Flood Control and Disaster Management in Taiwan

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Outline

I Introduction

II Taiwan's Water Environment

III Our Flood Management History

IV Current Measures

V Case Studies

VI Conclusion

I. Introduction

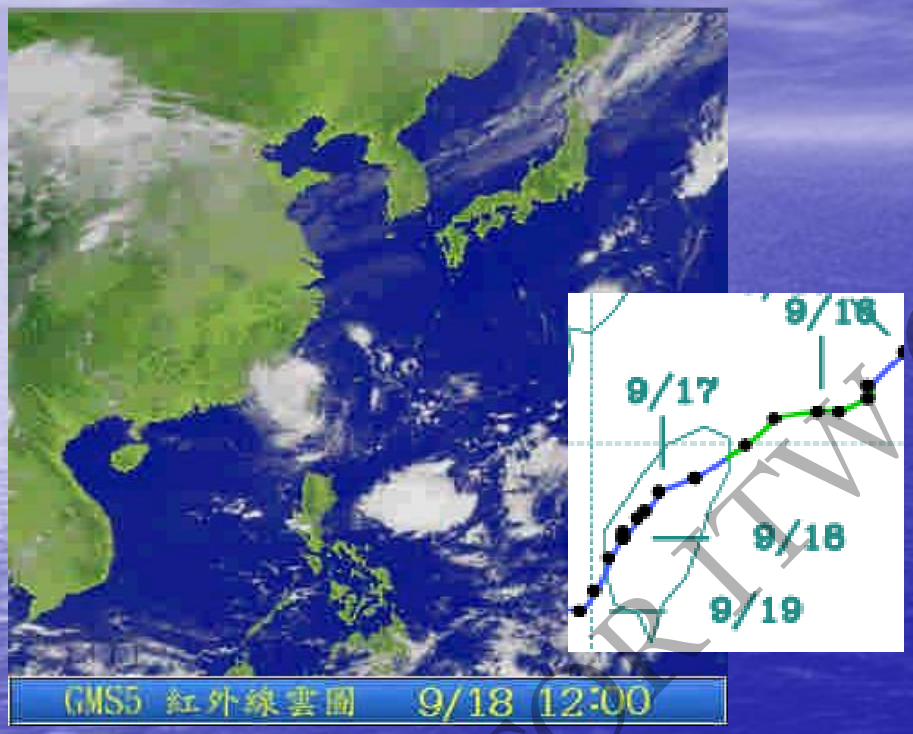
- River regulation, to keep up with latest social development, now needs to plan and implement the river basin regulation project on an integrated basis, including up-, mid- and down- stream river management.
- Public demand for better quality of life and awareness for eco-environment as well as sustainable use of resources also influences the policymaker to put more emphasis on preserving scenic beauty, ecological balance, and harmony between human and water in the future river management.

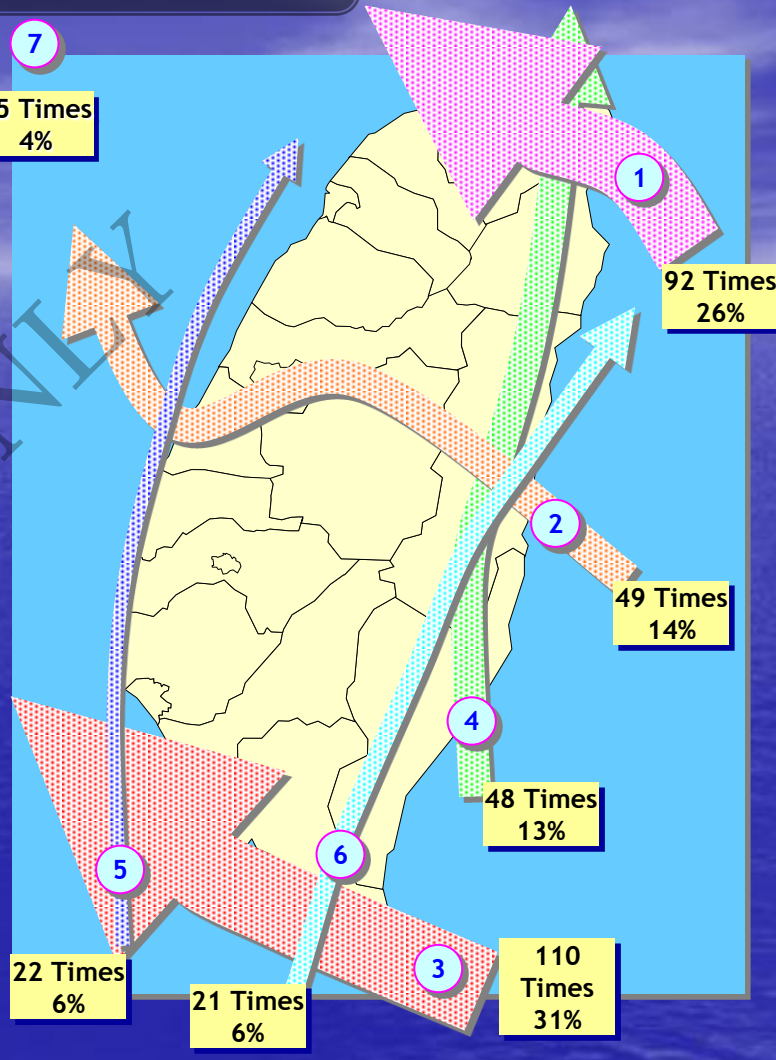
II. Taiwan's Water Environment

- Prone to Typhoons and Torrential Rains
- High Rainfall Intensity
- Short River, Steep Slope, and Limited Basin Area
- Fractured Geological Conditions and High Erodability
- Land Subsidence
- Land Development and Surface Runoff
- Climate Change and Global Warming

Prone to Typhoons and Torrential Rains

(Typhoon Nari, 2001)

