Preventing bridge-collapse disaster by real-time scour observation and reducing urbanization by LID

Presenter

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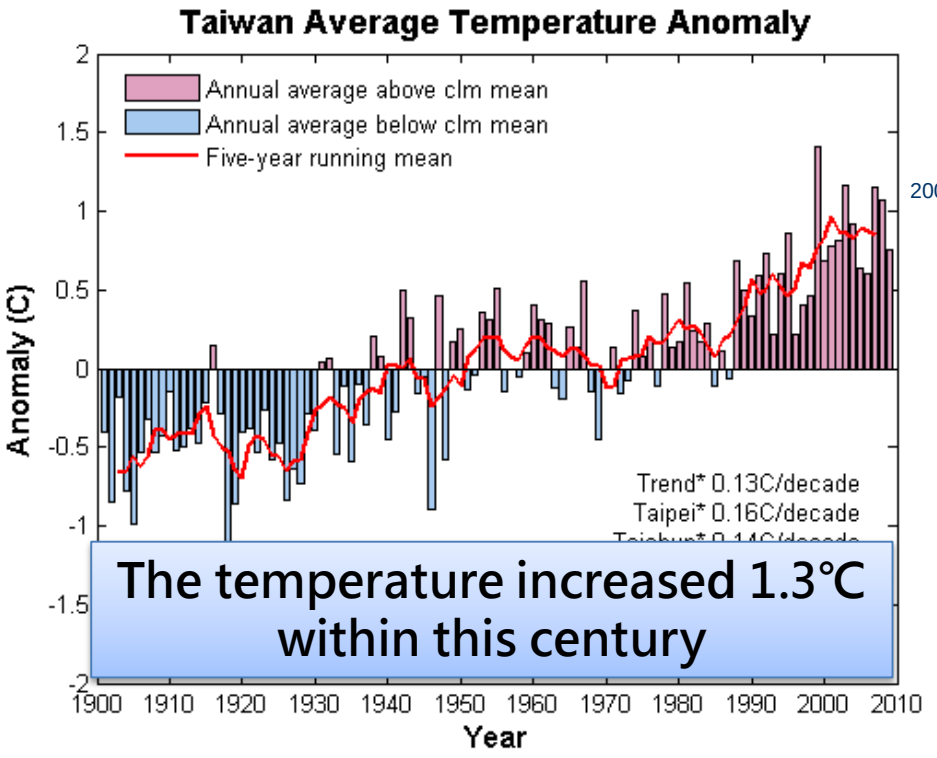
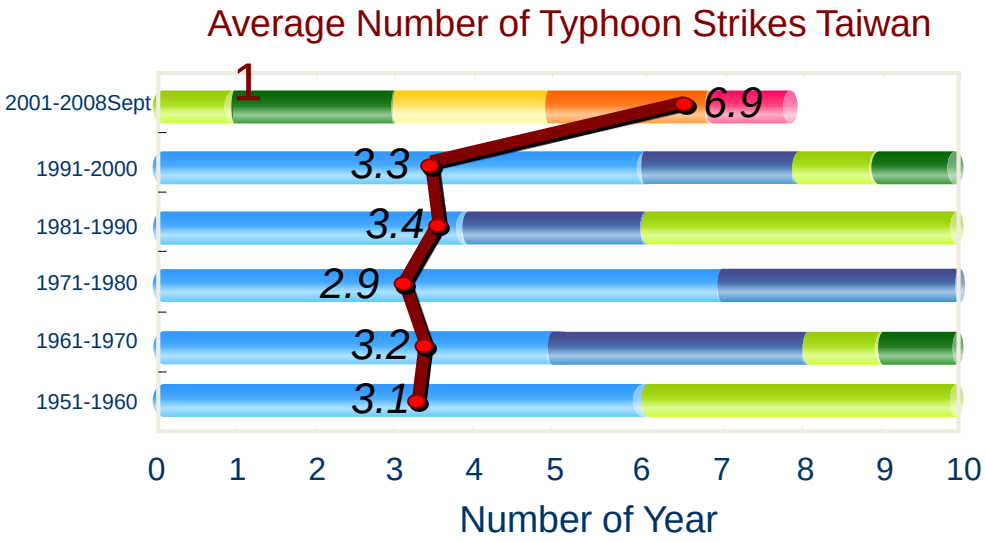
The truth that we must face

Climate change



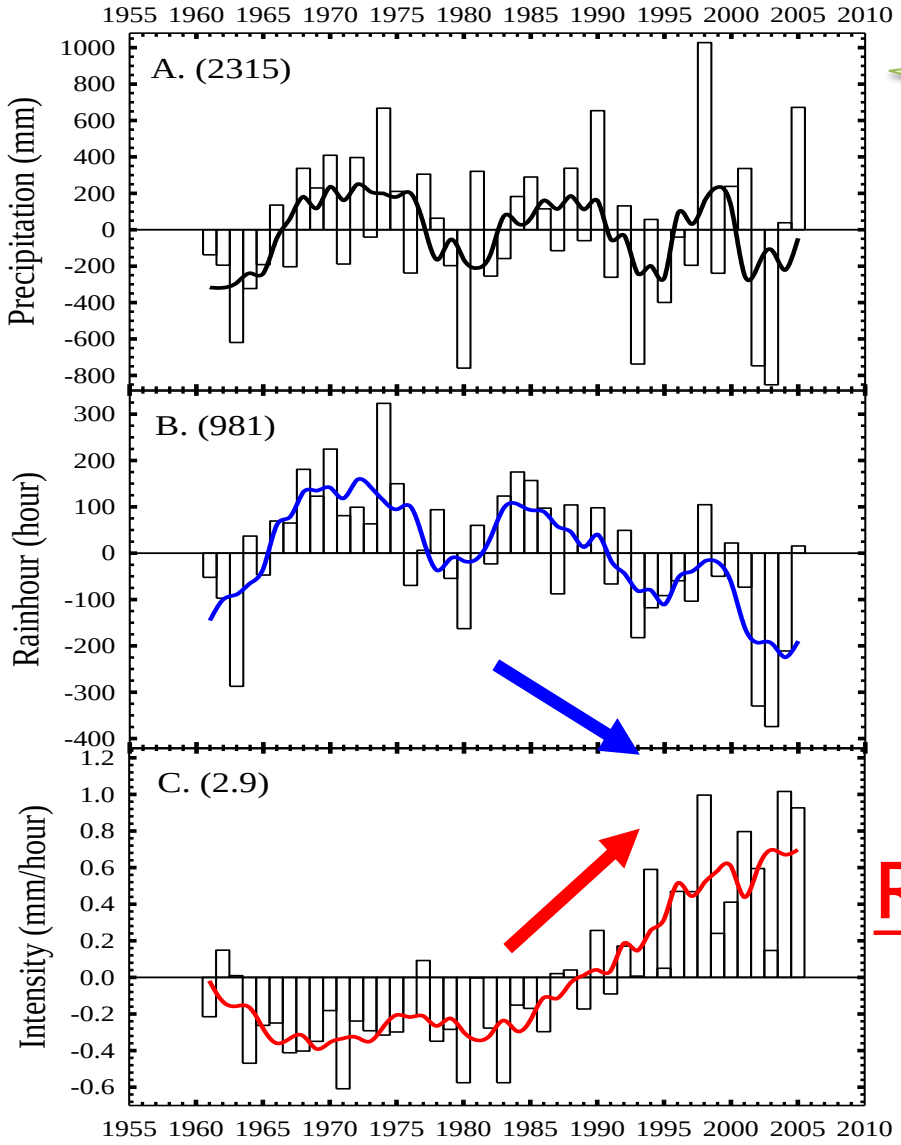
The temperature increased 1.3℃ within this century



