Provide high-efficiency performance.
- Unstructured Grids: Provide the accurate fitting of the irregular coastal geometry.



Time-Series Distribution of Inundation Extent and Precipitation

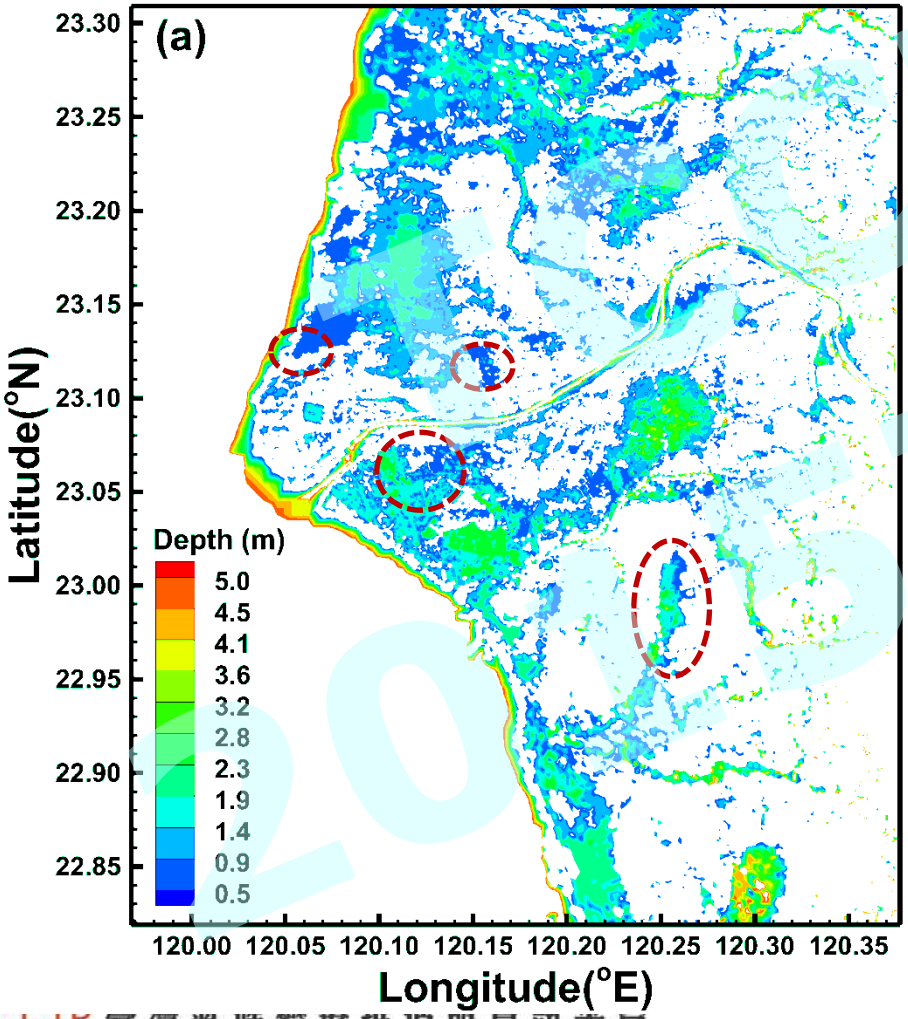
Inundation Extent of 2009 Morakot



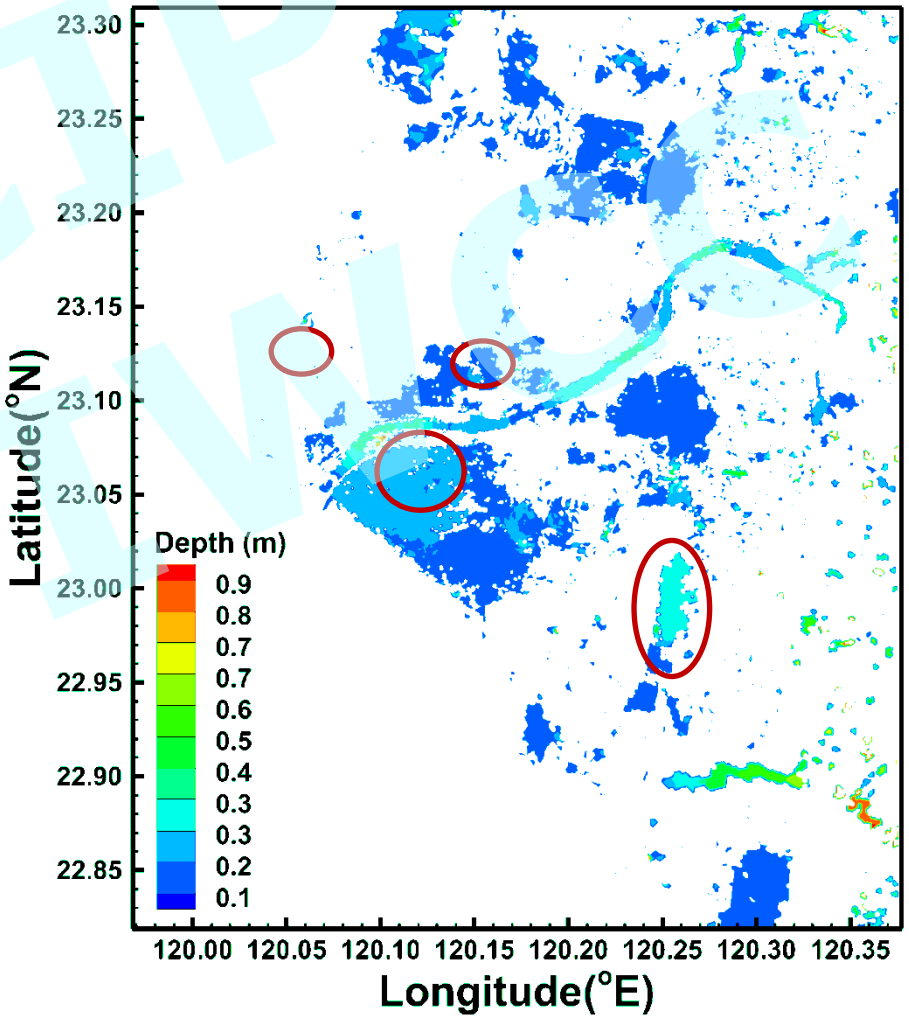
Precipitation of 2009 Morakot