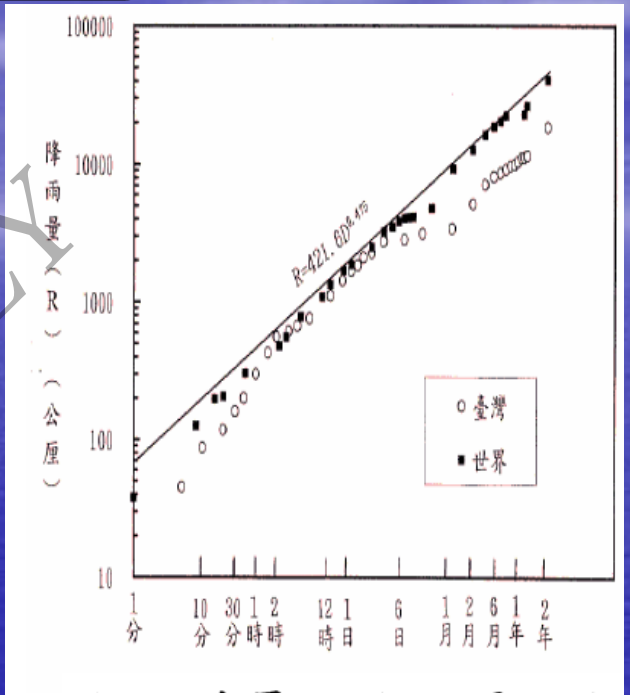




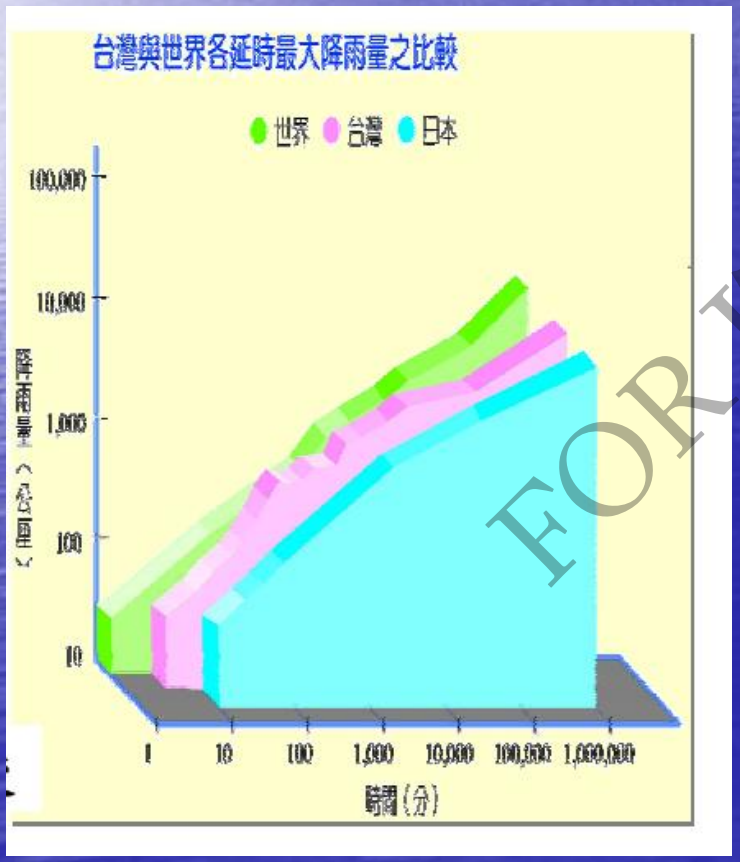
- Typhoon hits Taiwan about 3~5 times per year
- More than 10 times of torrential rain each year
- Billions of losses each year due to natural disasters

High Rainfall Intensity

- Annual Average Rainfall: 2500mm
  World Average: 973mm
- Highest Rainfall Intensity: 300mm/hour



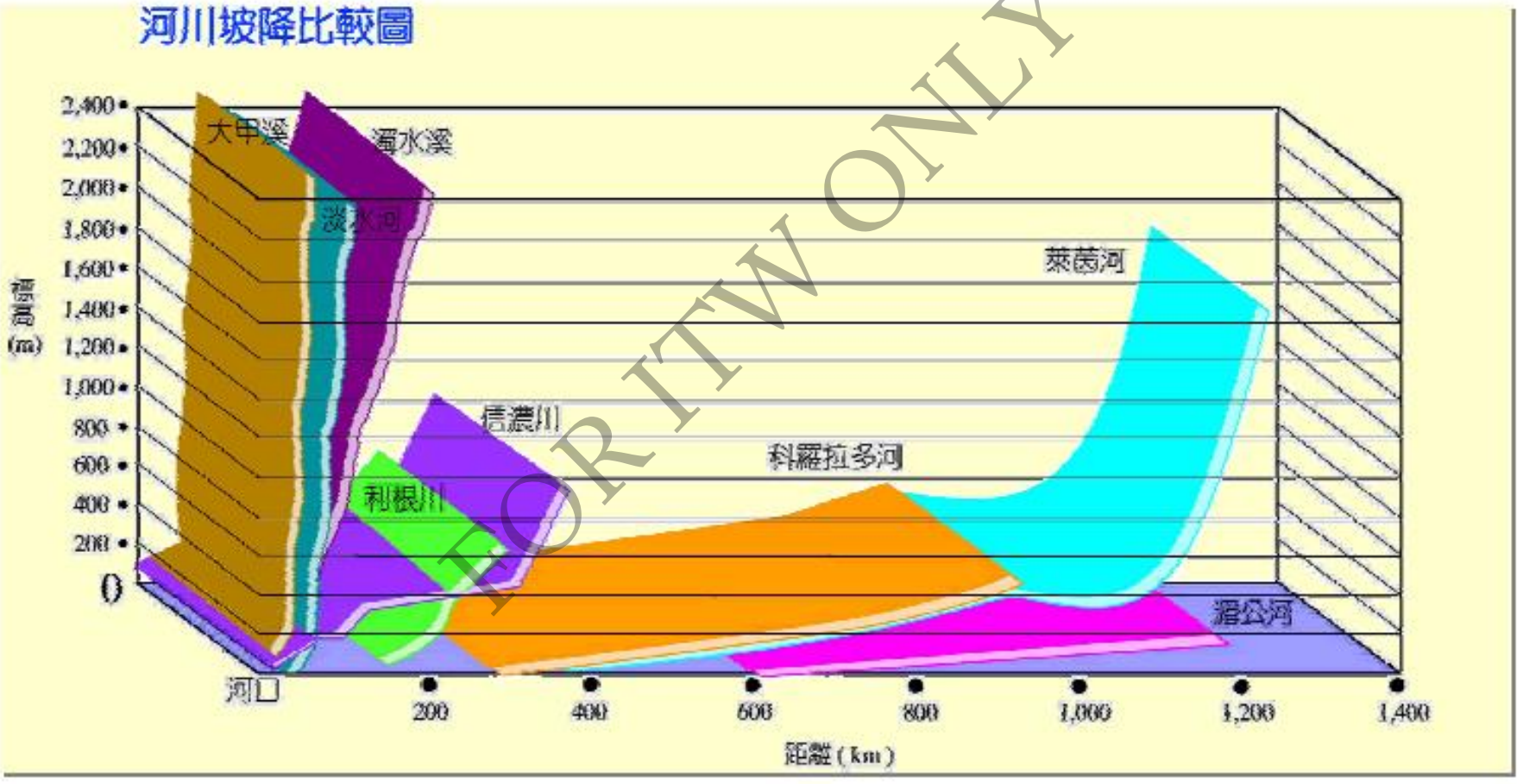
Amount for Rainfall with Different Durations