The number of Typhoon that strikes Taiwan increased

資料來源：「因應全球氣候變遷之我國水利公共設施政策與挑戰」簡報，永續公共建設決策與管理前瞻科技研討會。

The truth that we must face



Challenge

Annual rainfall remain stable

Rainfall-hour tend to decrease

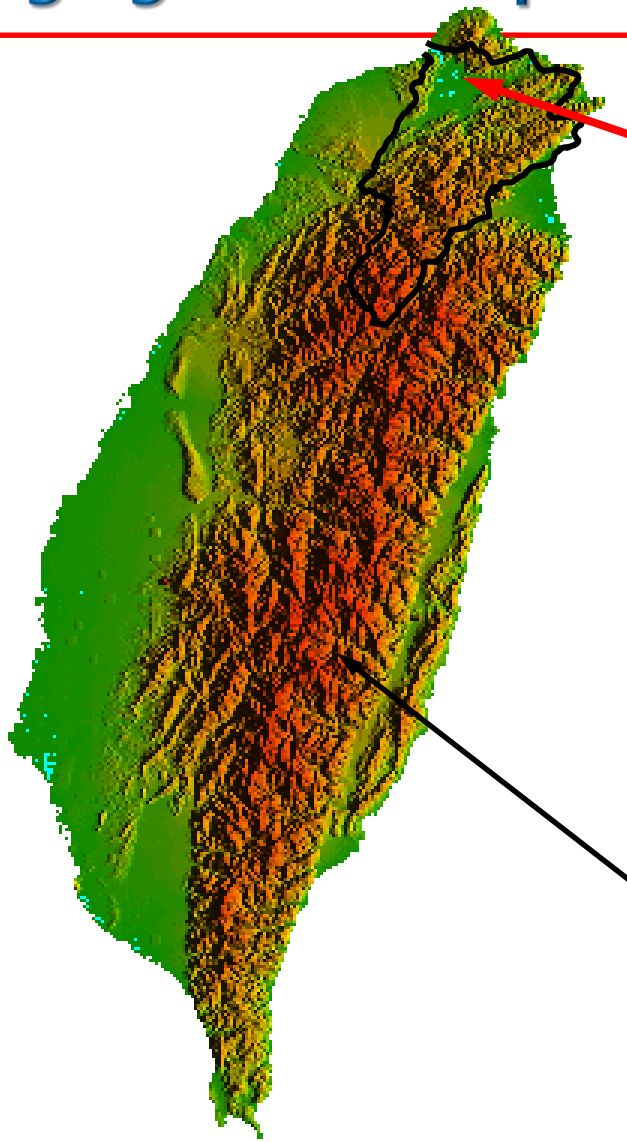
Rainfall intensity tend to increase

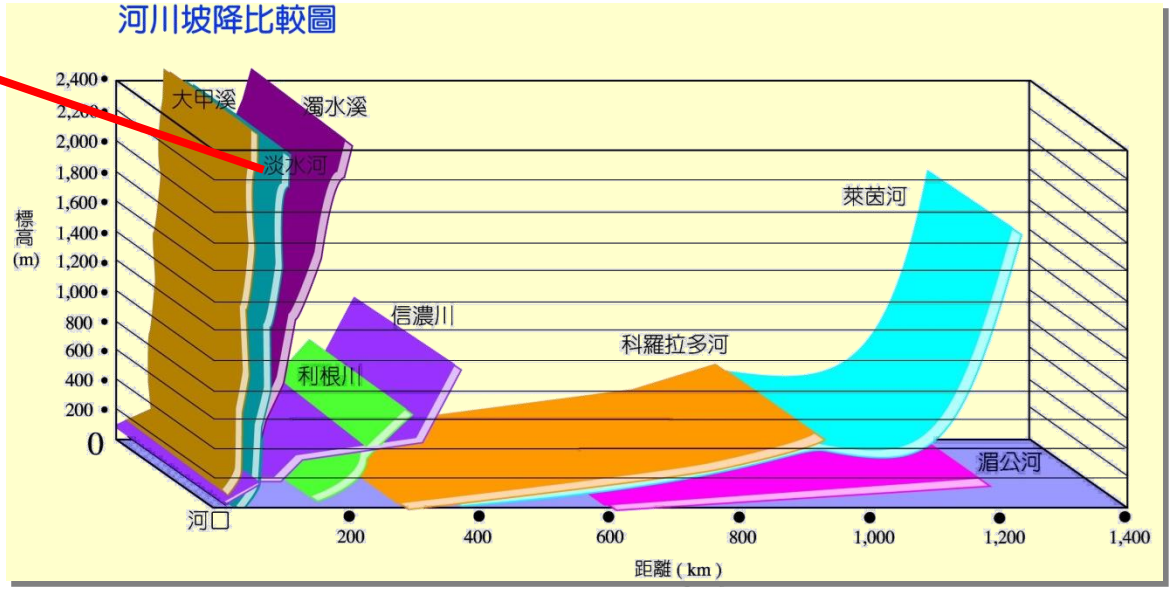
資料來源：「因應氣候變遷之調適策略」簡報，2010年。

The truth that we must face

The truth that we must face

high gradient slope and large flow velocity



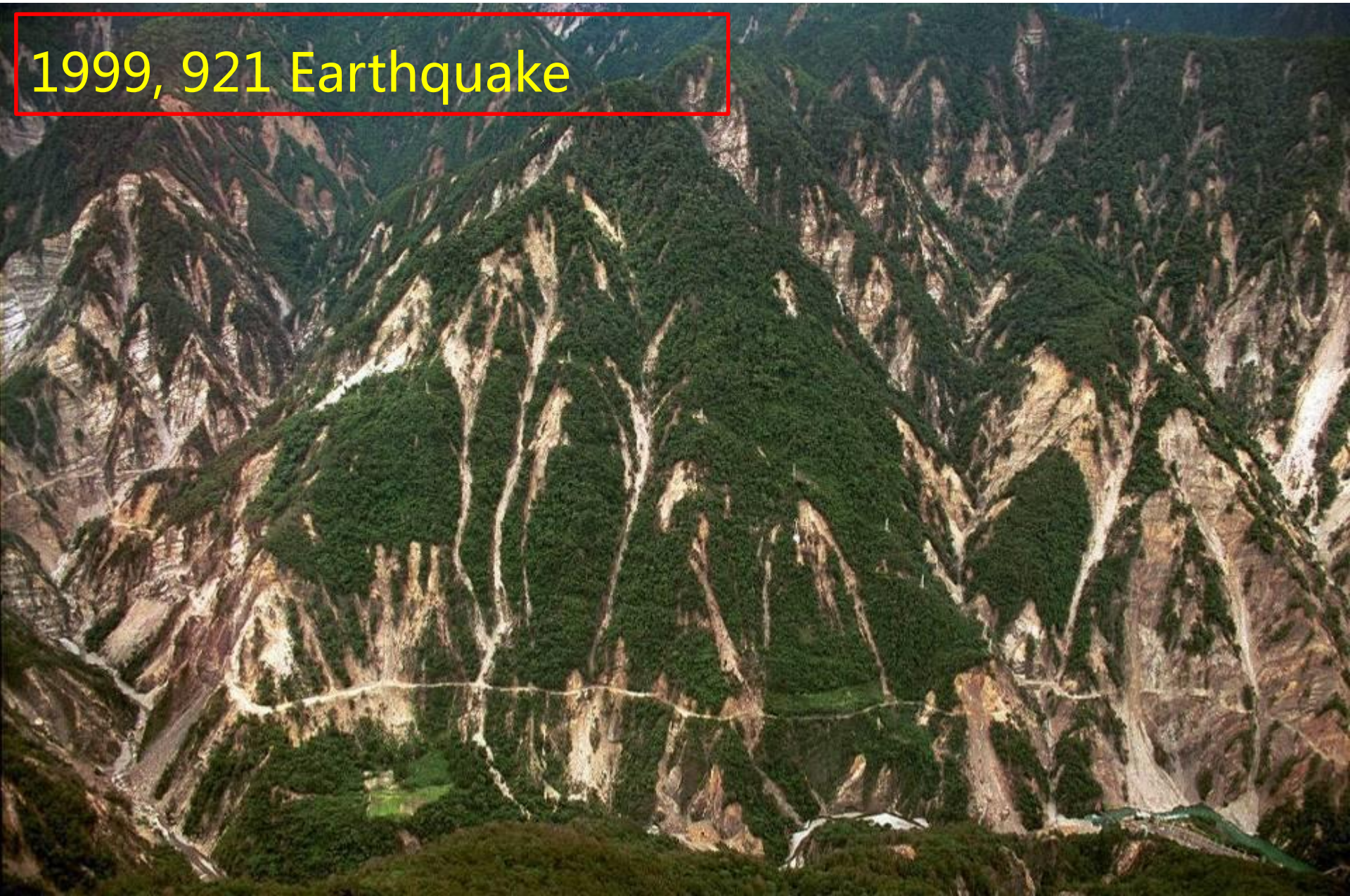


Island length : ~ 400 km

Island width : < 150 km

Highest mountain : 3950 m

The truth that we must face



Damages of the Typhoon event

Typhoon Morakot, Siao-lin villagers

Damages of the Typhoon event

Typhoon Morakot- A-Li Tribe

Damages of the Typhoon event

照片來源：中興大學林呈教授。

Damages of the Typhoon event

Typhoon Haitang– Feng-gang bridge

Damages of the Typhoon event

Typhoon Sinlaku– Ho-Fong bridge

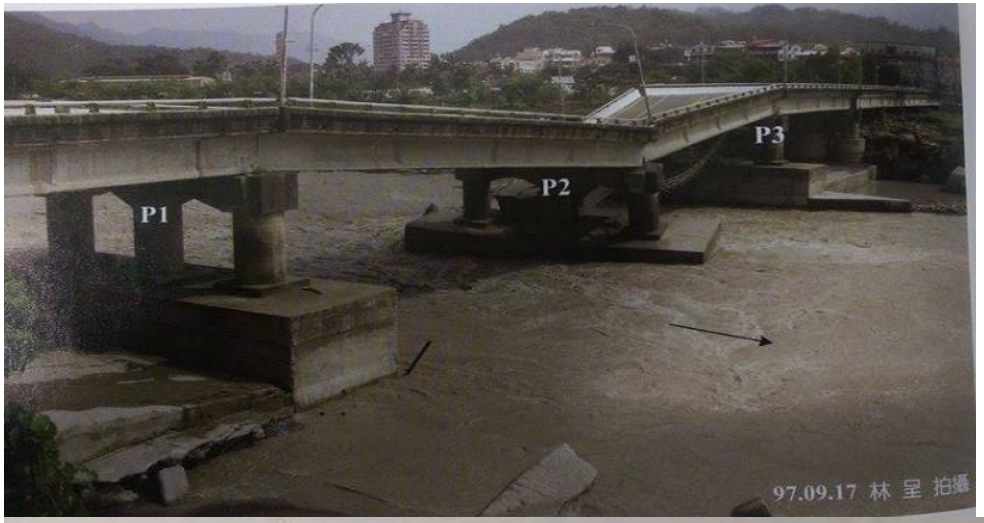
照片來源：記者謝鳳秋。

Damages of the Typhoon event

Typhoon Morakot– Shuan-gyuan Bridge

照片來源：記者謝鳳秋。

Causes of bridge damage



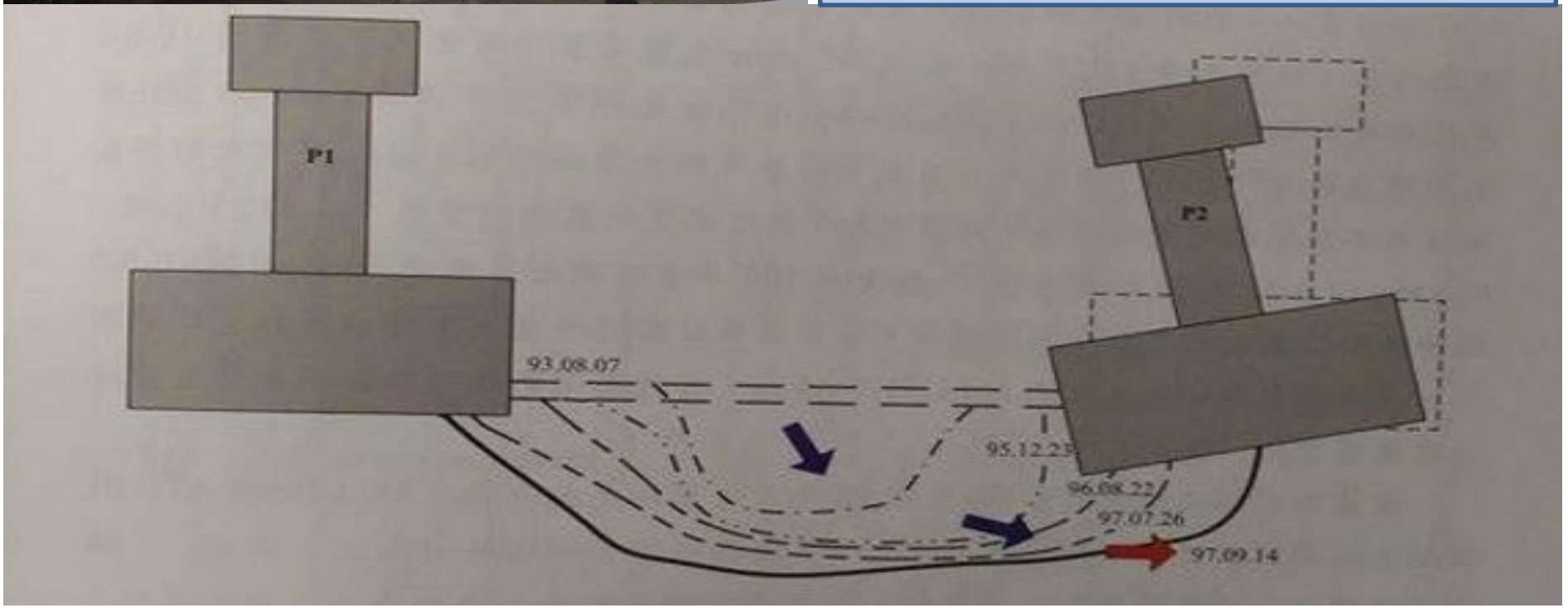
Reasons:

Impact of rock or driftwood

Overtopping

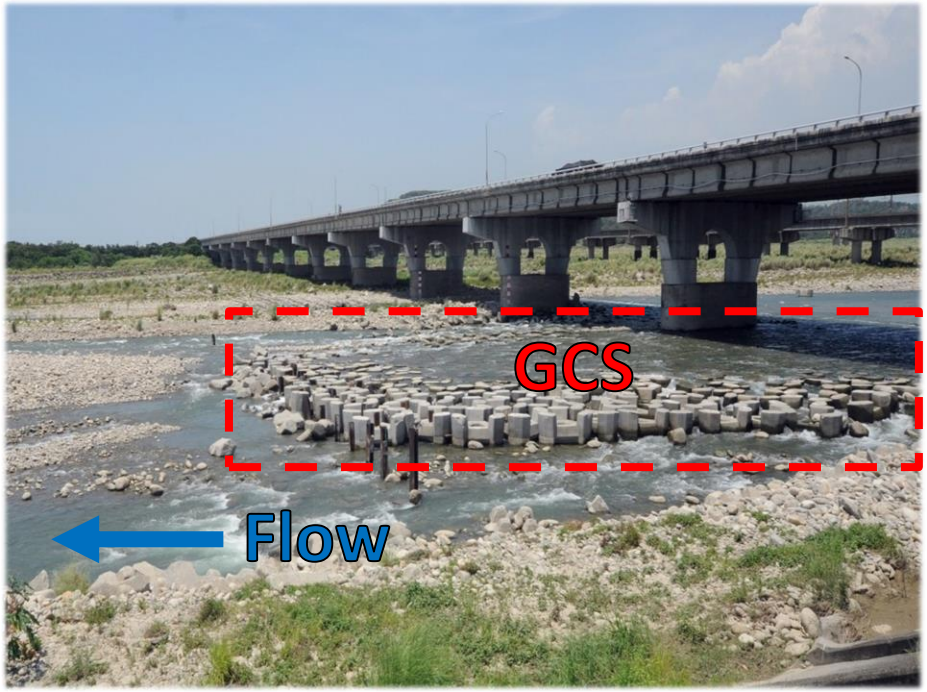
Bridge pier exposed

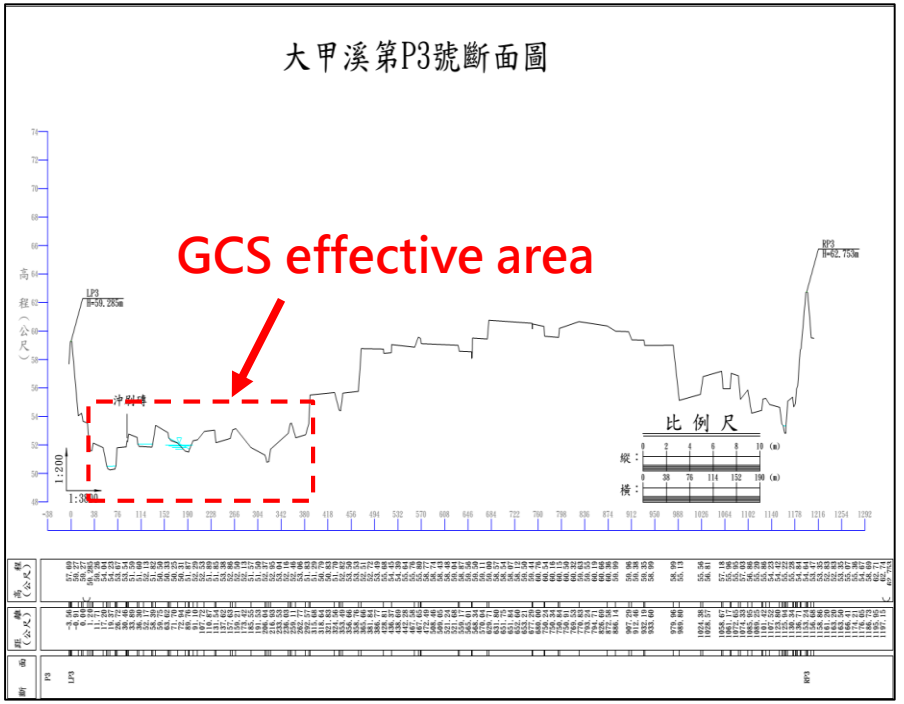
Local scour

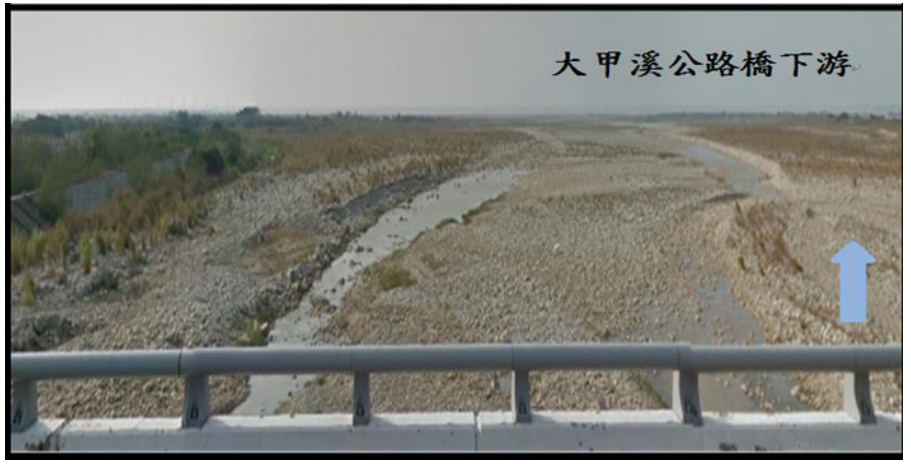


Local scour observation during typhoon period

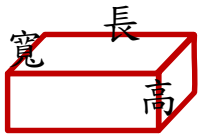
Observation site





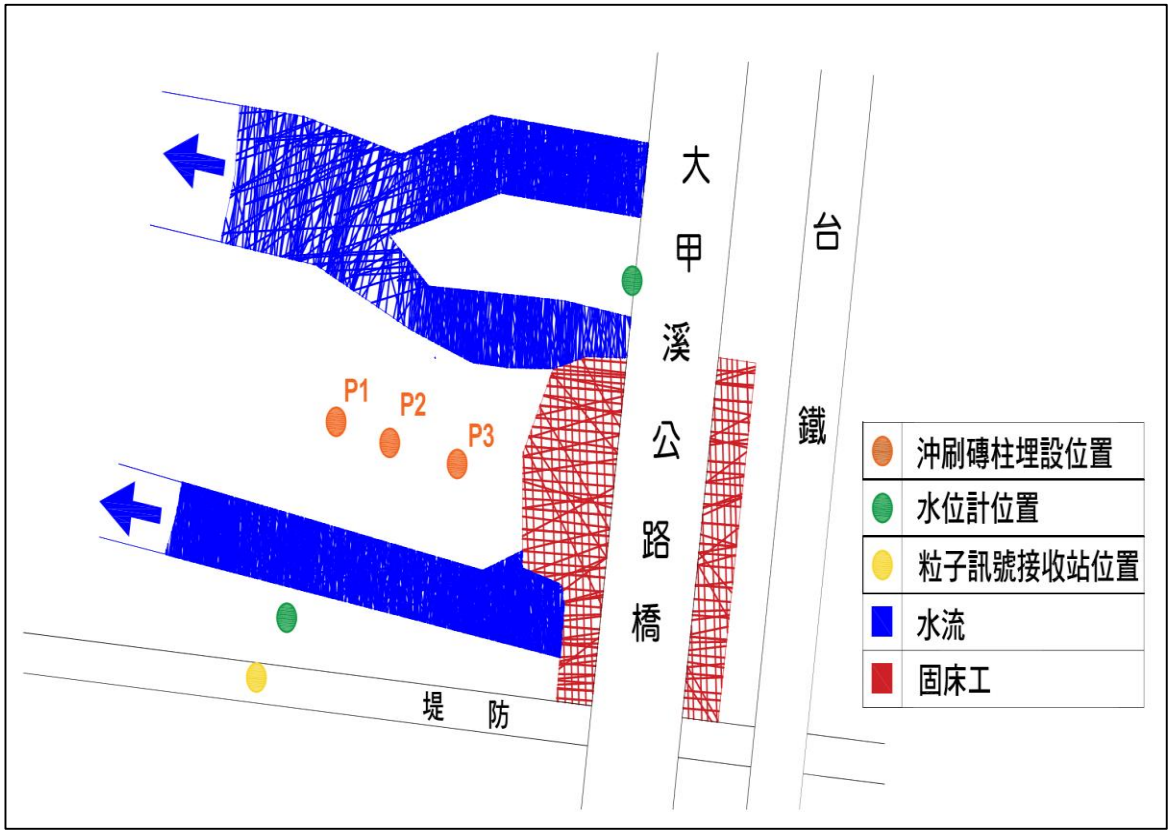


Local scour observation during typhoon period

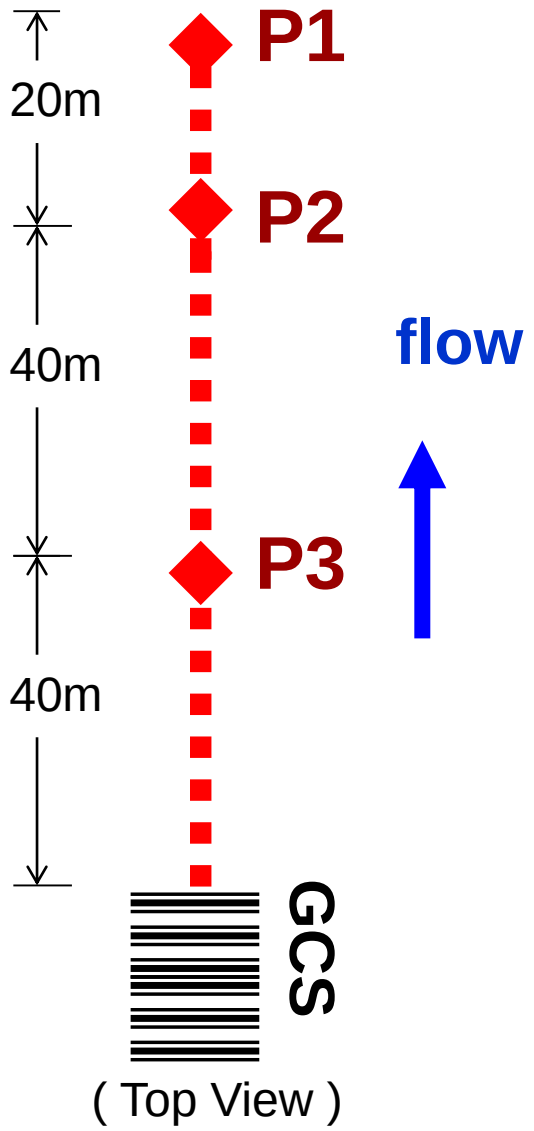


長：20 cm
寬：15 cm
高：5.5 cm

Local scour observation during typhoon period



	P3	P2	P1
Distances (m)	40	76.7	105.6
Depth (m)	5.40	4.96	5.40
Numbers of brick	90	82	90