Maxi. Inundation of 2009 Morakot

Historical event

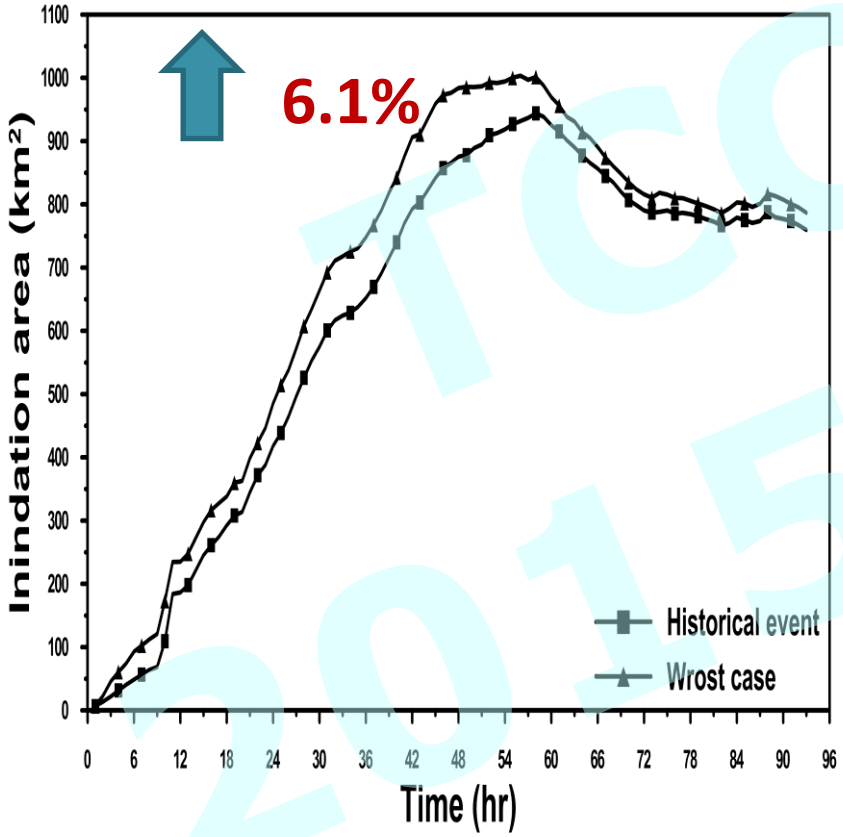


In A1B PGW situation

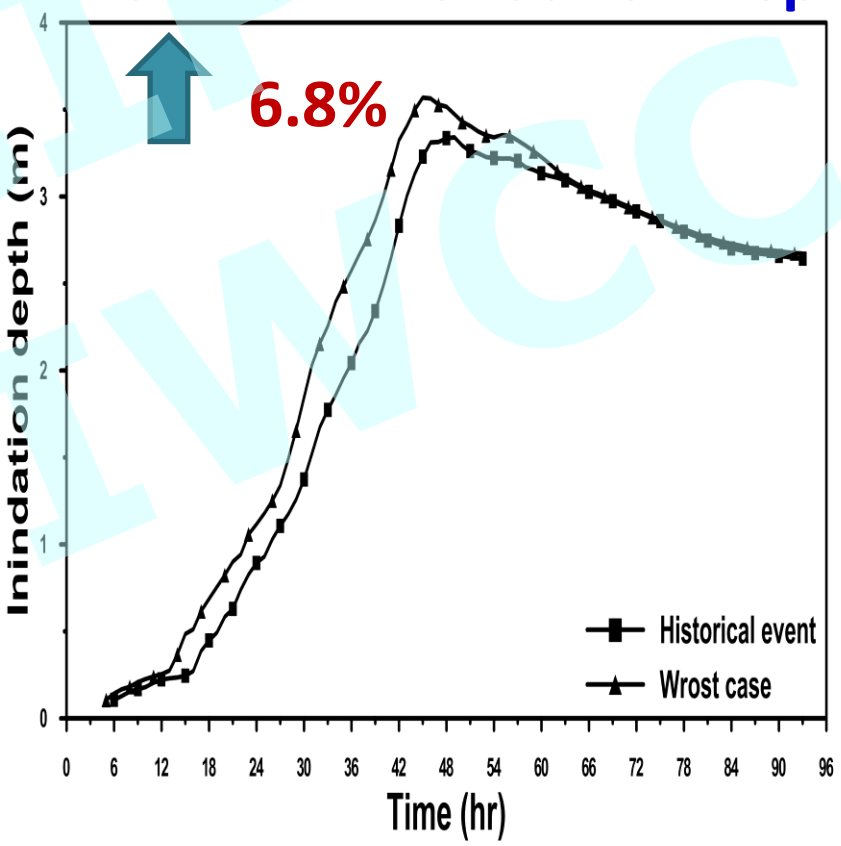


Time series of maxi. inundation area/depth

Maximum Inundation Area



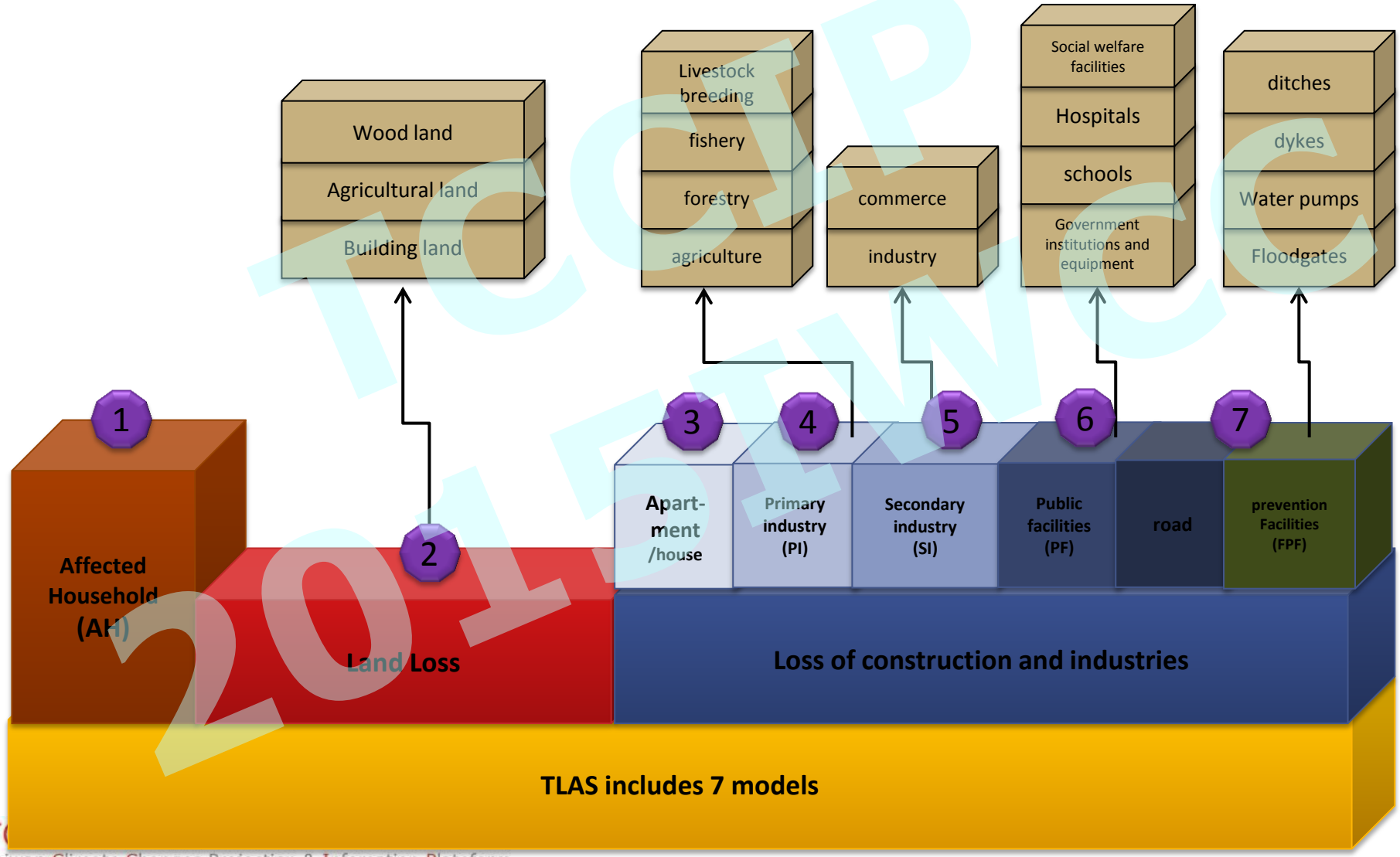
Maximum Inundation Depth



Loss Assessment

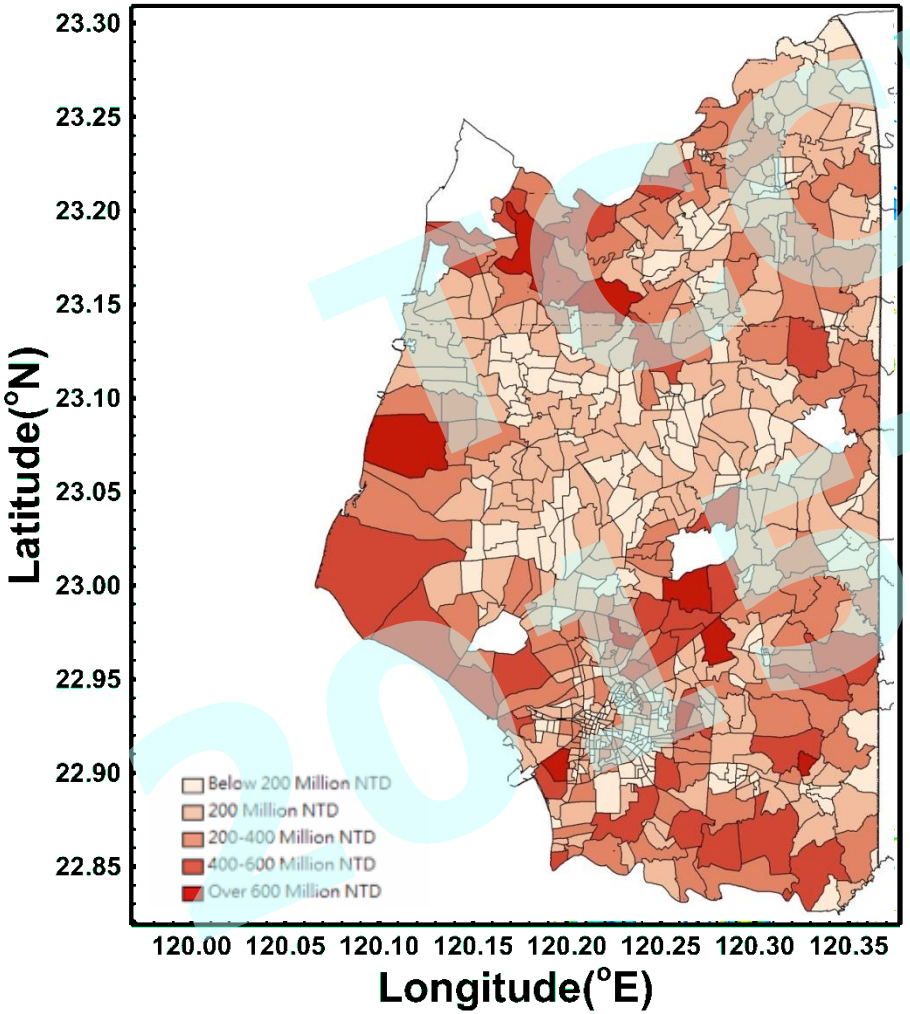