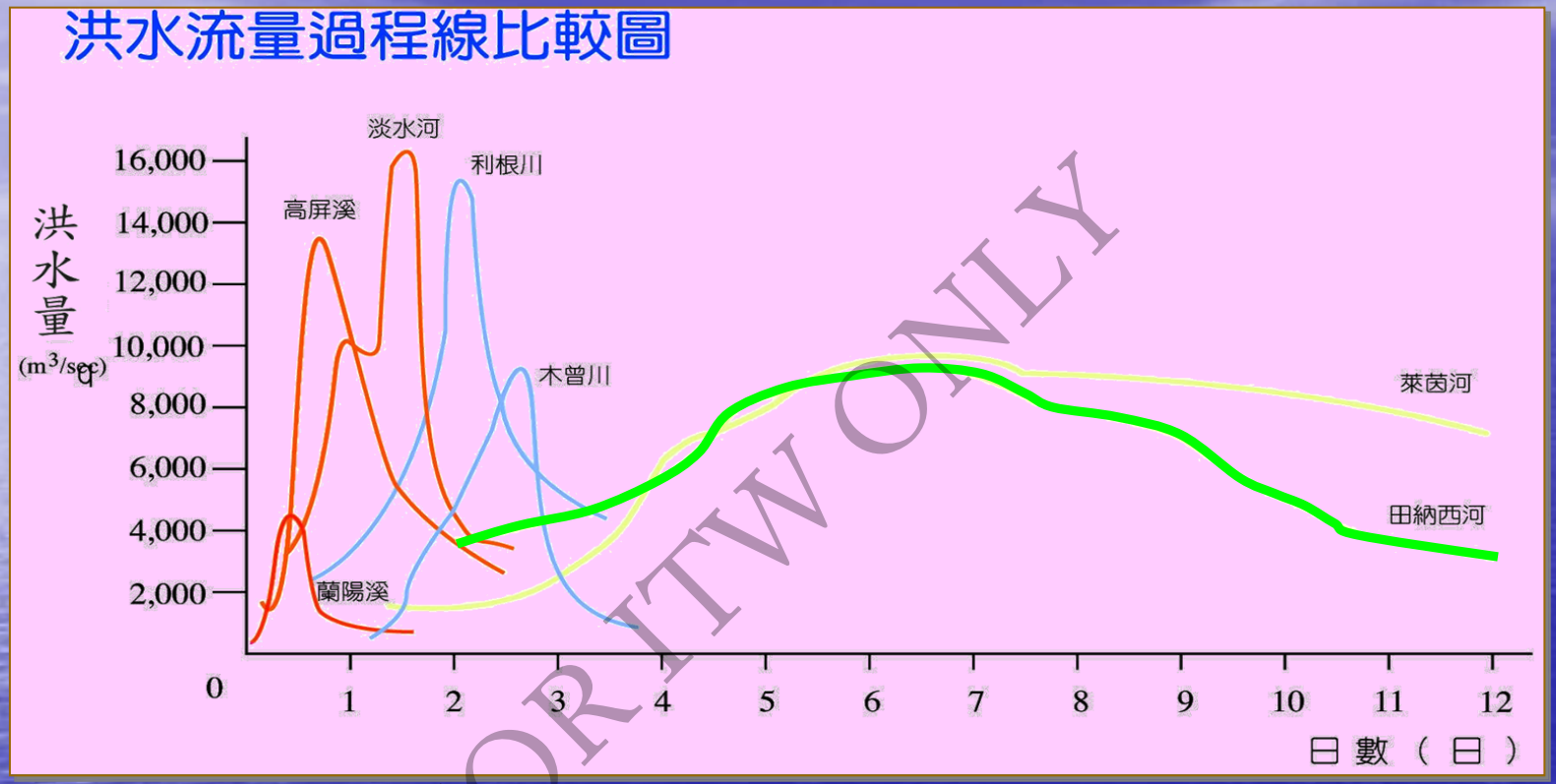
- Heaviest Rainfall in One Day: 1748mm (Typhoon Herb,1996)