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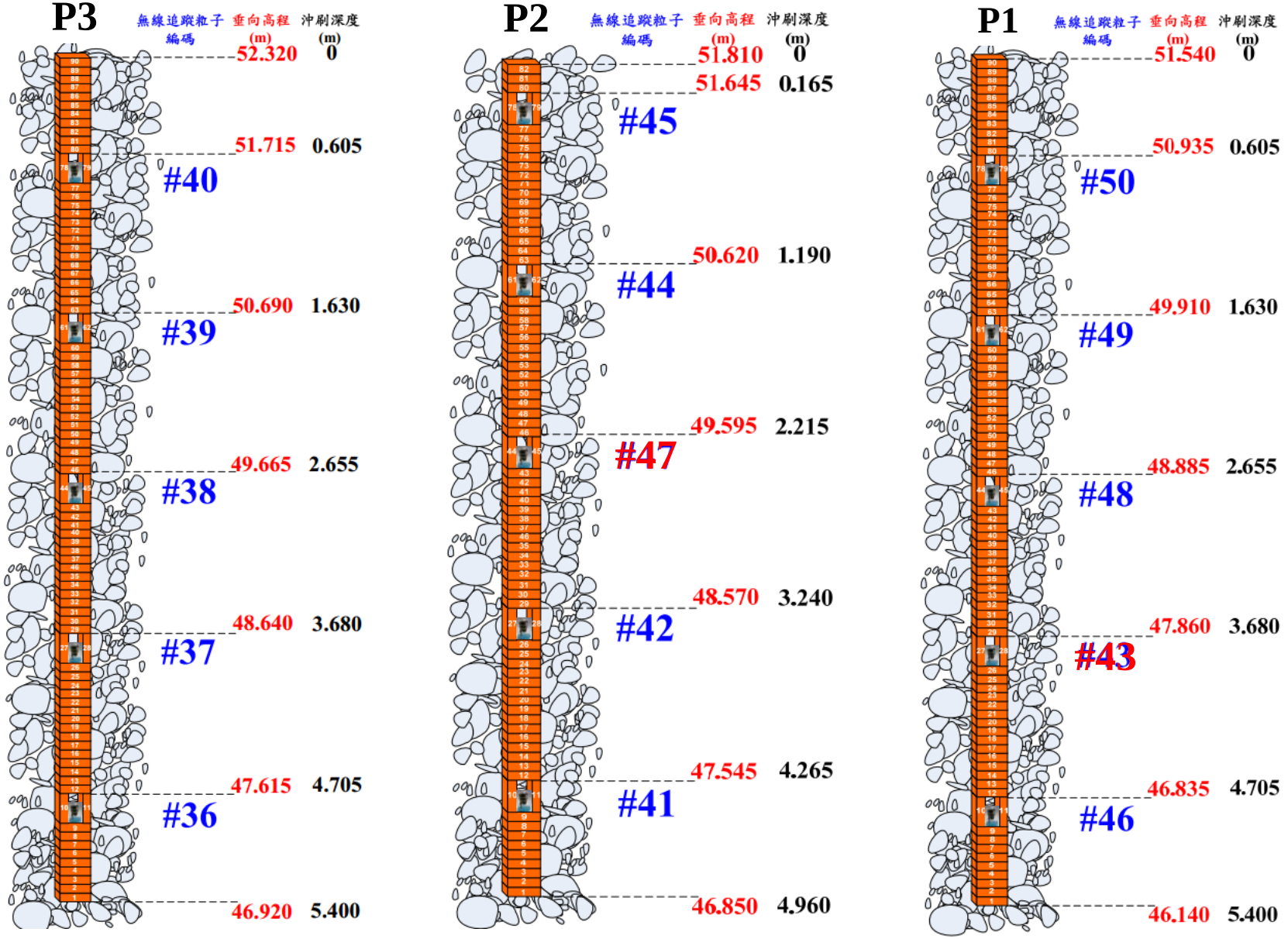

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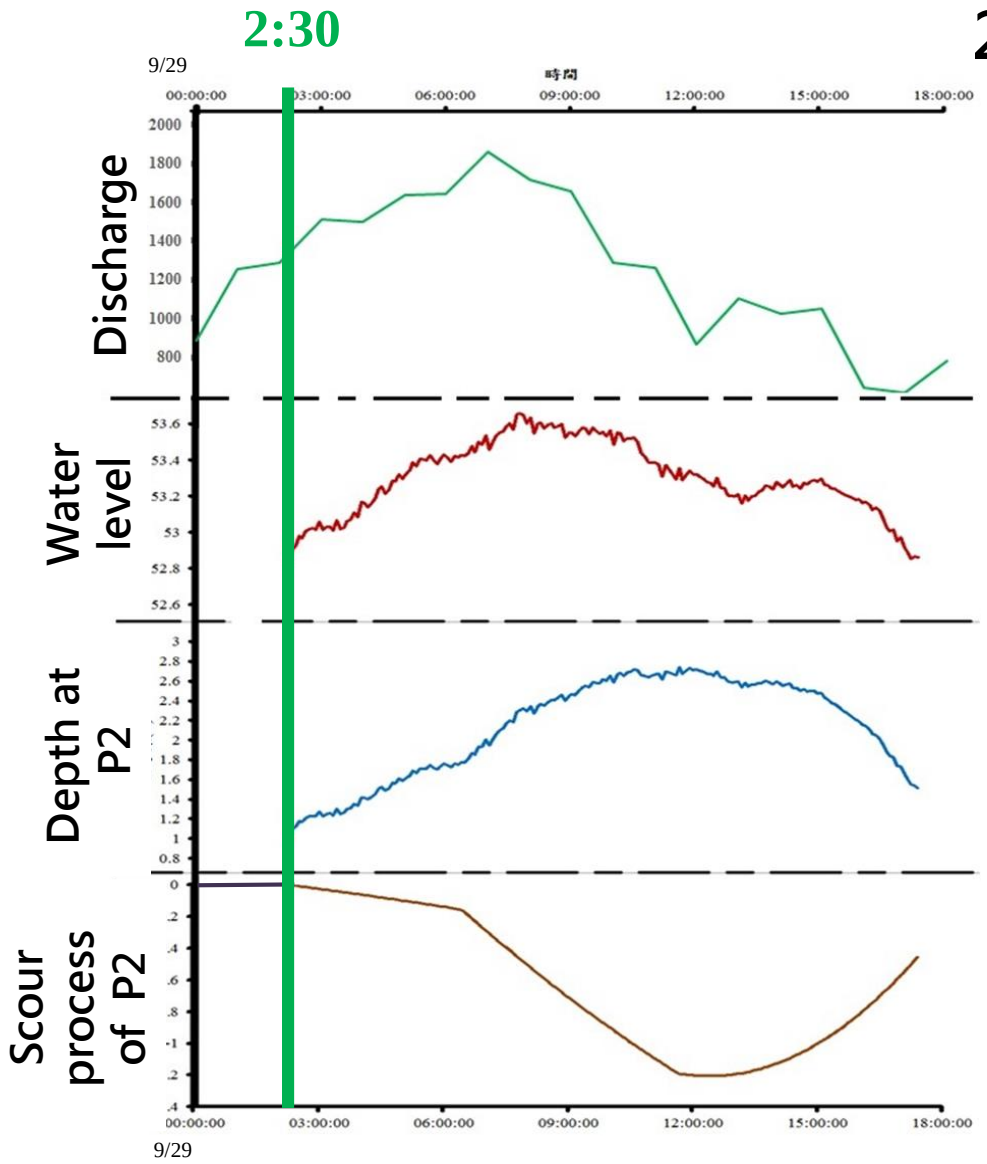
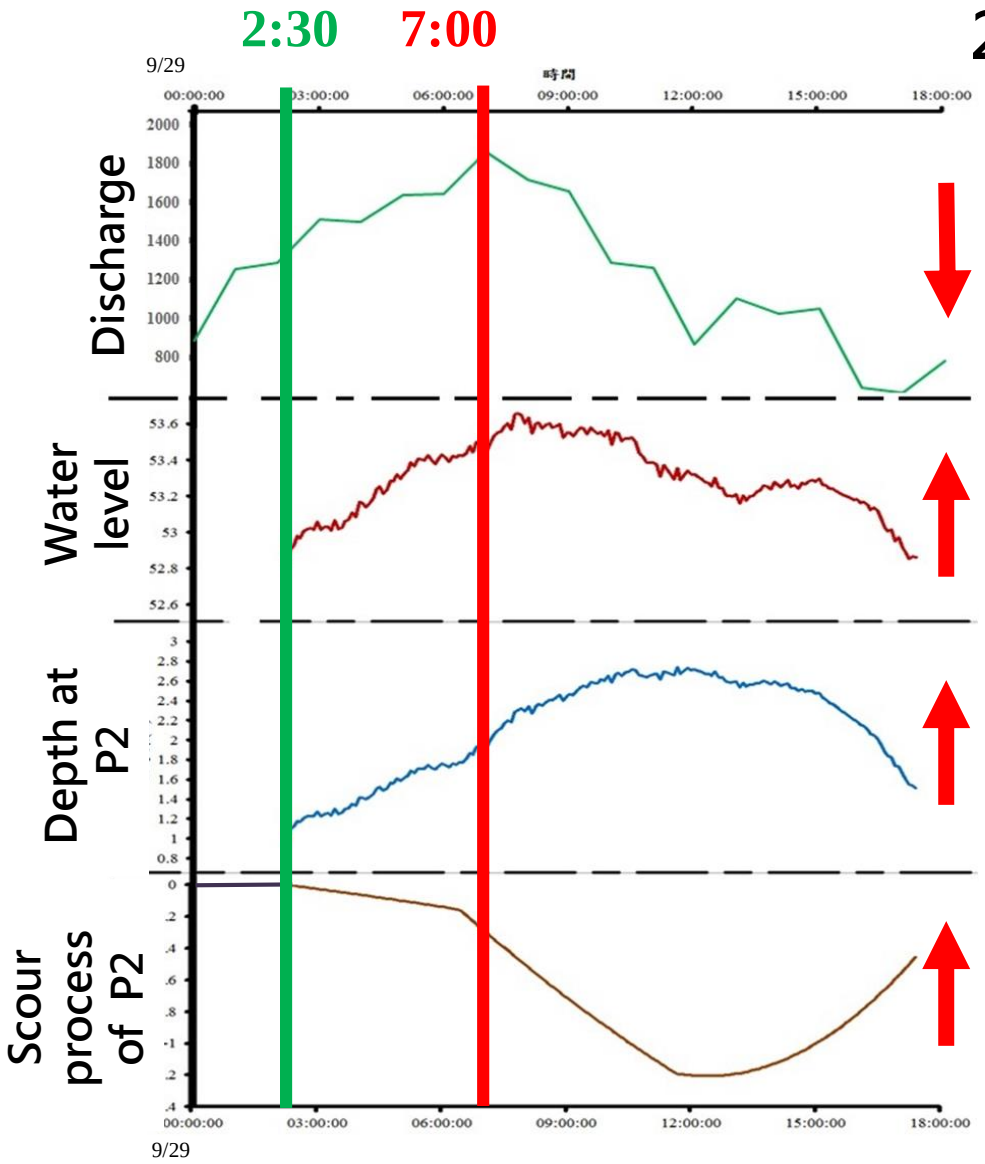


2015/09/28 typhoon Dujuan

- **This event start at 2:30, flow velocity exceed the initial velocity and the downstream of GCS begin to scour.**