Taiwan Typhoon Loss Assessment System

TLAS Taiwan Framework

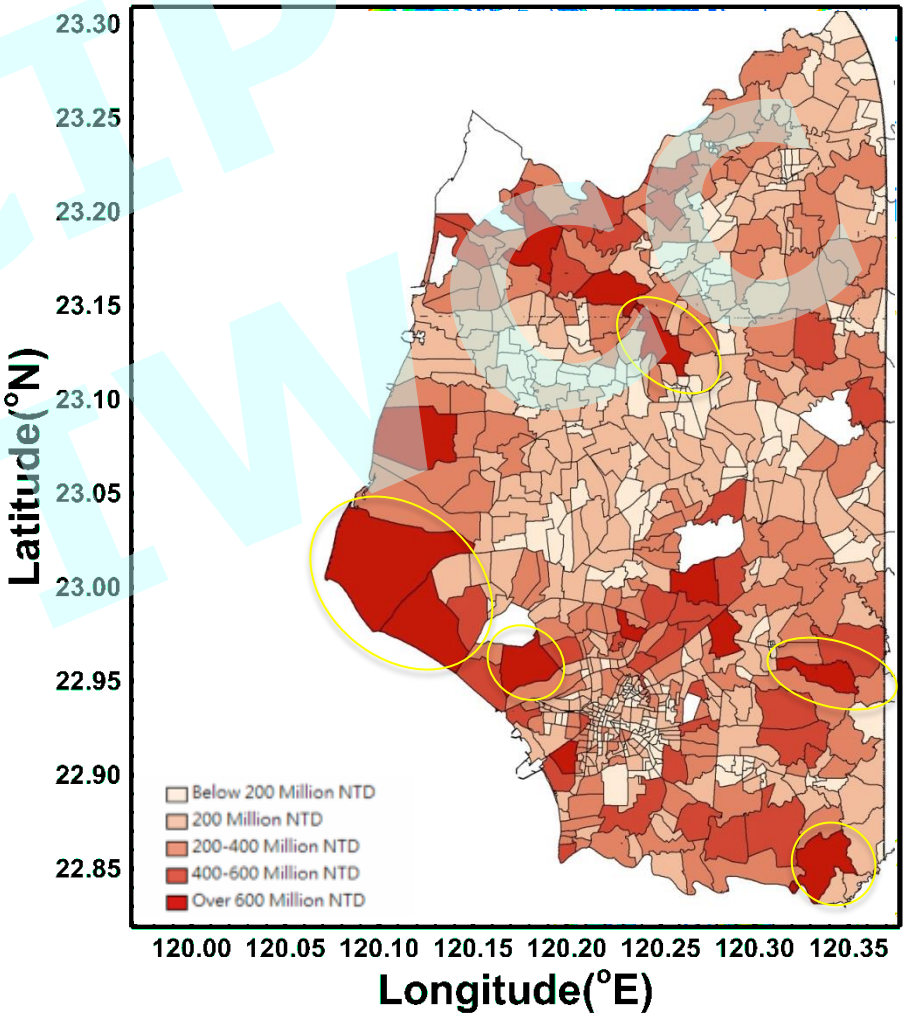


Flood Loss Assessment

Historical event



In A1B PGW situation

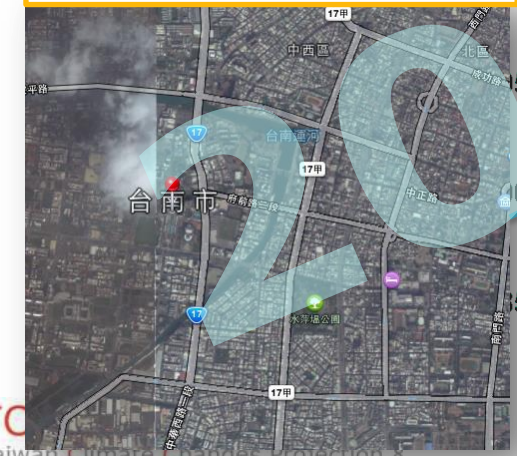


Flood Loss Difference

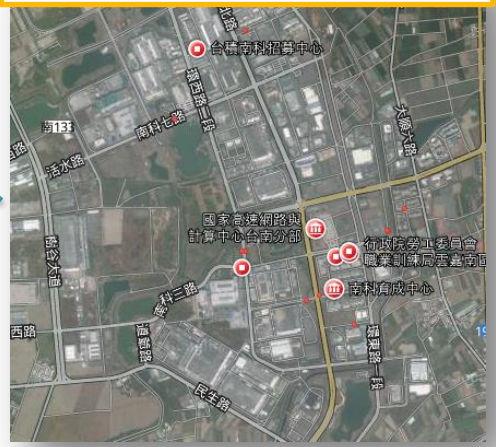
Agriculture and Aquaculture Industry Area