Short River, Steep Slope, and Limited Basin Area

✓Only 6 rivers are longer than 100km

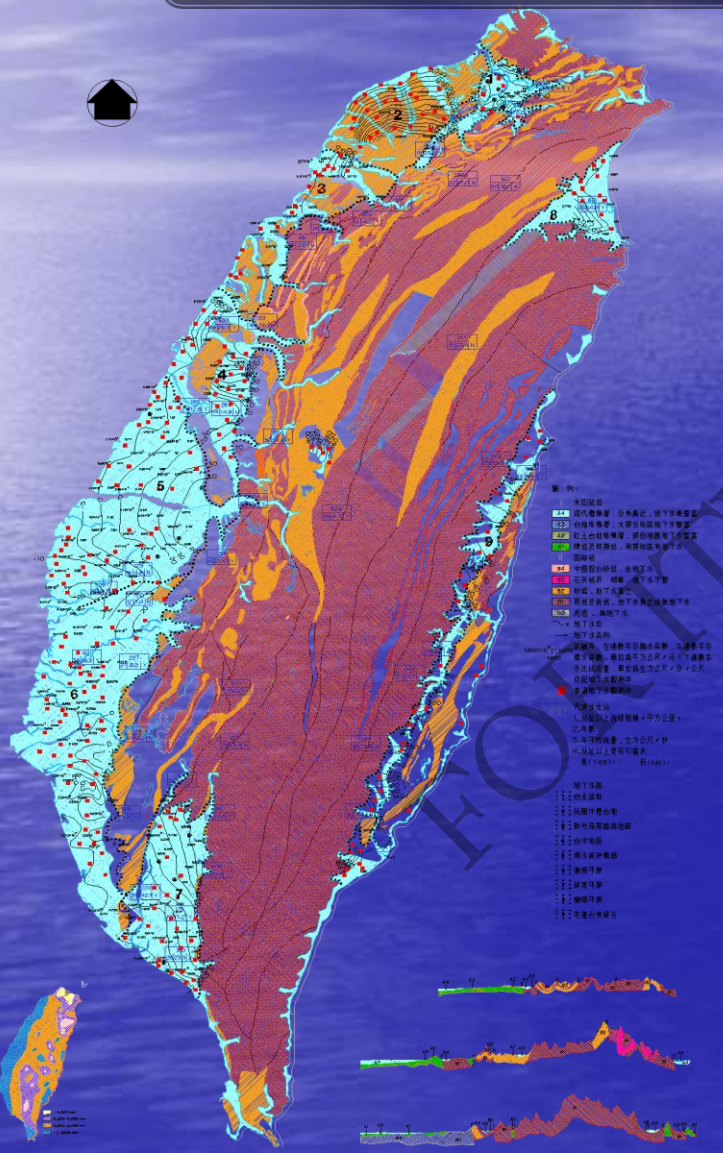


✓ Only 9 rivers have basin area larger than 1,000km^2



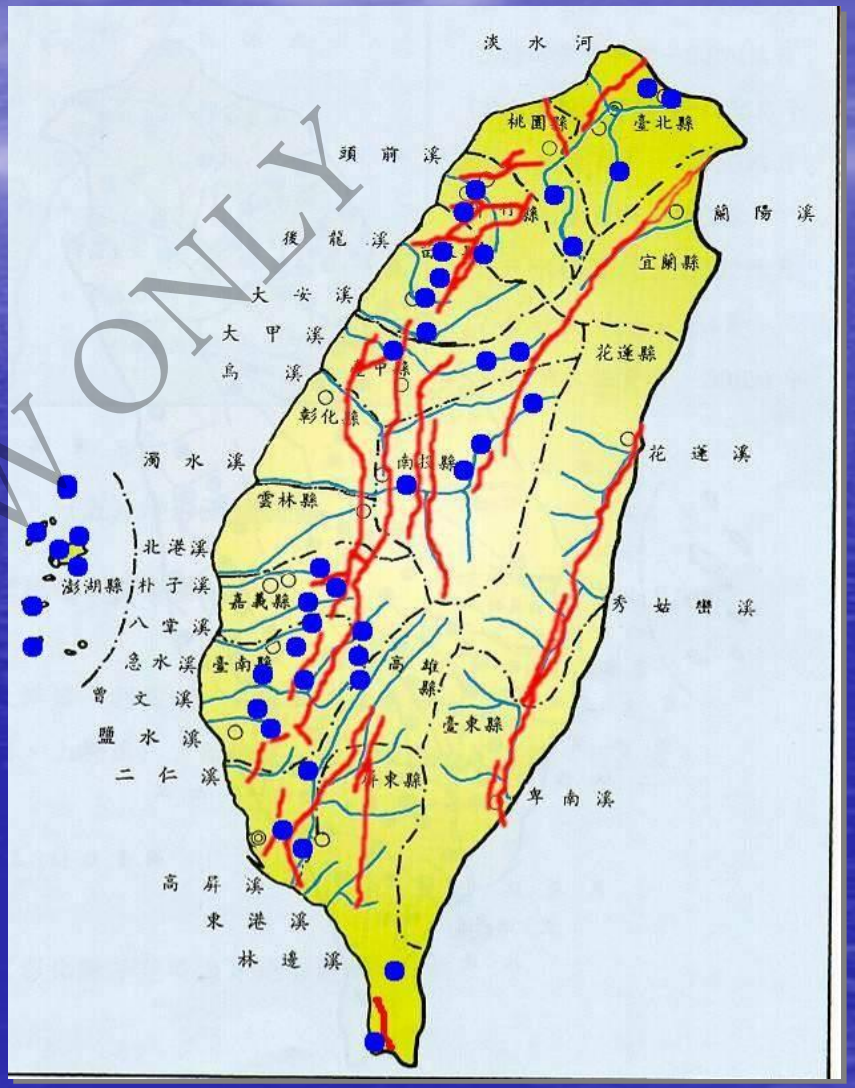
- ✓ Short flooding duration, it takes only 10~30 hours from normal to the peak discharge ; short flood recession period, ratio, specific discharge can be 33 sec*m^3/km^2
- ✓ Peak discharge rises and falls sharply

Fractural Geological Condition, Strong Erosion

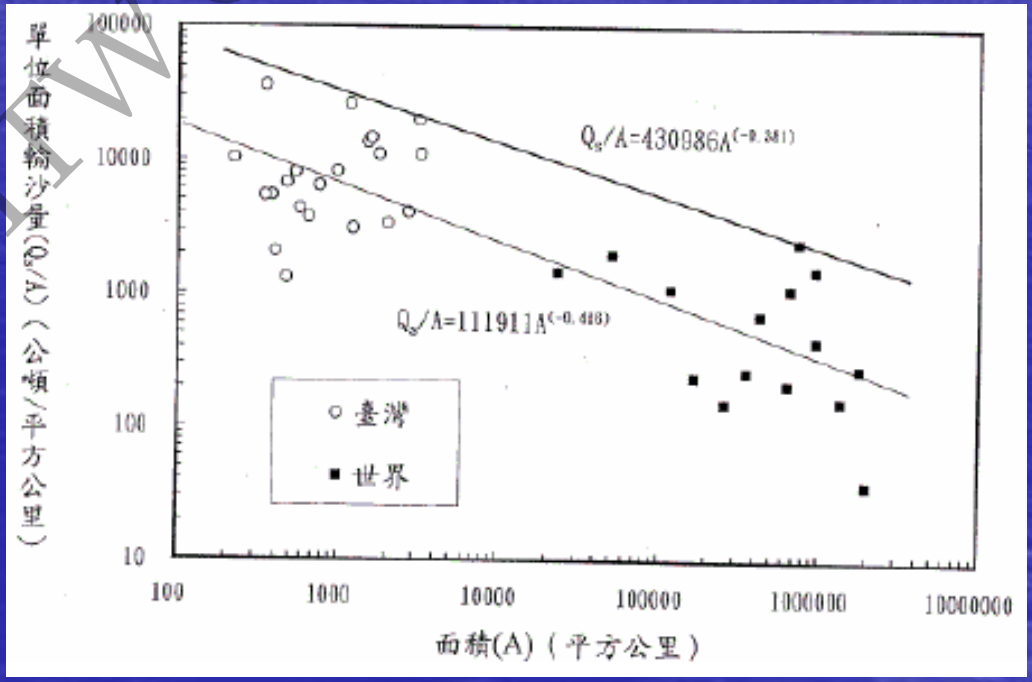


- Most of the mountains in Taiwan were formed by fragile, fractural, highly weathered sedimentary and metamorphic rocks.
- High rainfall intensity and flow velocity together resulted in severe erosions.

- **Frequent Earthquake and Many Faults**
  - Thousands of earthquakes per year
  - 51 fault zones densely distributed below the island
  - Hydraulic infrastructures have to be located above or near fault zones



- Rivers at Taiwan has a total amount of sediment transport about 323 million tons, sedimentation transport per unit area of about 10600/km^2, and average erosion depth of about 8.8mm.
- Many rivers in Taiwan not only have small catchment areas, their amount of sediment transport per unit area are also larger than the top one river in this world.
- Under the condition of same reservoir storage capacity and catchment area ratio, Taiwan is 10 times more likely to have sedimentation than Japan



- Steep mountain and hence limited storage capacity
- Poor geological condition at the catchment areas and high erosion ground surface causes sedimentation in reservoirs and makes river management more difficult.

Region		Annual Erosion (mm)
USA	Tennessee Valley	0.25
Taiwan	North	2-7
	Central	10-30

(With similar dam height, yet the storage capacity is differed by 24 and 170 times)

	Dam Height (m)	Storage Capacity (billion m3)
Three Gorges Dam, China	180	39.3
Shasta Dam, CA, USA	183	5.54
Techi Reservoir	175	0.232