Local scour observation during typhoon period



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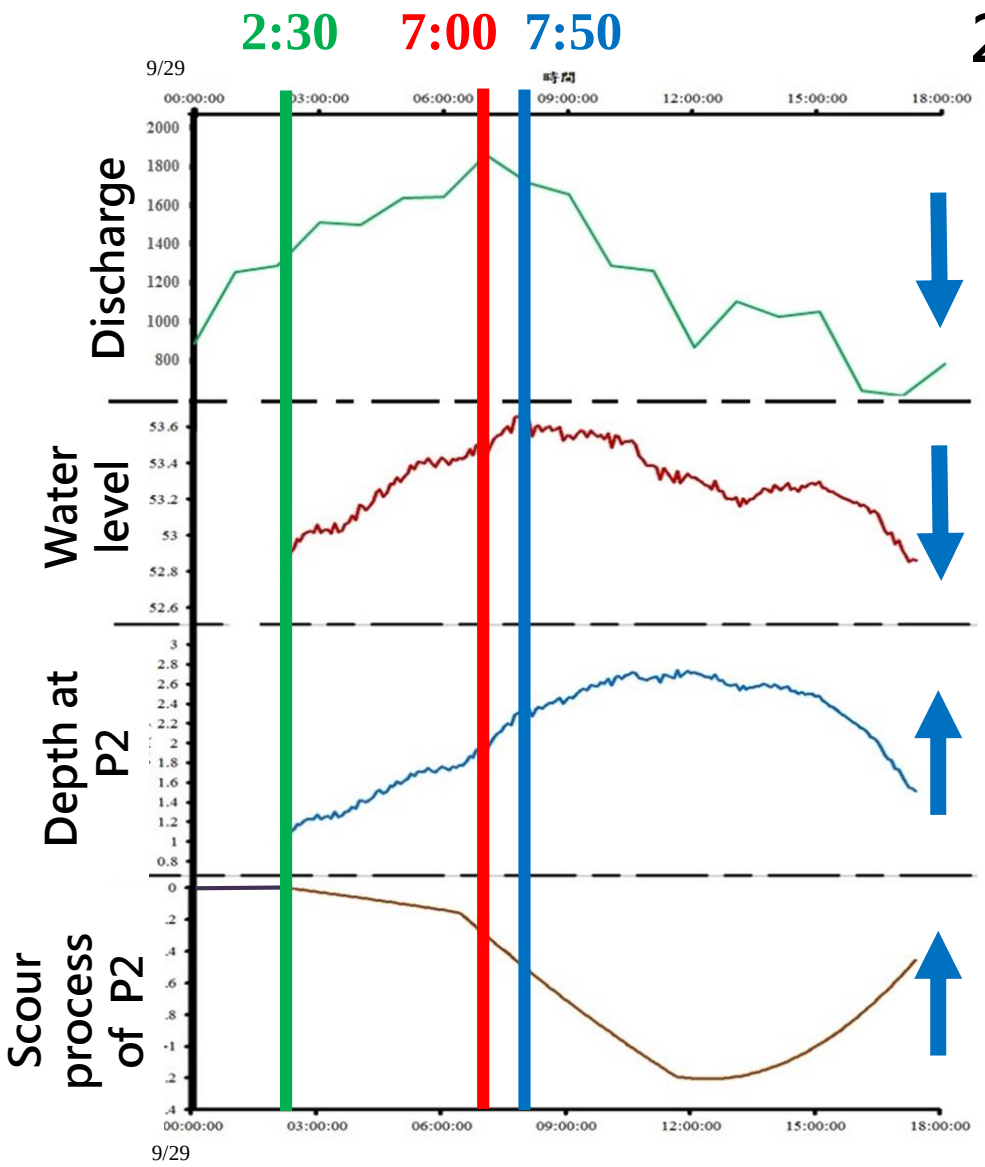
- **After 7:00，the discharge decrease，but the water level , depth at P2 and the scour depth still increasing.**

Local scour observation during typhoon period



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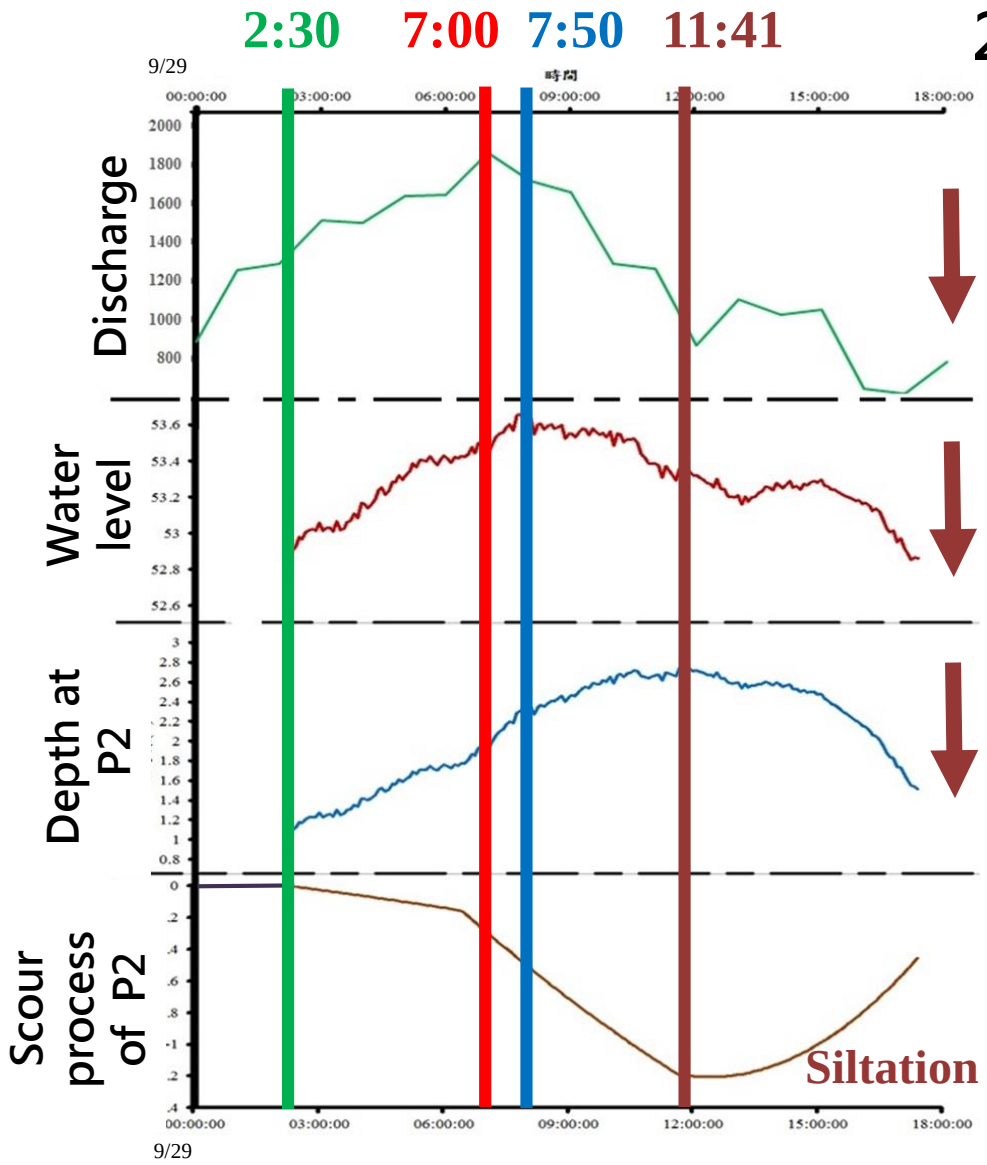
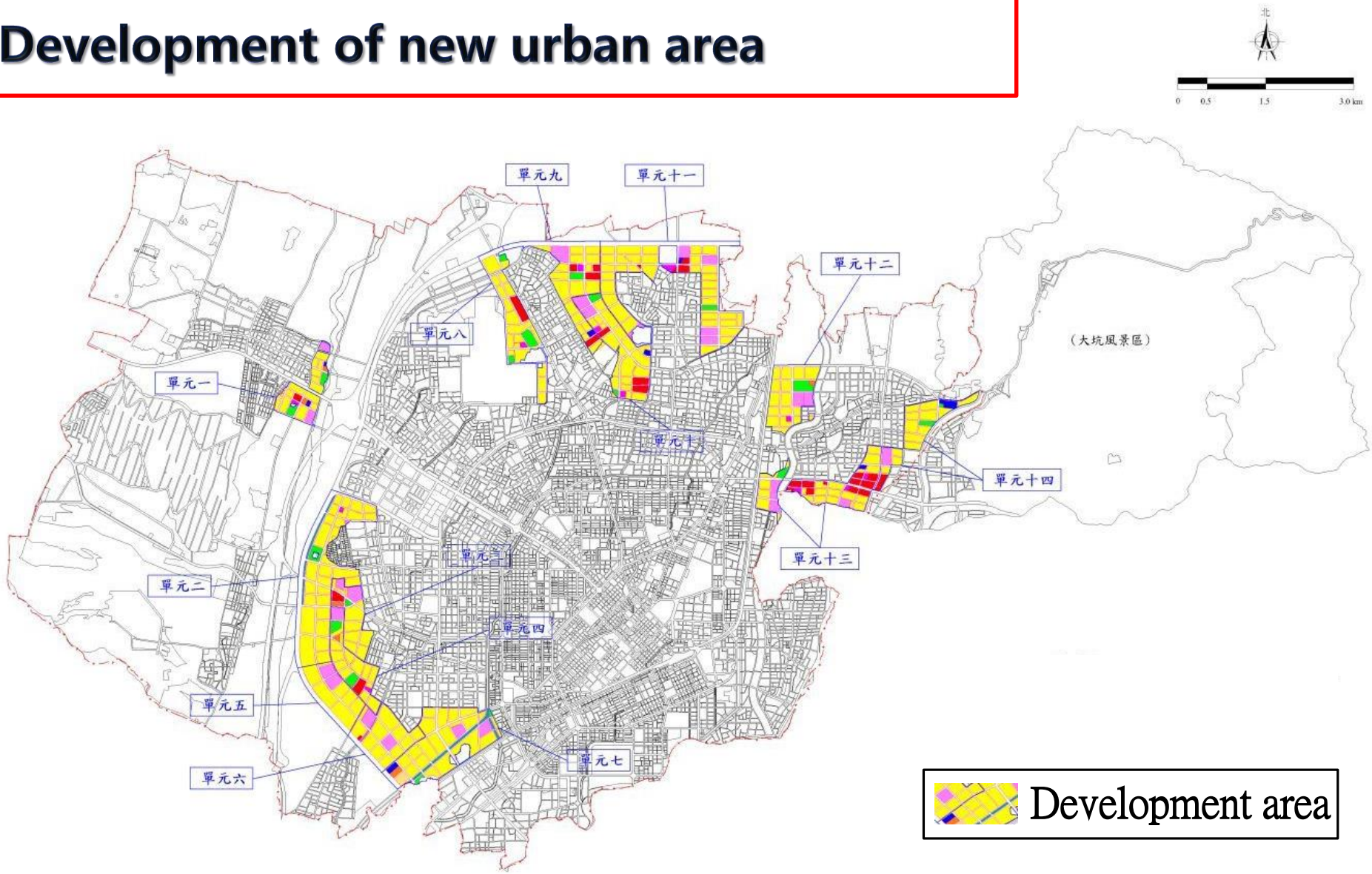