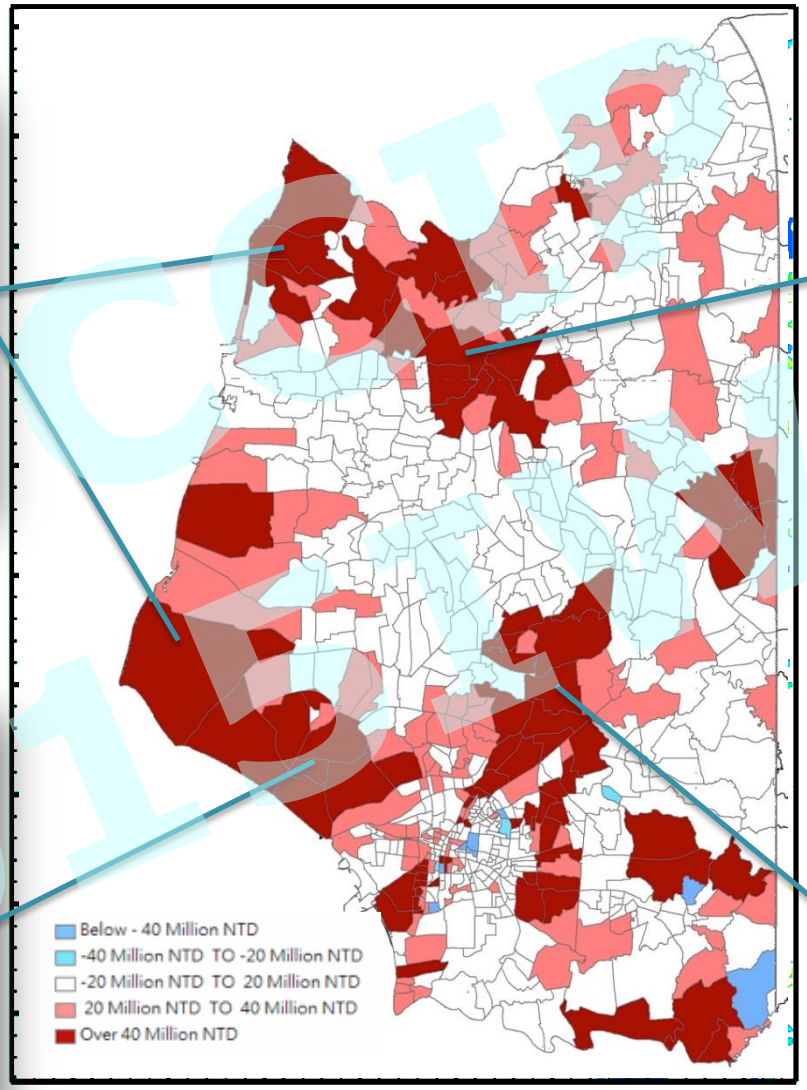
Xue-Jia Suburb Housing Area

Tai-Nan City Downtown

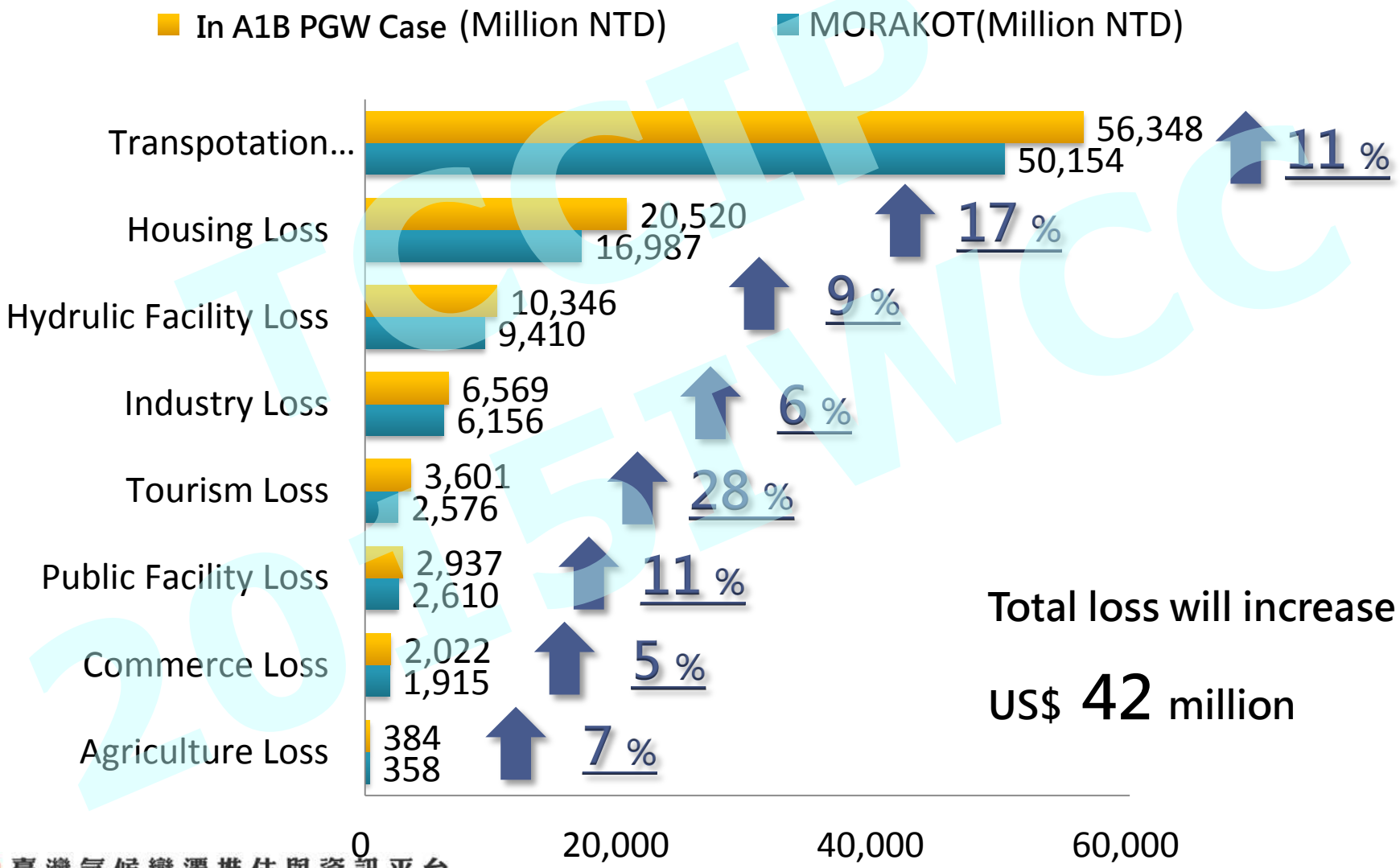


Tan-Nan Science Park

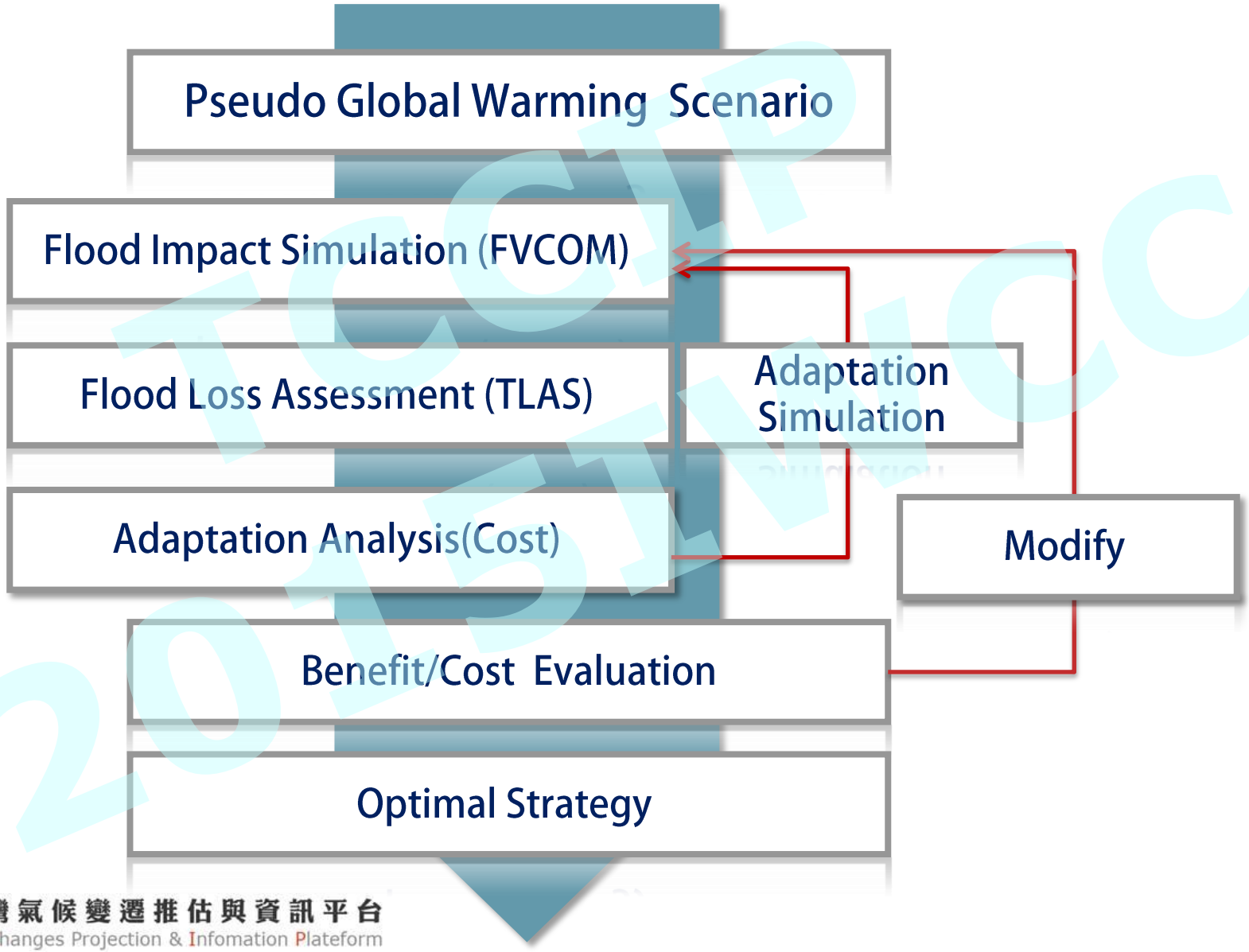




Loss Difference Under Different Land Use



Optimal Adaptation Method

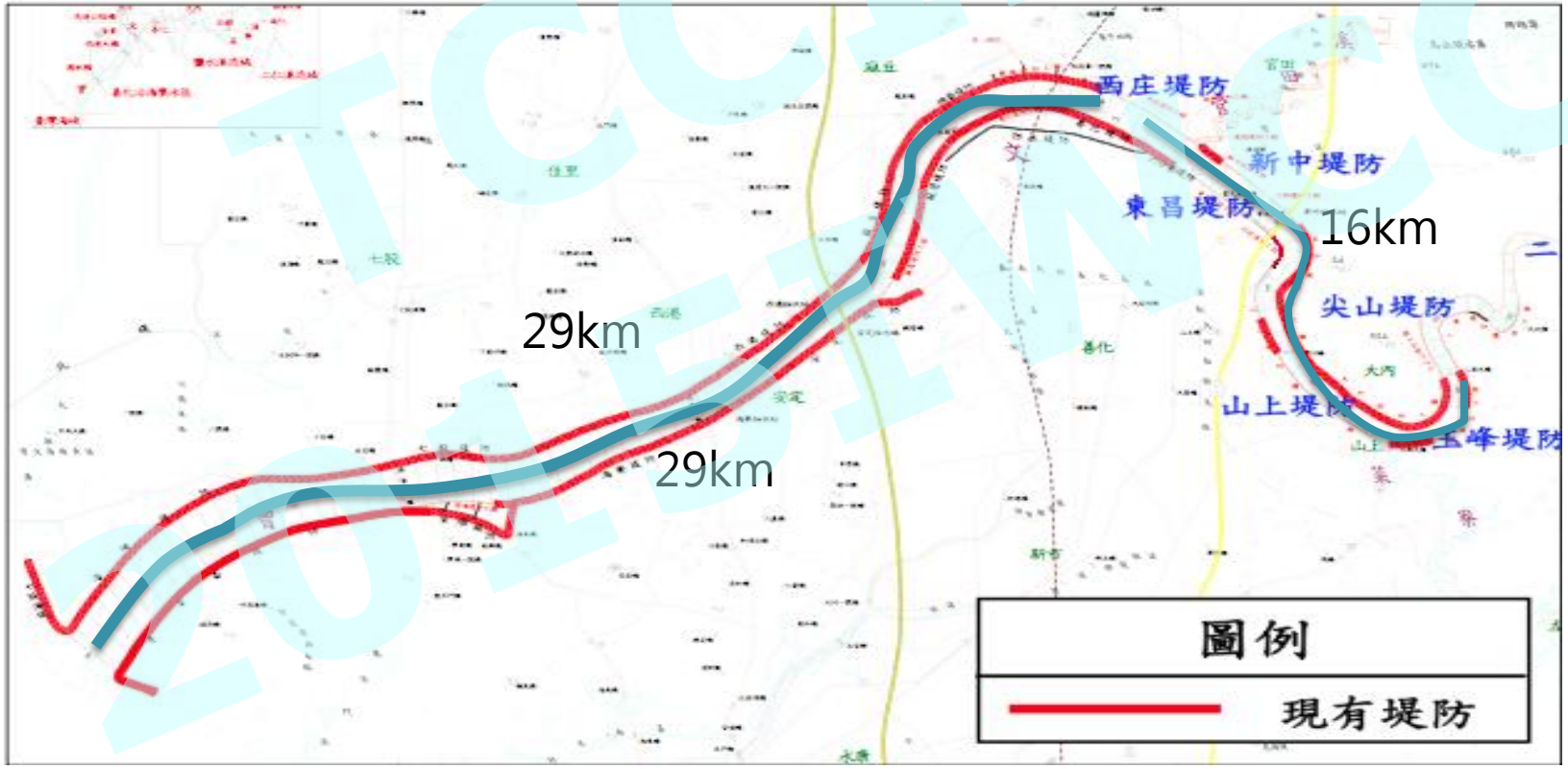


Flood Engineering Adaption Options

Project	Method	Content
Project 1	Strengthen flood prevention facilities	Raise up embankments
Project 2	Increase detention space at the midstream	Build detention pools