Land Subsidence

桃園(資料起訖：86-95)
目前持續下陷面積：0 km^2
歷年累積最大下陷量：0.13m
95年最大年下陷速率：0.5cm/yr

台北(資料起訖：39-97)
目前持續下陷面積：0 km^2
歷年累積最大下陷量：2.11m
97年最大年下陷速率：0.6cm/yr

彰化(資料起訖：74-97)
目前持續下陷面積：213.65km^2
歷年累積最大下陷量：2.52m
97年最大年下陷速率：6.4cm/yr

宜蘭(資料起訖：73-96)
目前持續下陷面積：0 km^2
歷年累積最大下陷量：0.45m
96年最大年下陷速率：1.0cm/yr

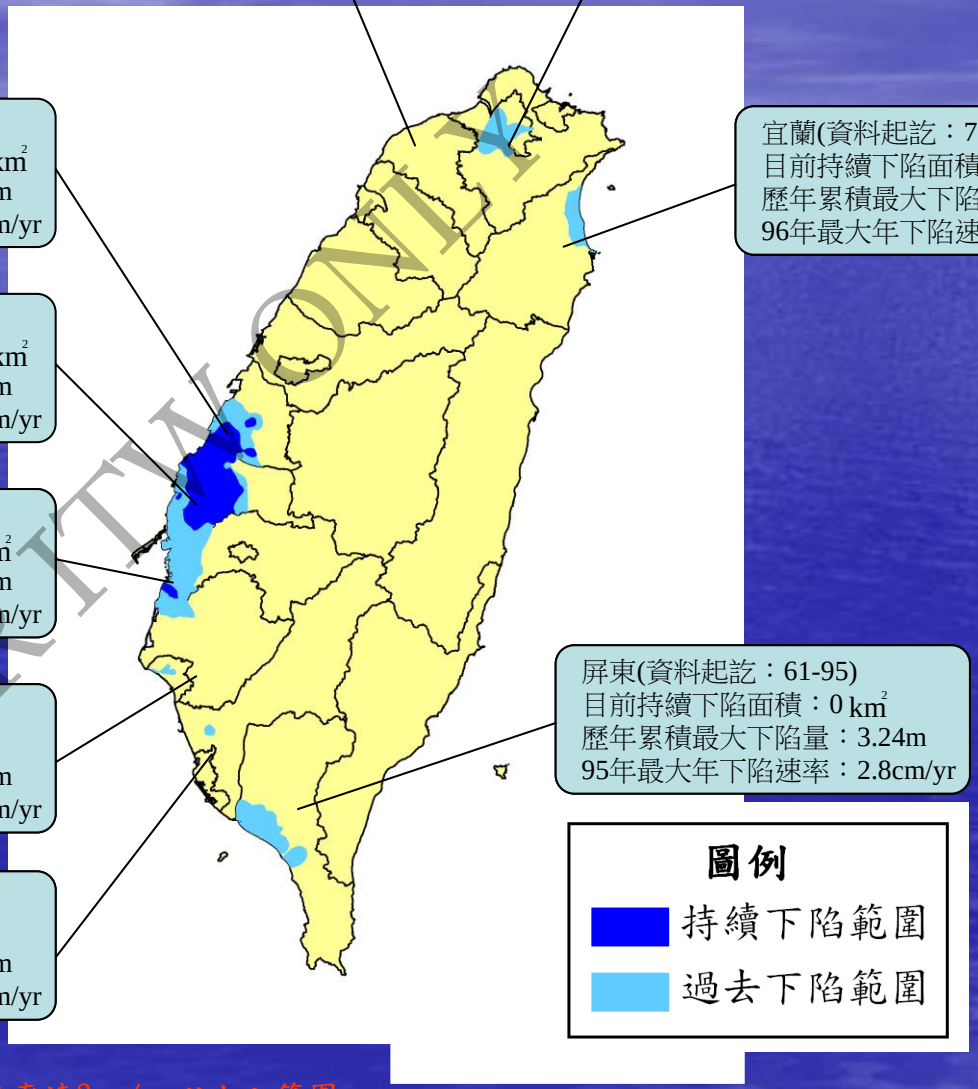
雲林(資料起訖：64-97)
目前持續下陷面積：580.72km^2
歷年累積最大下陷量：2.40m
97年最大年下陷速率：7.1cm/yr