2015/09/28 typhoon Dujuan

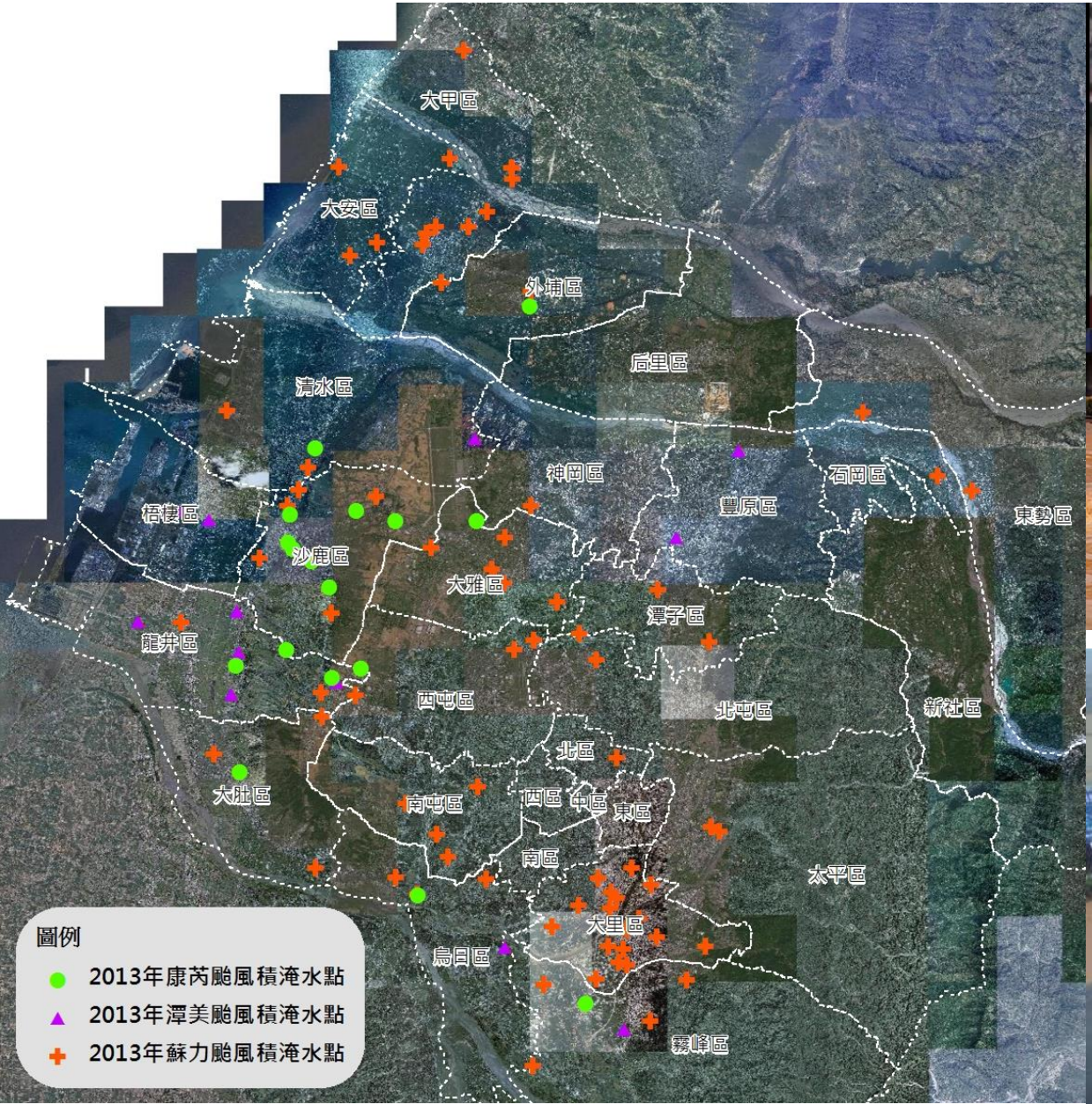
- **This event start at 2:30, flow velocity exceed the initial velocity and the downstream of GCS begin to scour.**
- **After 7:00，the discharge decrease，but the water level , depth at P2 and the scour depth still increasing.**
- **After 7:50 ,the discharge and the water level decrease gradually, but the depth at P2 and the scour depth still increasing.**
- **After 11:41, downstream of the GCS start to siltation.**

Challenge of Hydrologic Engineering

Development of new urban area



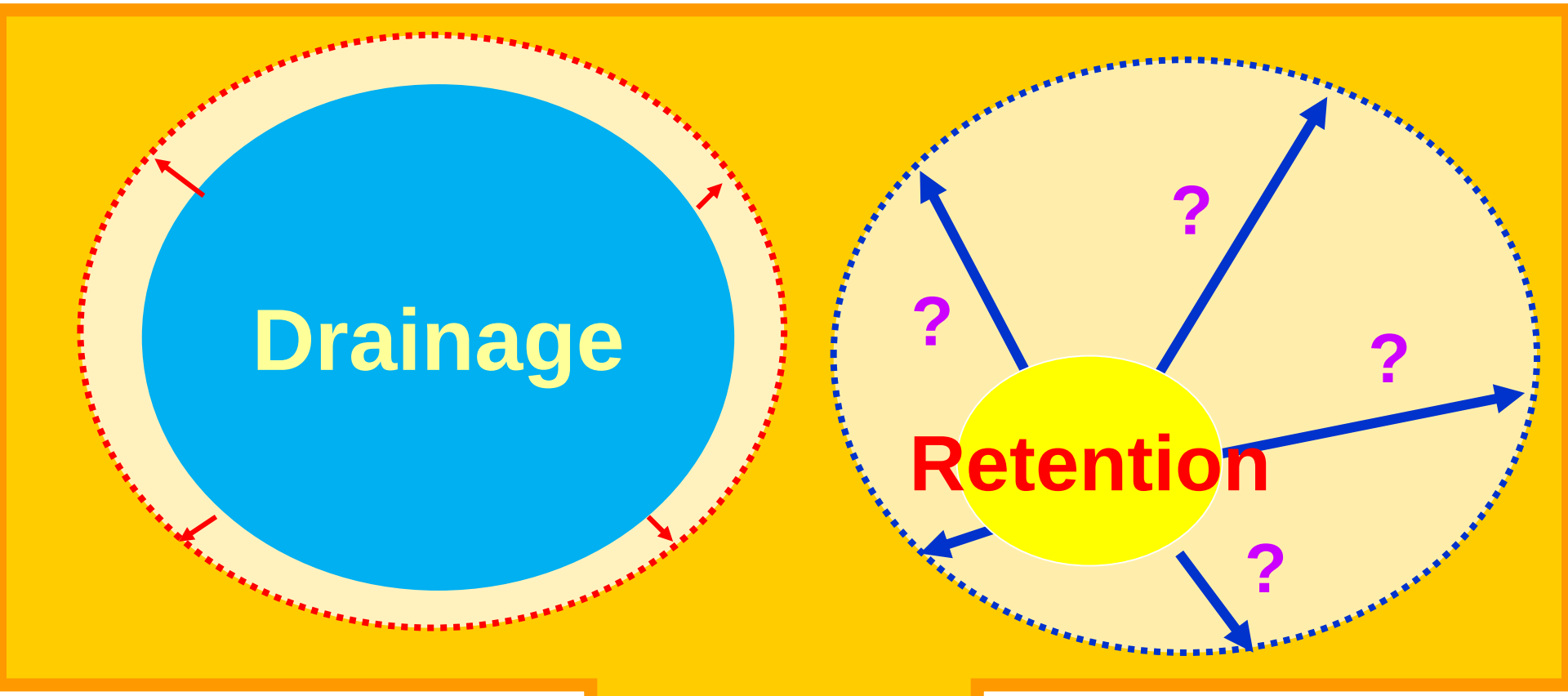
Limitation of the drainage capacity



潭美颱風沙鹿區淹水情形

蘇力颱風台灣大道淹水情形

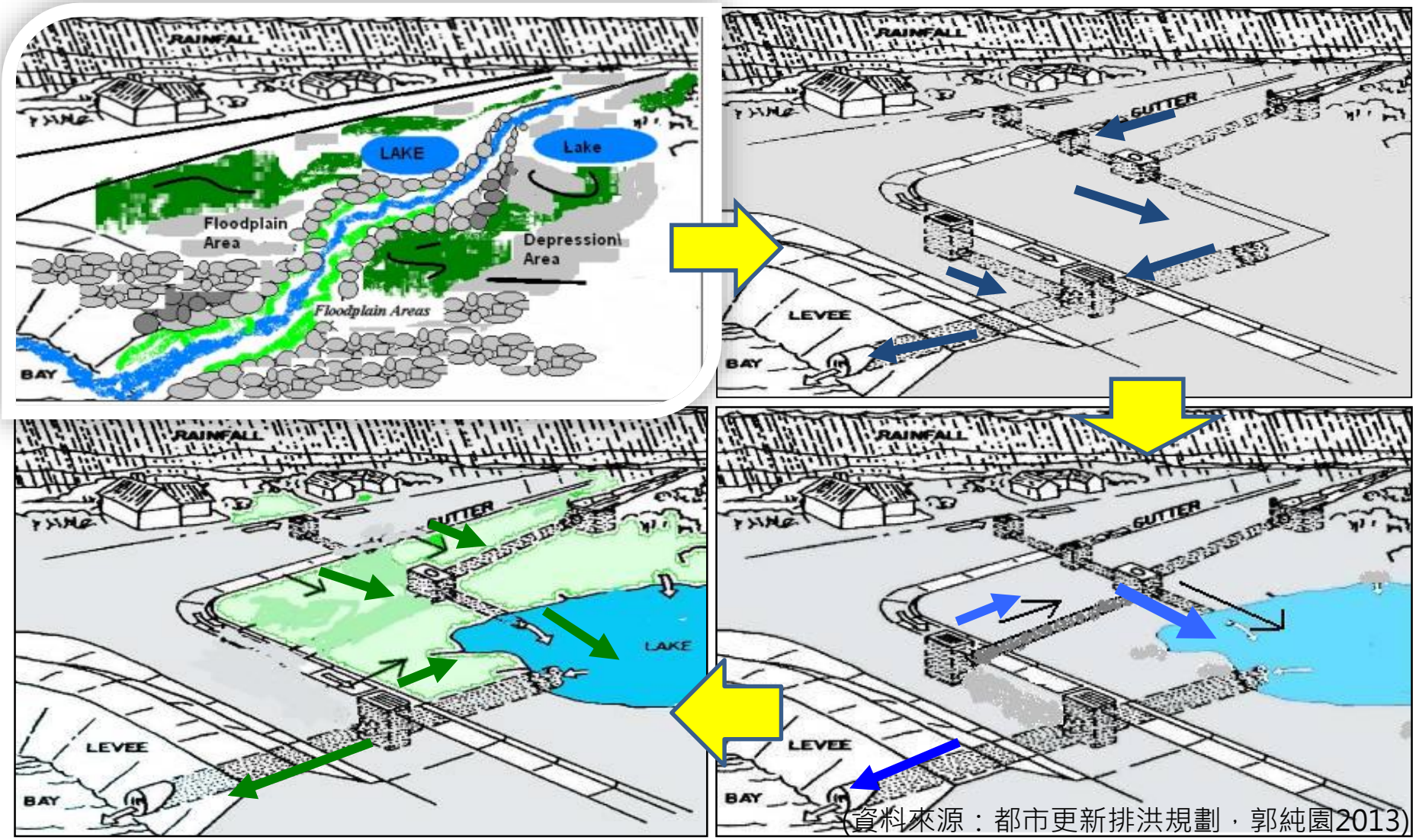
Reflection of flooding disaster



Storm water management in urban area

the potential of rainfall management - reduce disasters

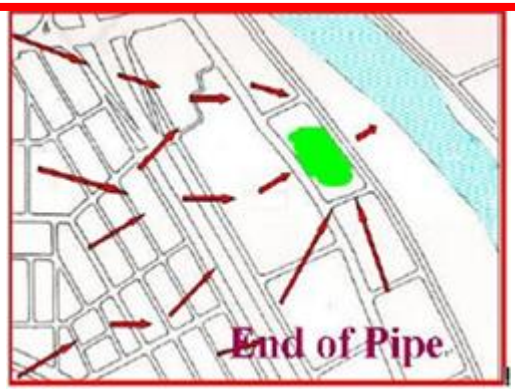
Storm water management in urban area

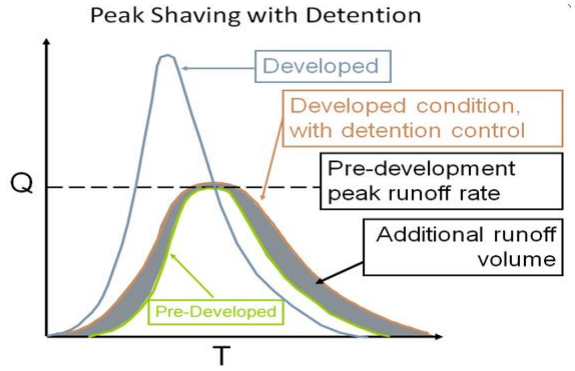


(資料來源：都市更新排洪規劃，郭純園2013)