Project 3	Improve downstream rainwater catchment	Infiltration facility of schools
Project 4	Improve downstream rainwater catchment	Infiltration facility of public parks
Project 5	Increase the river basin′ s capacity	Flood diversion, sediment dredging
Project 6	Improve downstream run-off management	Pump stations

Project 1

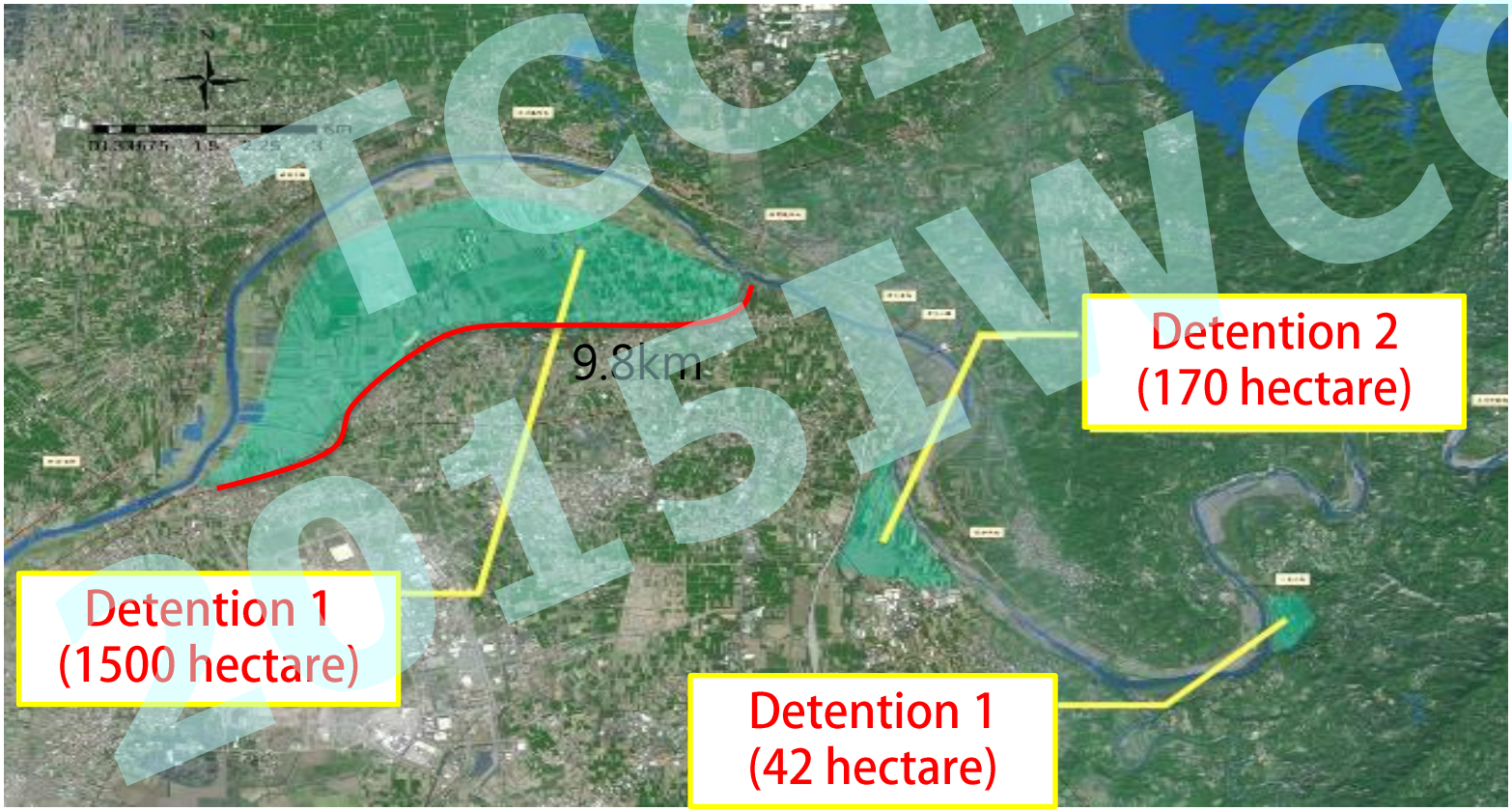
PROJECT	Method	Content
Project 1	Strengthen flood prevention facilities	Raise up embankments 0.5m