嘉義(資料起訖：77-96)
目前持續下陷面積：26.1 km^2
歷年累積最大下陷量：1.39m
96年最大年下陷速率：3.8cm/yr

台南(資料起訖：76-96)
目前持續下陷面積：0 km^2
歷年累積最大下陷量：0.92m
96年最大年下陷速率：2.9cm/yr

屏東(資料起訖：61-95)
目前持續下陷面積：0 km^2
歷年累積最大下陷量：3.24m
95年最大年下陷速率：2.8cm/yr

高雄(資料起訖：76-95)
目前持續下陷面積：0 km^2
歷年累積最大下陷量：0.23m
95年最大年下陷速率：1.3cm/yr

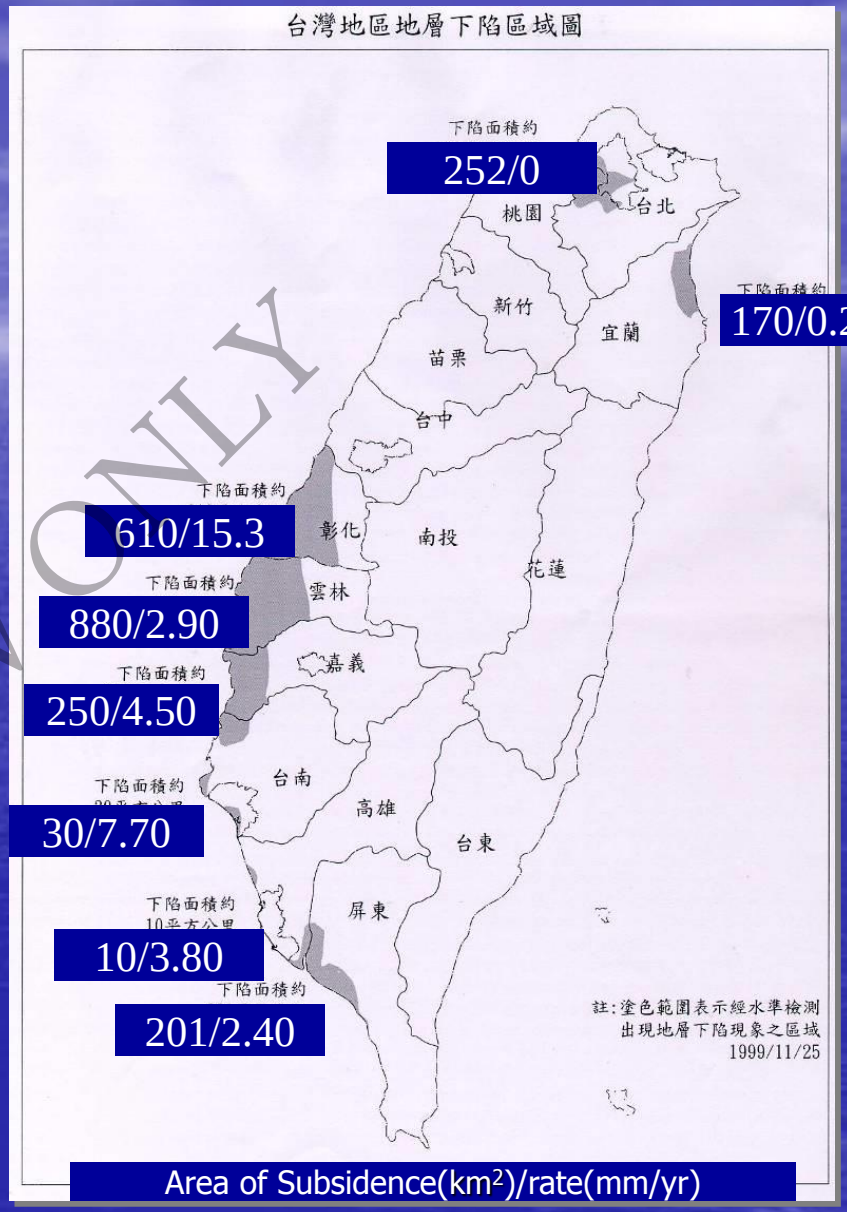


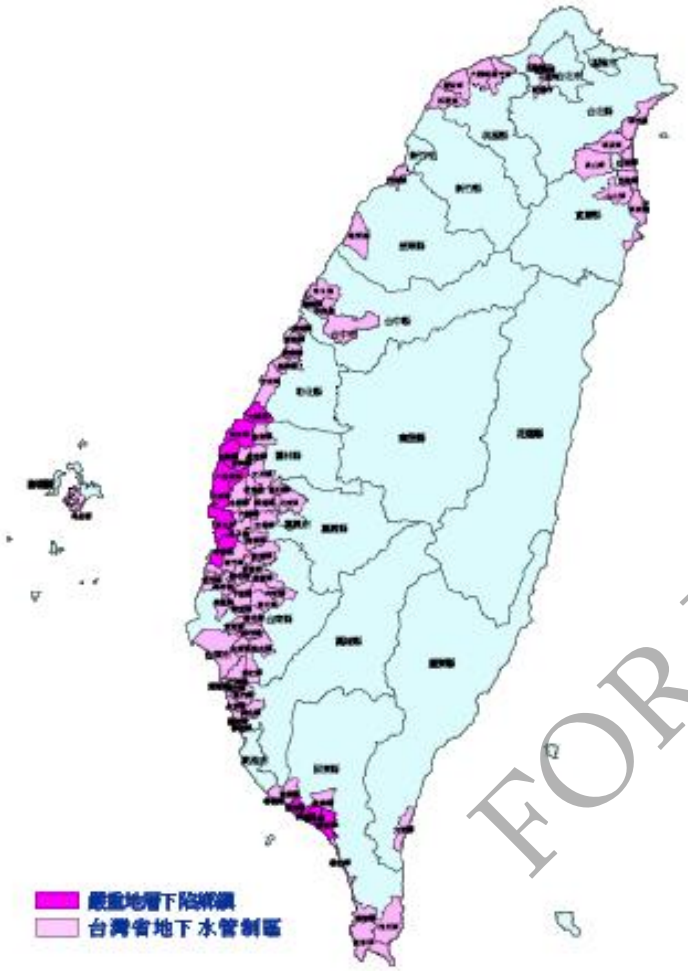
持續下陷面積：年下陷速率達3cm/yr以上之範圍

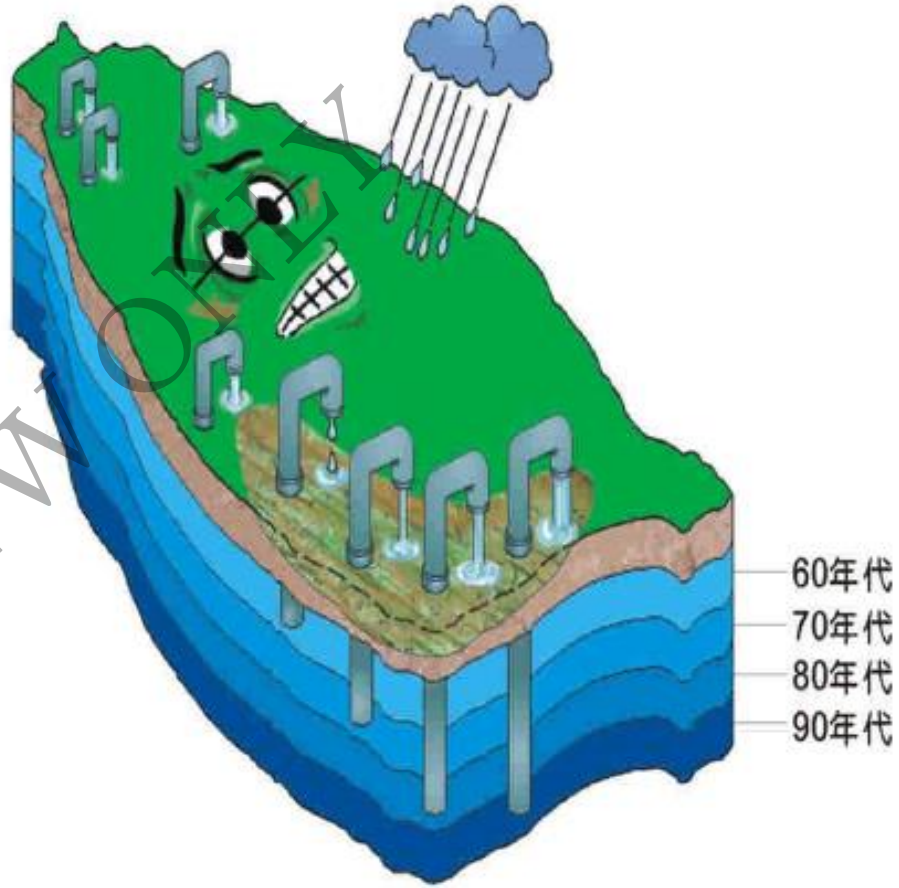
- Land Subsidence
  - Scale
    - South of Wu River to Southwest coast of Pingtung
    - Coastal area of Lanyang Plain
    - Taipei Basin

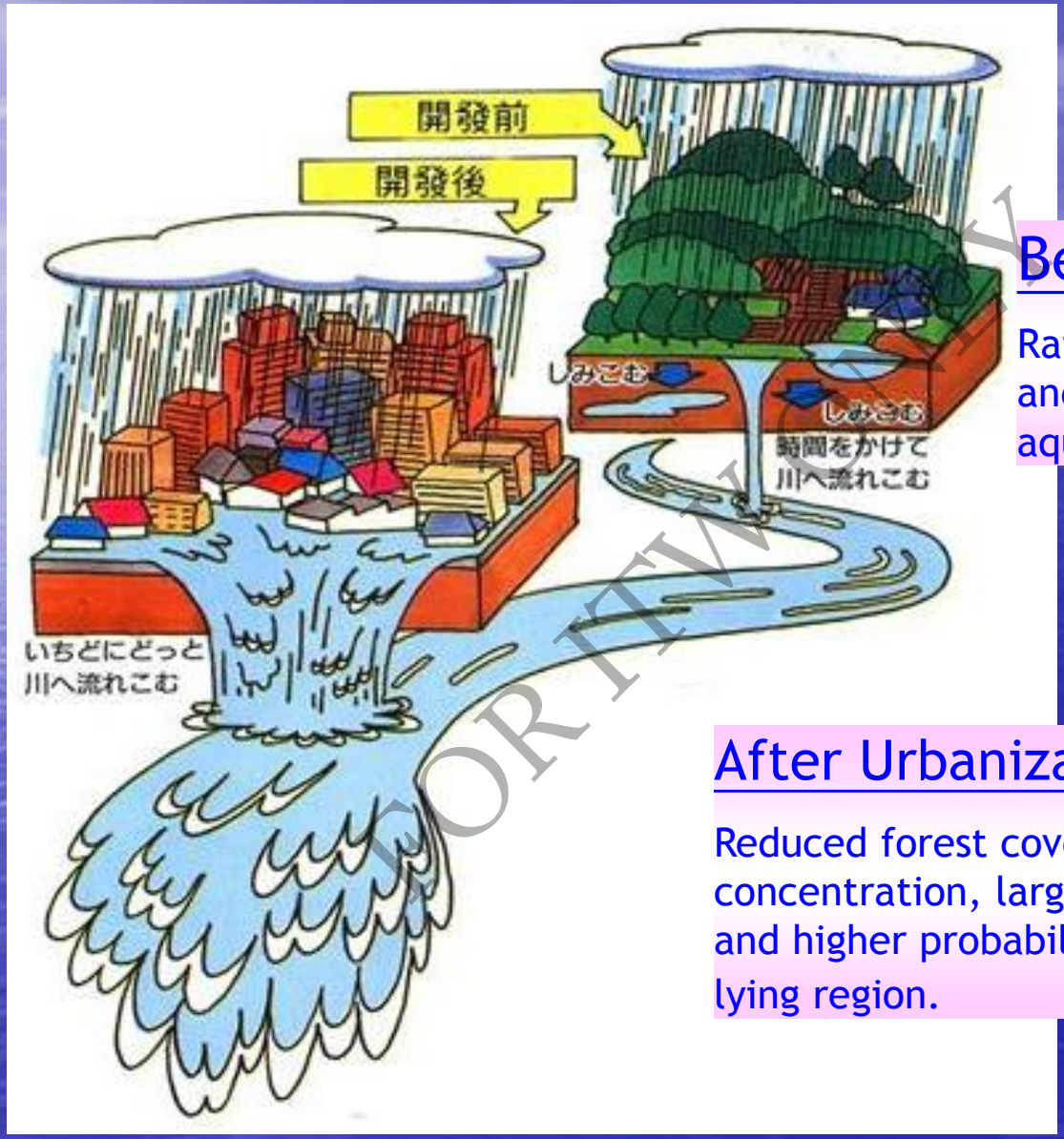
      (No more subsidence since 1995)
  - Severity
    - Areas over 2403km²