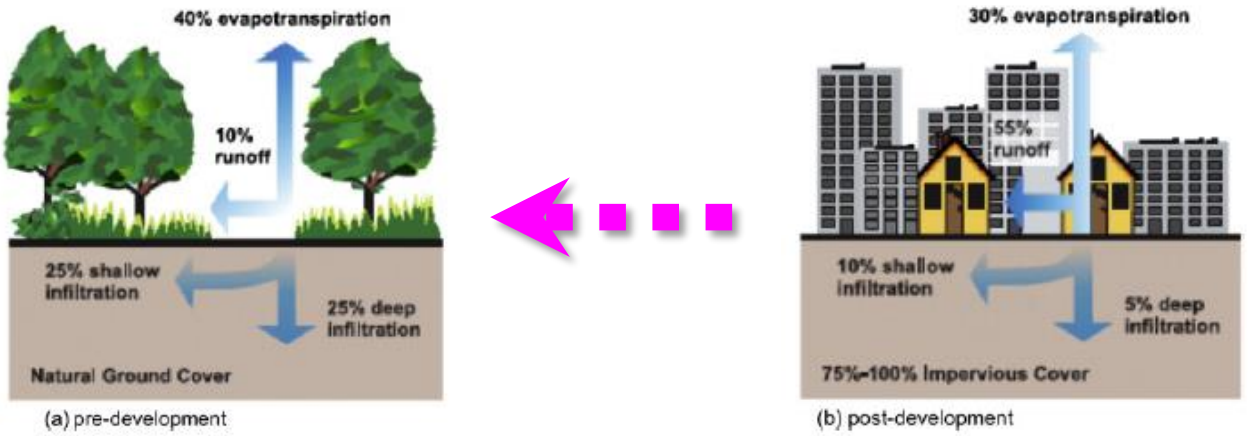
The purpose of infiltration enhancing

Applying concept of LID into detention infrastructure: Enhance Infiltration Capacity





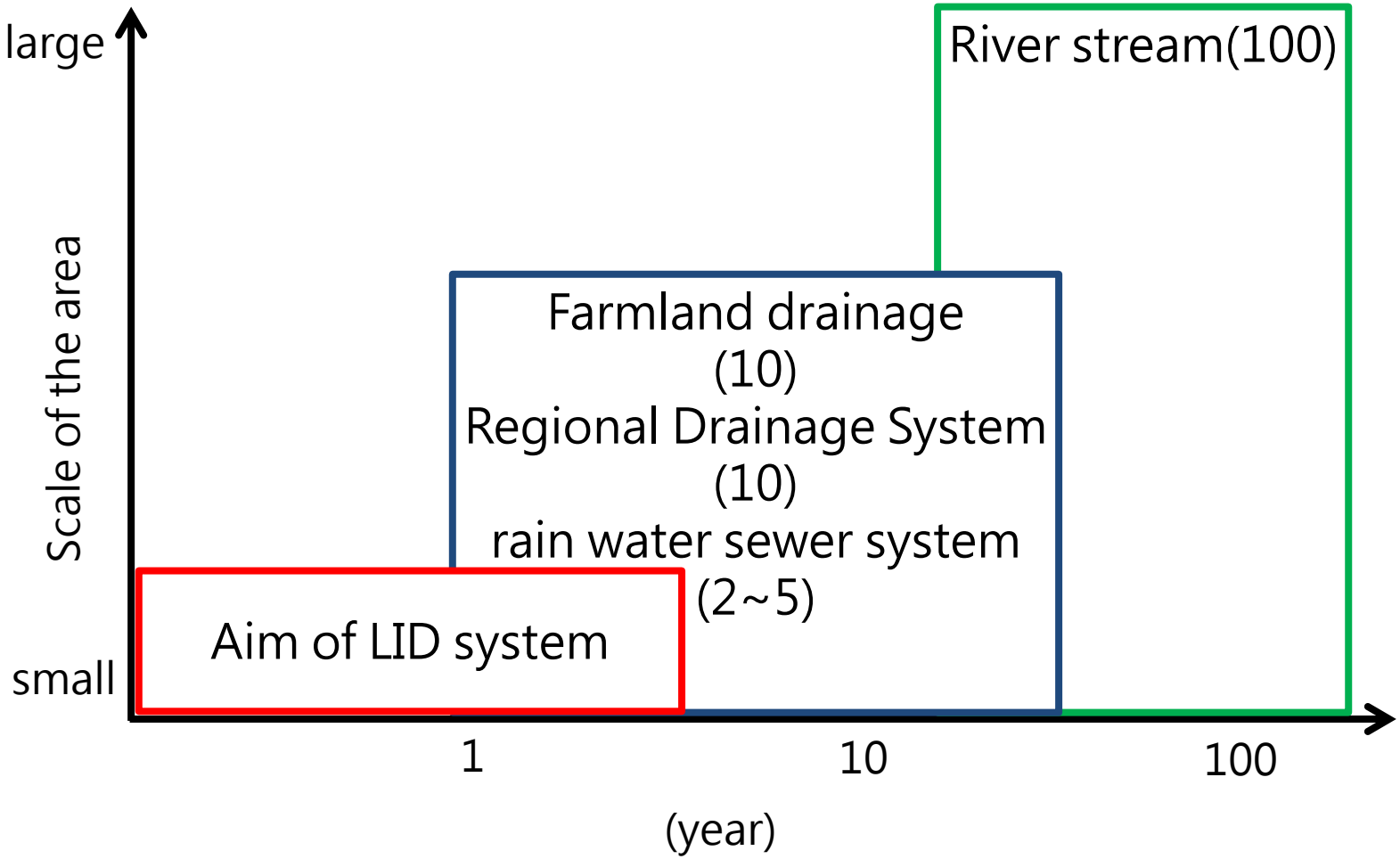
- create infiltration environment, and restore the original hydrological state



Aim of L I D

LID系統以增加透水、滯洪與綠地面積，減輕其他上位系統負擔為原則

配合綜合治水整體架構進行完整規劃

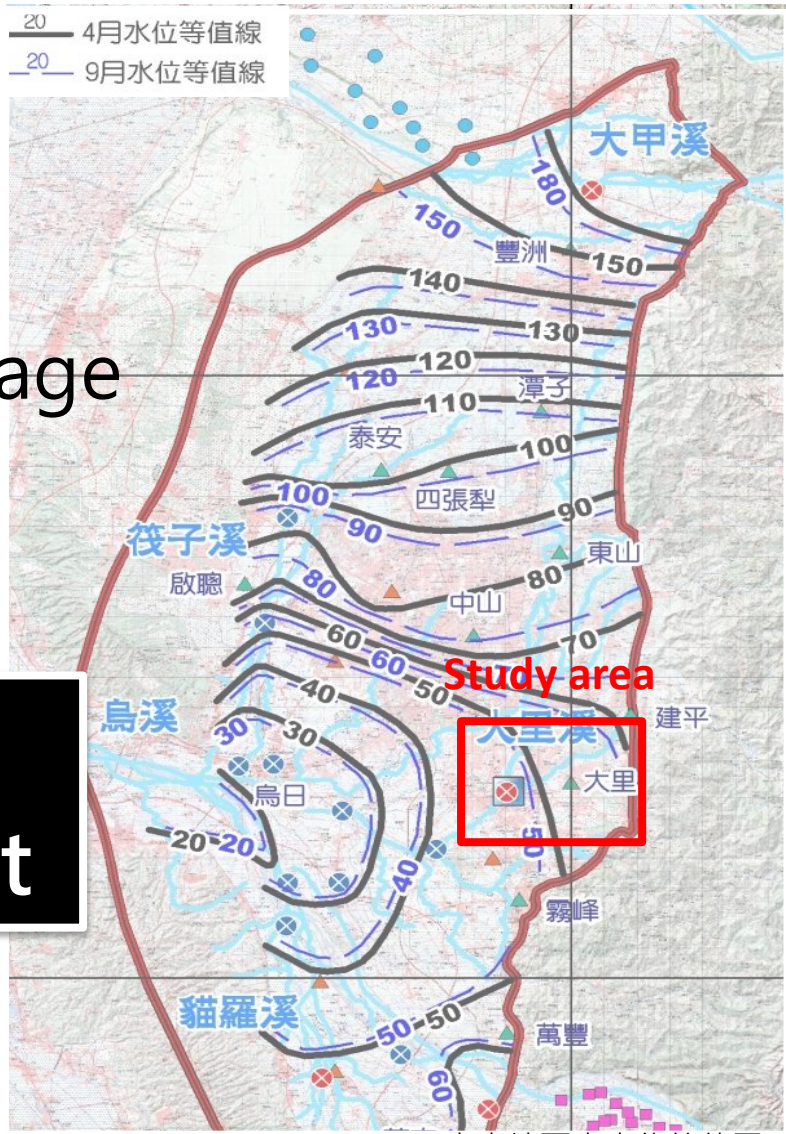


Background of study location

Geological condition

- Thick gravel layer，**High conductivity**
- Quick infiltration and drainage
- Low water table