Source : Water Resource Agency

Project 2

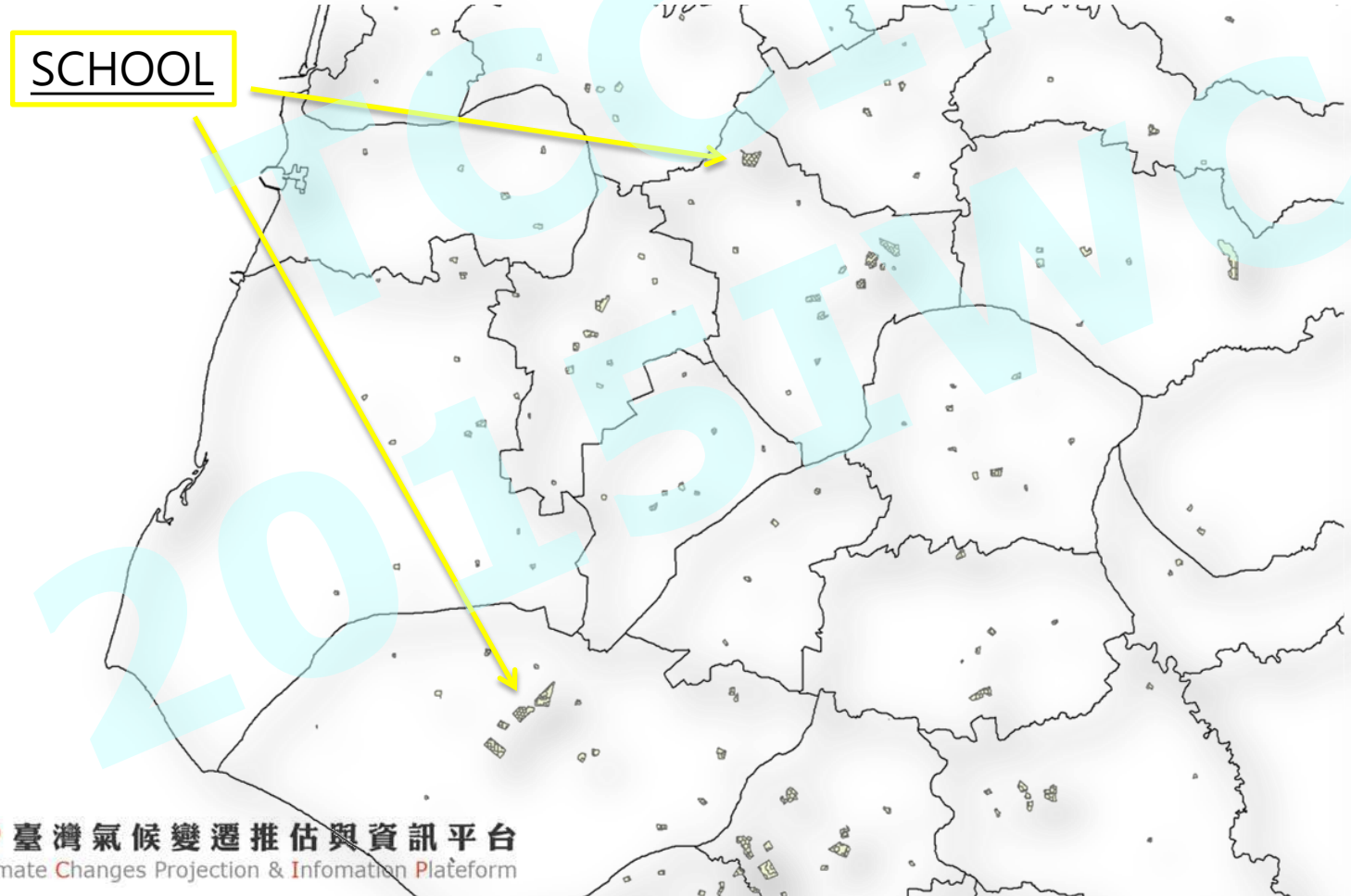
PROJECT	Method	Content
Project 2	Increase detention space at the midstream	Build detention pools



Source : Water Resource Agency

Project 3

PROJECT	Method	Content
Project 3	Improve downstream rainwater catchment	Infiltration facility of schools (1200 hectare)



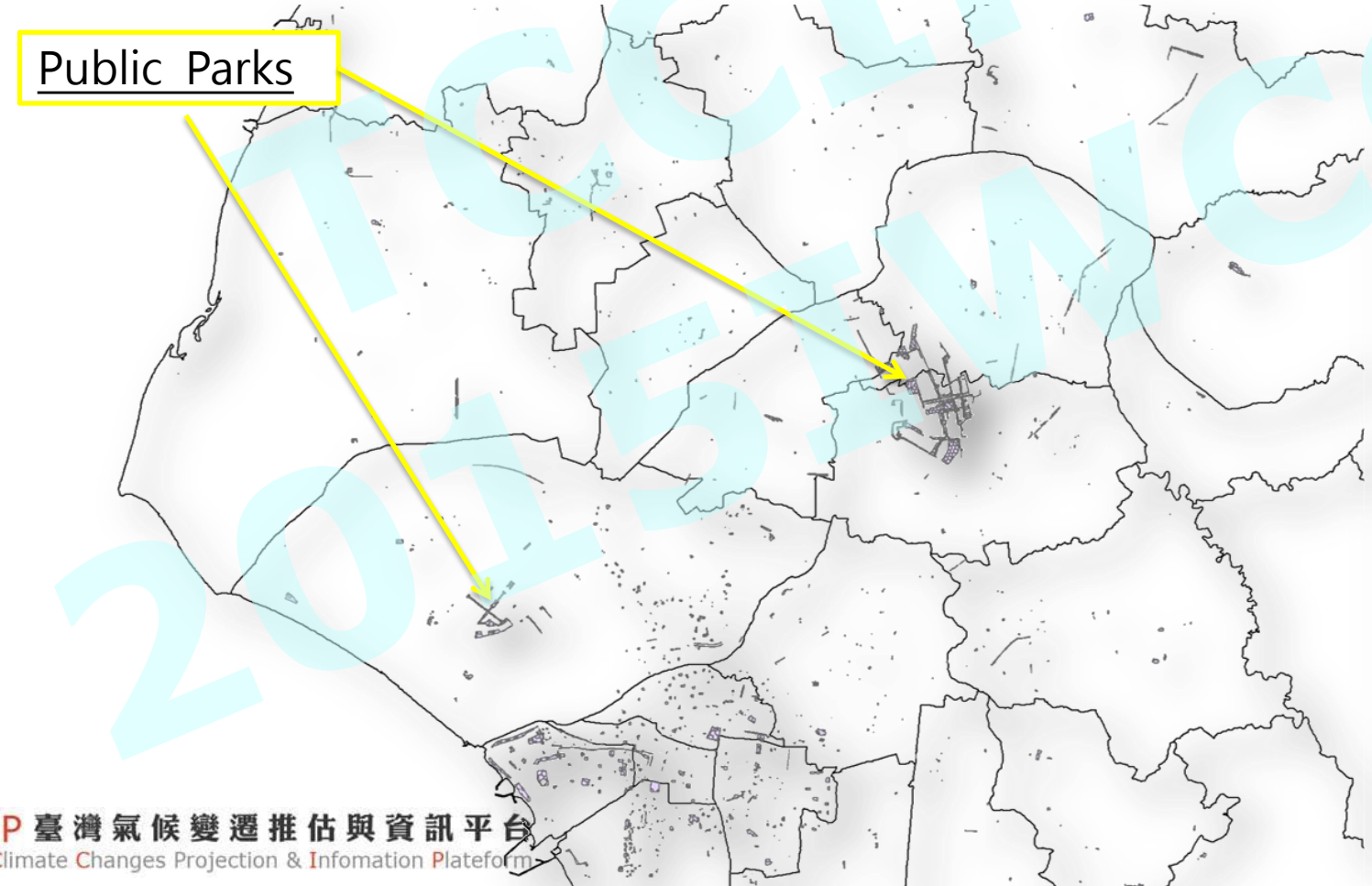
Taiwan Case

Dig 50 cm depth

Park lot 18 cm depth

Project 4

PROJECT	Method	Content
Project 4	Improve downstream rainwater catchment	Infiltration facility of public parks (1200 hectare)