      (Almost 8.8 Taipei City)
    - 21.8% of flat land area
    - Persistent land subsidence area over 767 Km²









Before Urbanization

Rainfall seeps down into earth and becomes stored in the aquifers

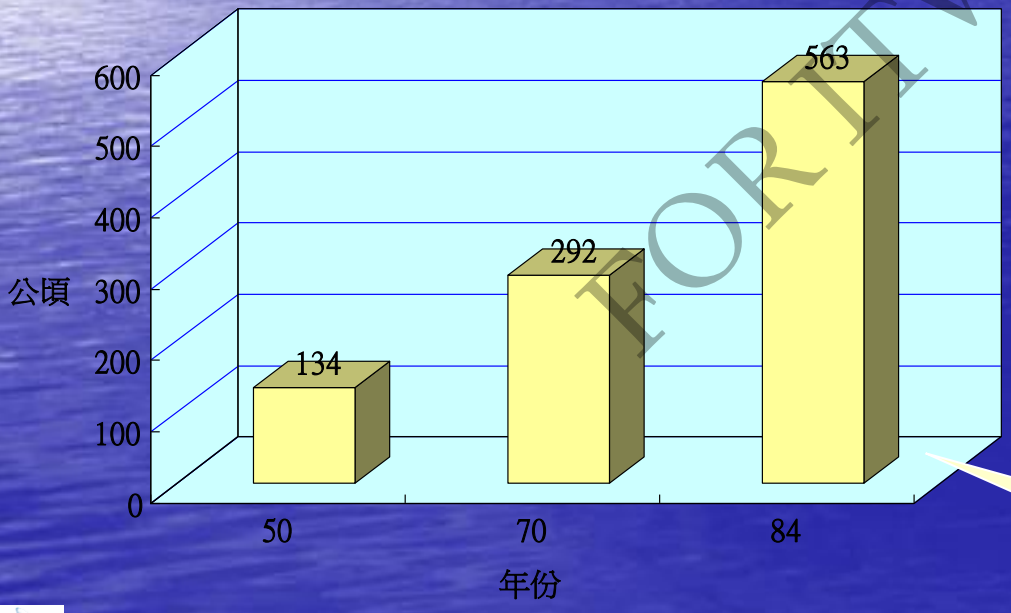
After Urbanization

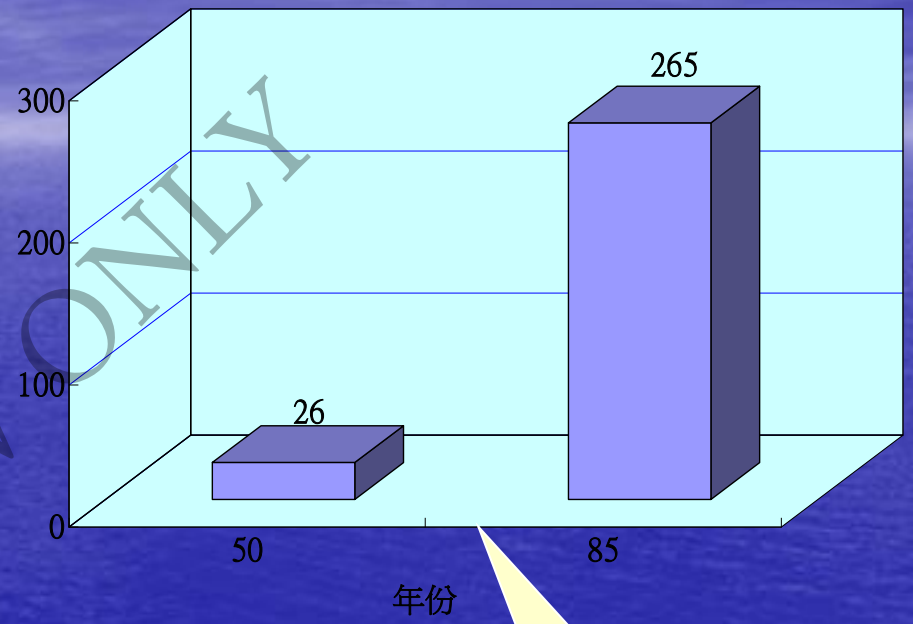
Reduced forest cover, shorter time of concentration, larger peak discharge, and higher probability to flood at low-lying region.