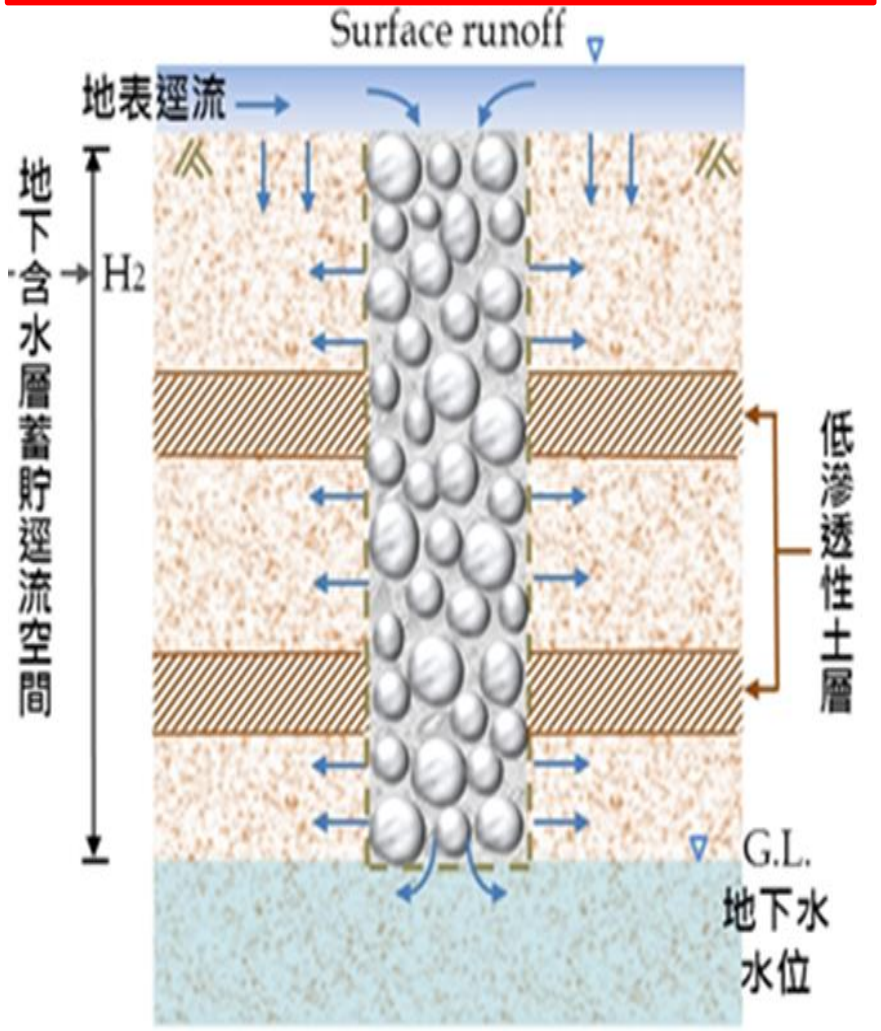
Suitable for
Low Impact Development



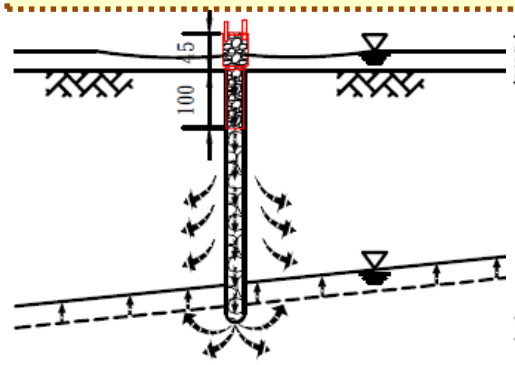
臺中地下水水位等值圖

Urban area
– Bio-retention pond(gravel pile)

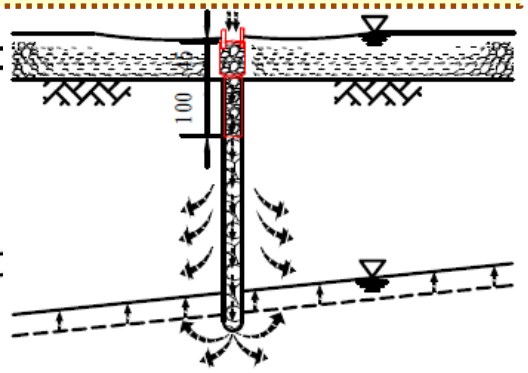
Concept and Approach



- Utilize high conductivity of gravel pile, by penetrated low conductivity layer, to enhance flow in the vertical direction.
- By import surface runoff into ground and recharge groundwater.



礫石樁補注地下水層之情況(低水)
N.T.S



礫石樁補注地下水層之情況(高水)
N.T.S

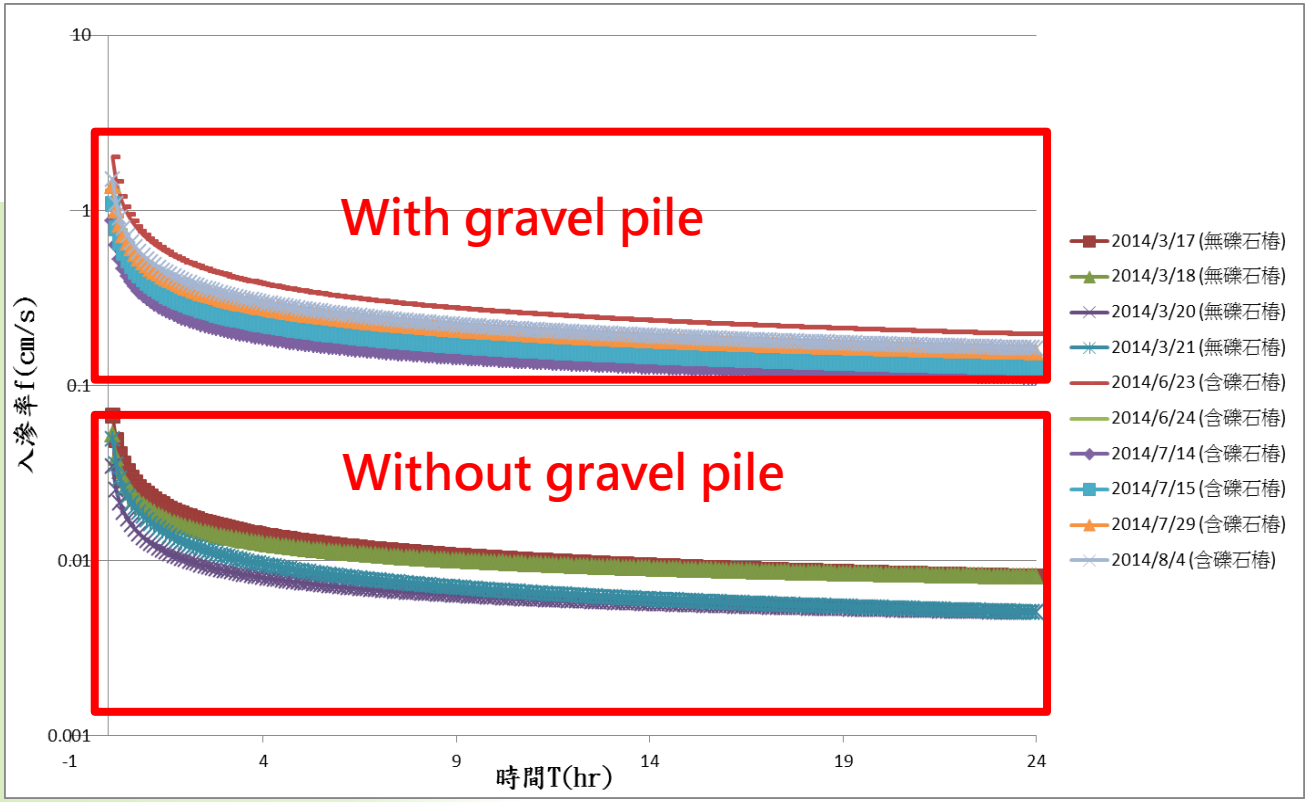
Bio-retention pond with gravel pile

w/ gravel pile

traditional

Bio-retention pond with gravel pile

results



排水性	排水性良好			排水性不良		實用上不排水				
土壤種類	不含黏土之礫石		不含黏土之砂及礫石			微細砂，有機質及無機質沉泥，砂等與黏土之混合土，疊層堆積黏土			風化帶以下之均質黏土	
K=(cm/sec)	100	10	1	10^{-1}	10^{-2}	10^{-3}	10^{-4}	10^{-5}	10^{-6}	10^{-7}	10^{-8}	10^{-9}

Bio-retention pond with gravel pile

Landscaping

SWMM model evaluation

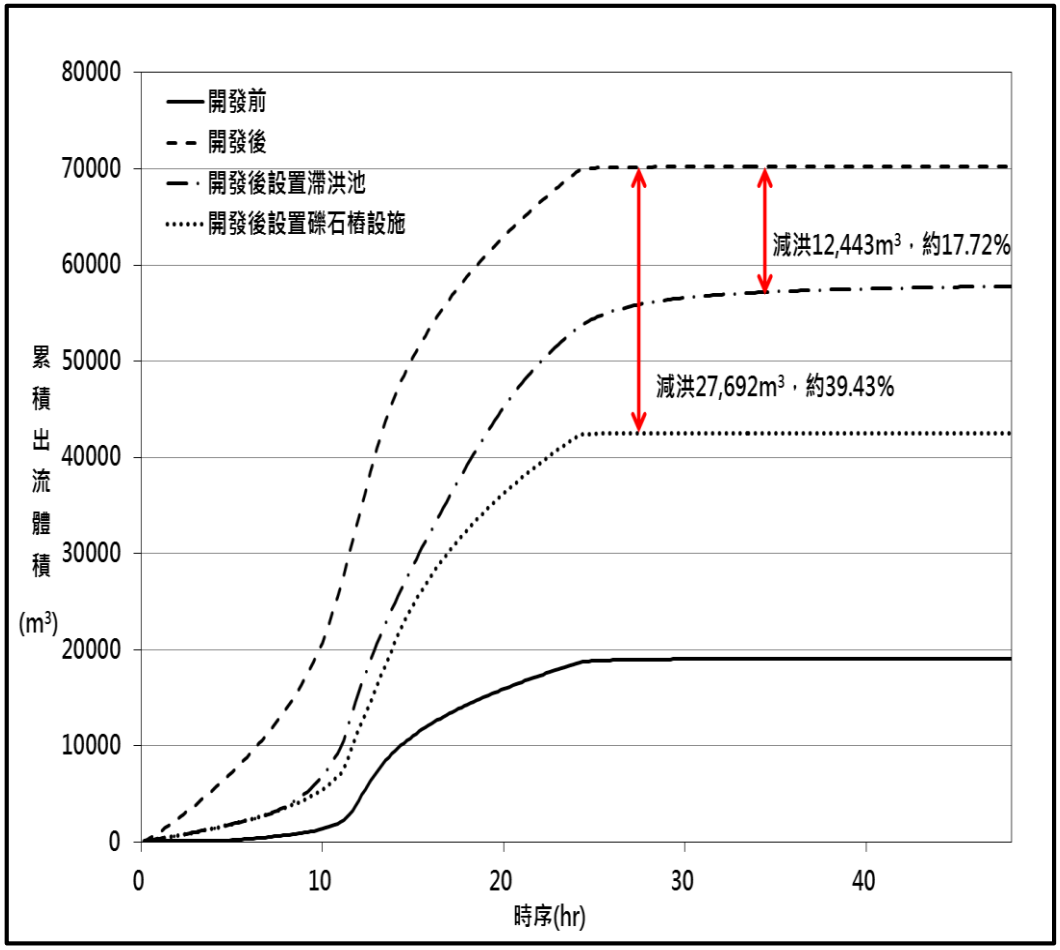
Evaluation of the flood reduction of watershed

Modeling scenarios
Before development
After development
After development W/ detention pond
After development W/ Bio-retention pond

Conceptual model of the watershed

SWMM model evaluation

Evaluation of the flood reduction of watershed



Results of SWMM modeling

According to the result, the LID can release the pressure of flooding control of downstream area.

And the summary area of Bio-retention pond only half of the traditional retention pond.

Change of Concepts on flood prevention

BEFORE

- No flooding

(Spongy City)

FUTURE：Resilient Cities

- Tolerate flooding
- Coexist with flooding


Thank you