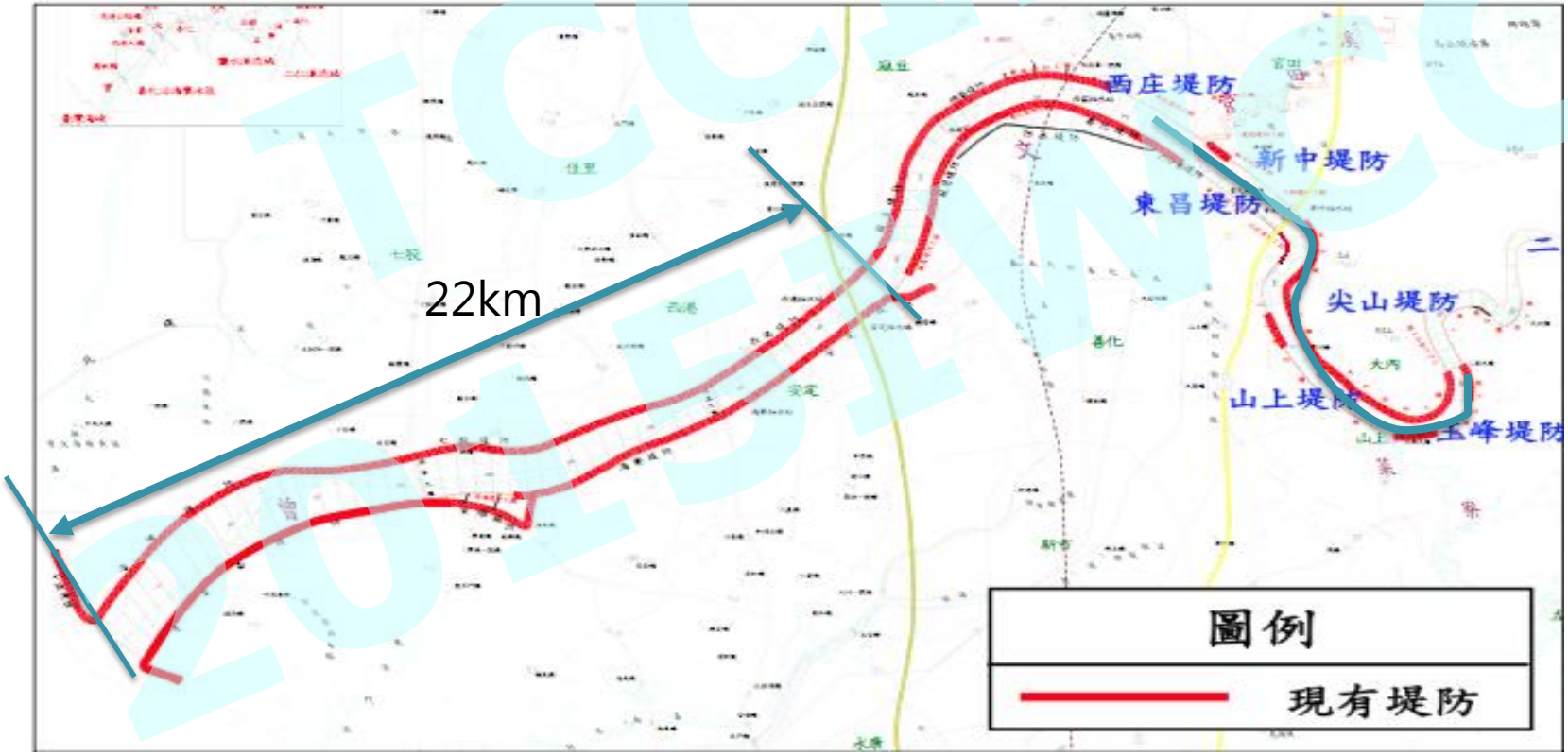
America Case

Surface runoff control

Source : Water Resource Agency

Project 5

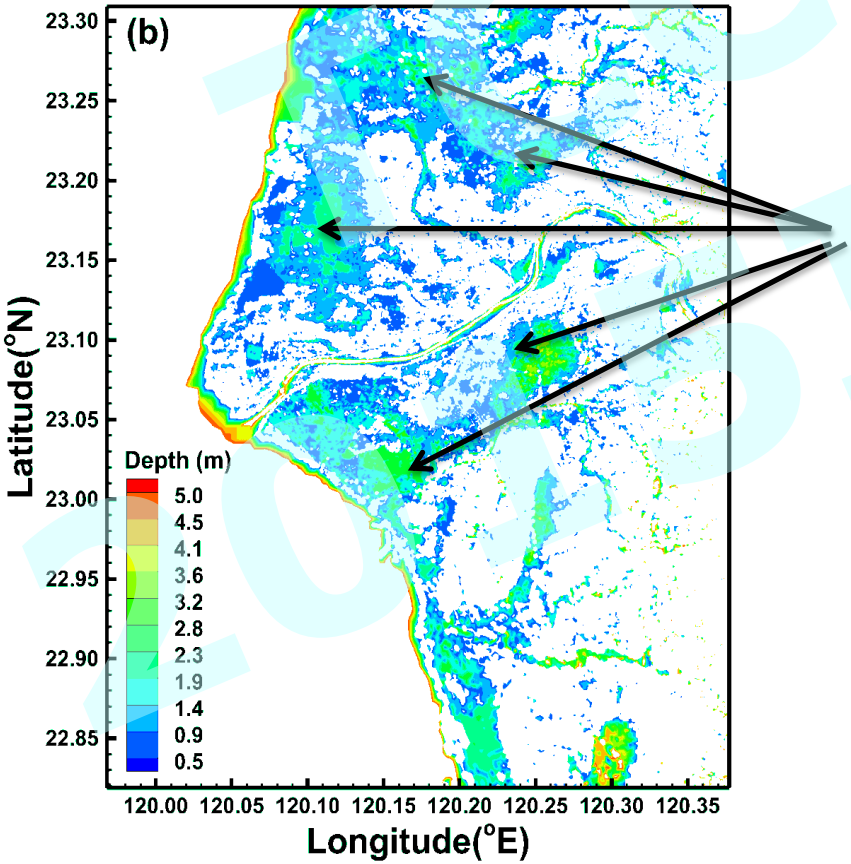
PROJECT	Method	Content
Project 5	Increase the river basin’s capacity	Sediment dredging 1m



Source : Water Resource Agency

Project 6

PROJECT	Method	Content
Project 6	Improve downstream run-off management	Build pump stations or set up pump machines



Regional drainage and sewer system (Pump stations or set up pump machines)

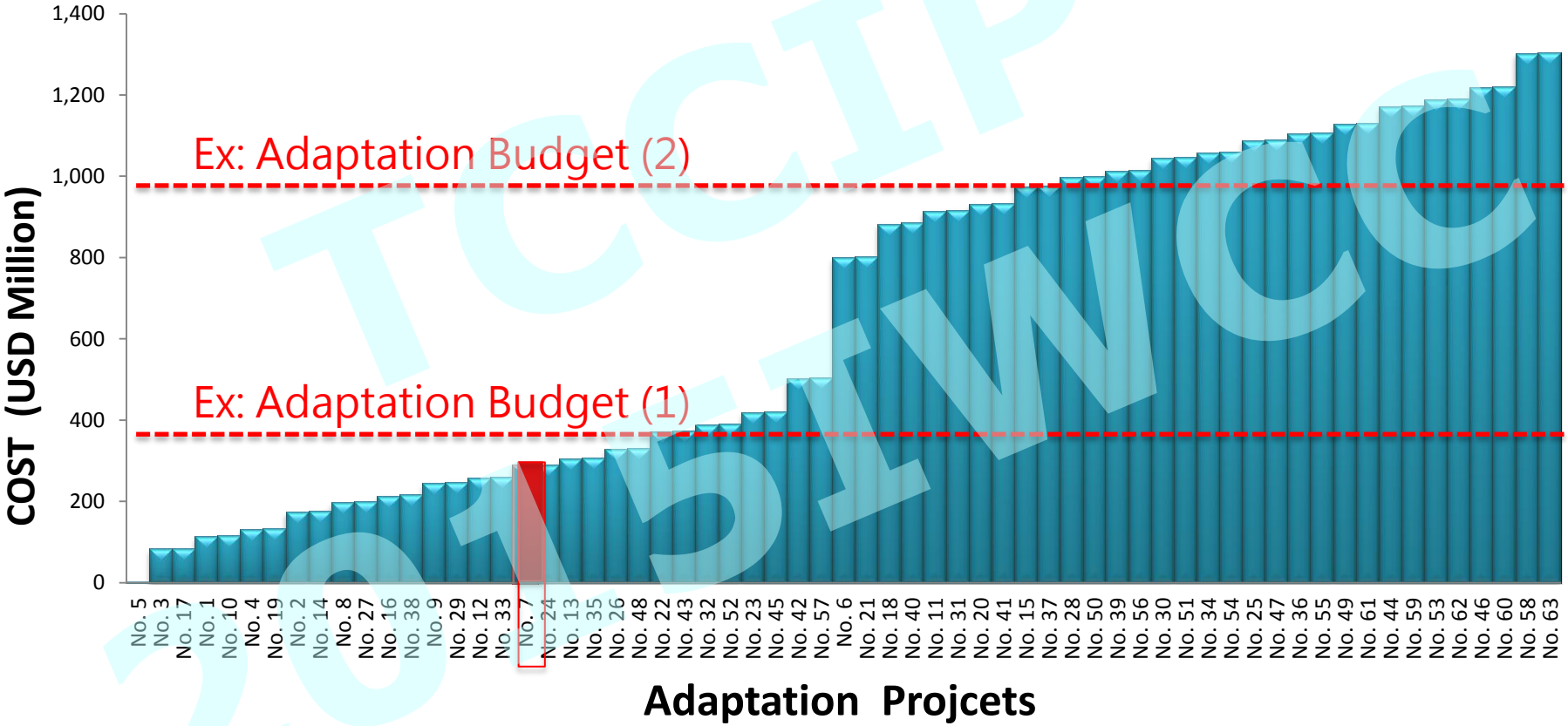
Cost Analysis of Adaptations (1/2)

Strategy	Combine project	Strategy	Combine project
1	p1	17	p3+p5
2	p2	18	p3+p6
3	p3	19	p4+p5
4	p4	20	p4+p6
5	p5	21	p5+p6
6	p6	22	p1+p2+p3
7	p1+p2	23	p1+p2+p4
8	p1+p3	24	p1+p2+p5
9	p1+p4	25	p1+p2+p6
10	p1+p5	26	p1+p3+p4
11	p1+p6	27	p1+p3+p5
12	p2+p3	28	p1+p3+p6
13	p2+p4	29	p1+p4+p5
14	p2+p5	30	p1+p4+p6
15	p2+p6	31	p1+p5+p6
16	p3+p4	32	p2+p3+p4

Cost Analysis of Adaptations (2/2)

Strategy	Combine project	Strategy	Combine project
33	p2+p3+p5	49	p1+p3+p4+p6
34	p2+p3+p6	50	p1+p3+p5+p6
35	p2+p4+p5	51	p1+p4+p5+p6
36	p2+p4+p6	52	p2+p3+p4+p5
37	p2+p5+p6	53	p2+p3+p4+p6
38	p3+p4+p5	54	p2+p3+p5+p6
39	p3+p4+p6	55	p2+p4+p5+p6
40	p3+p5+p6	56	p3+p4+p5+p6
41	p4+p5+p6	57	p1+p2+p3+p4+p5
42	p1+p2+p3+p4	58	p1+p2+p3+p4+p6
43	p1+p2+p3+p5	59	p1+p2+p3+p5+p6
44	p1+p2+p3+p6	60	p1+p2+p4+p5+p6
45	p1+p2+p4+p5	61	p1+p3+p4+p5+p6
46	p1+p2+p4+p6	62	p2+p3+p4+p5+p6
47	p1+p2+p5+p6	63	p1+p2+p3+p4+p5+p6
48	p1+p3+p4+p5		

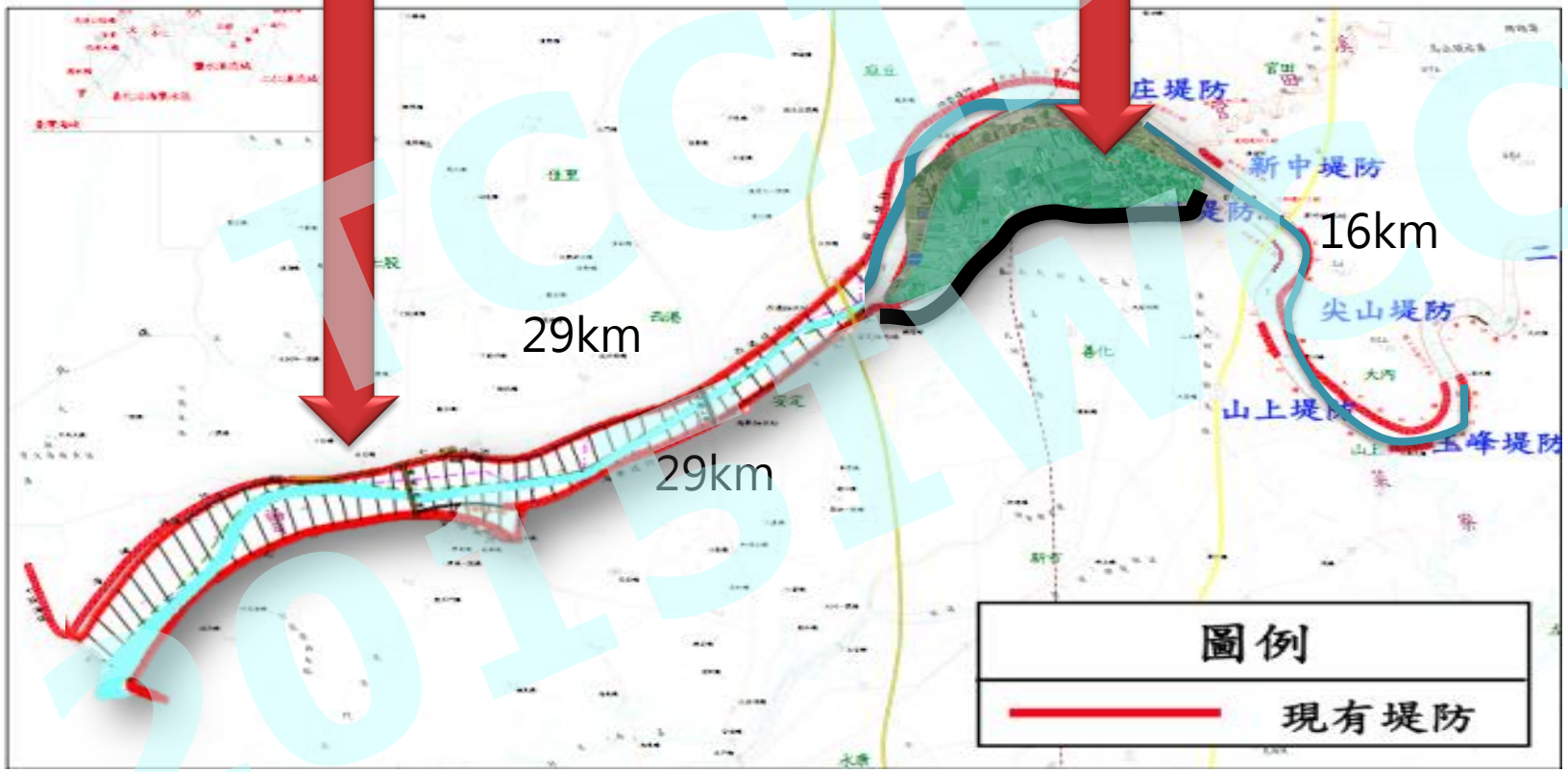
Adaptations Cost



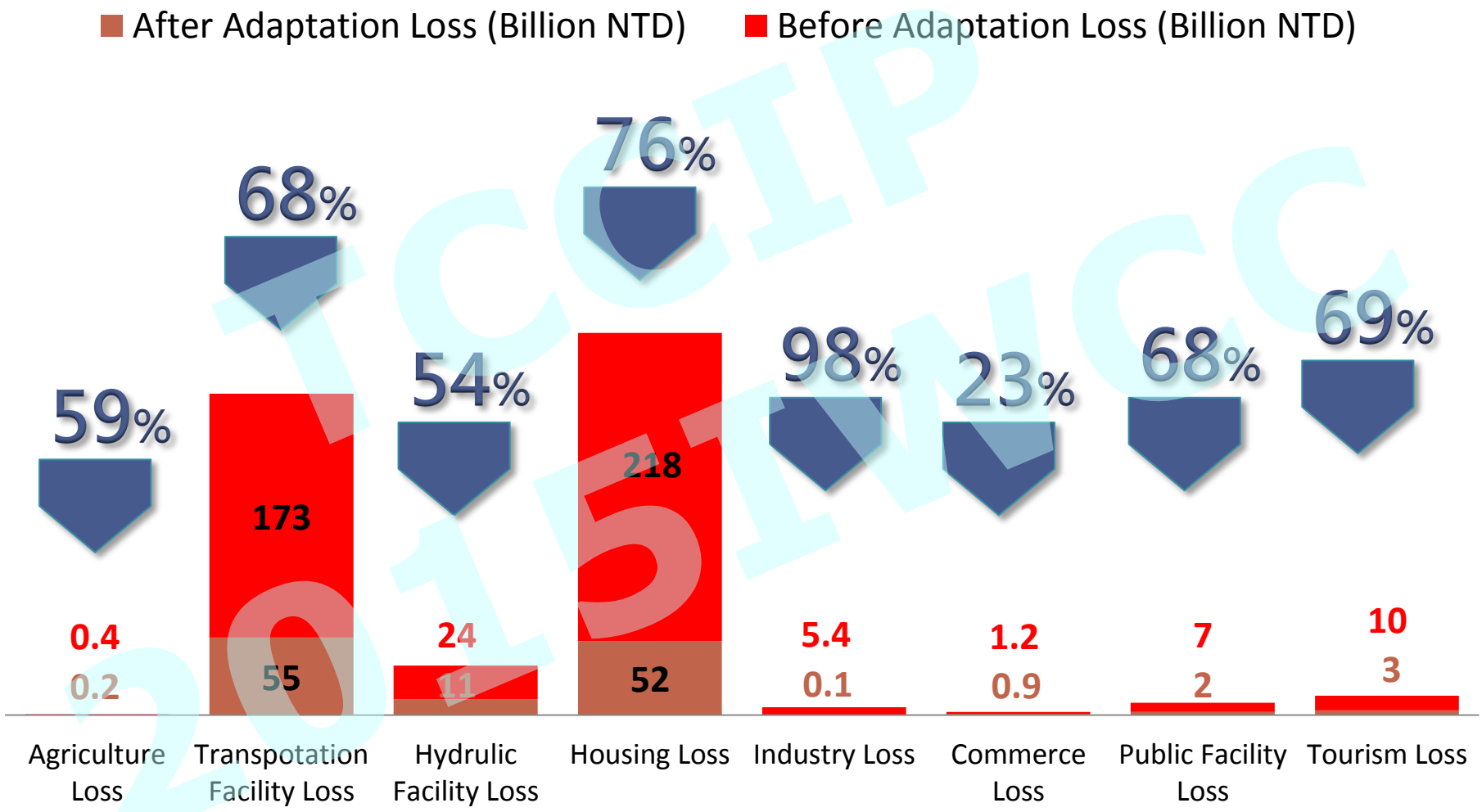
Strategy 7 _case study

Project 1
Raise up embankments 0.5m

Project 2
Build detention pool



Strategy 7 _ benefit analysis



Thanks for your attention