●Hsichih City

□ Development of Hsichih City (From 1961 to 1996)

- 4.2 increase in construction site areas
- 10 times increase in road areas





Road Area

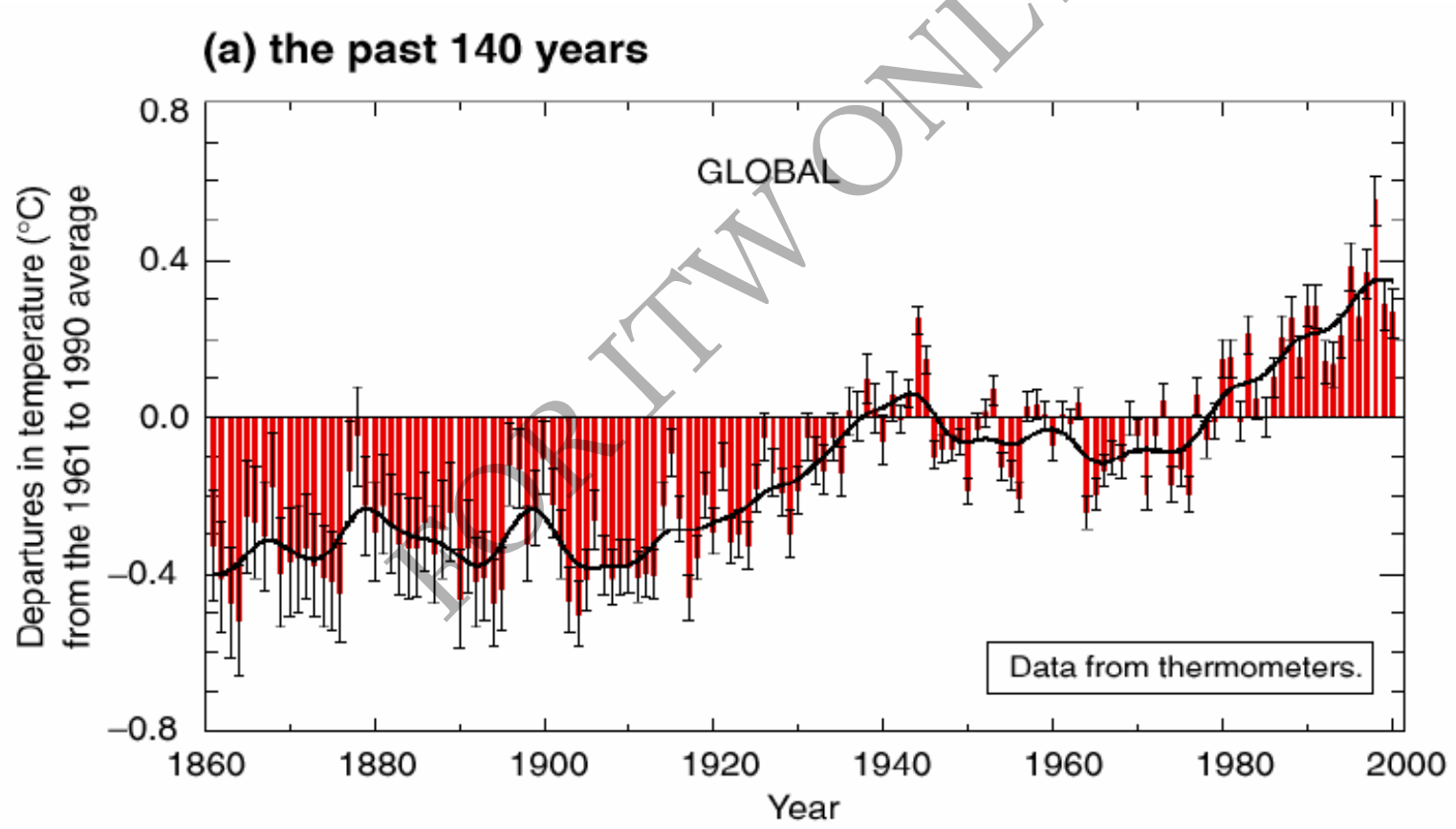
Construction Site Area

●Major Flood Event at Keelung River

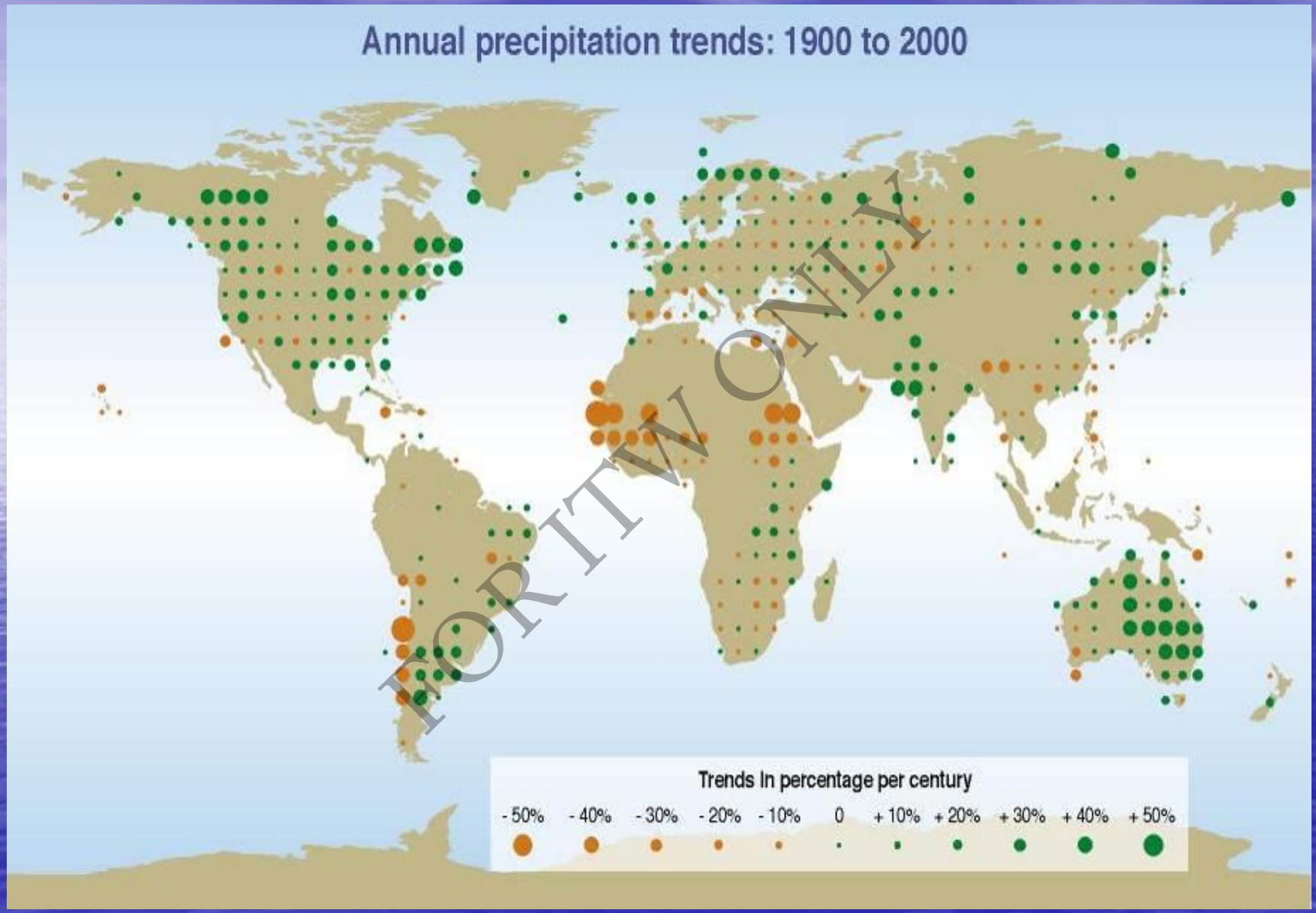
	Wu-du Area		Keelung River Basin	
	High Rainfall Intensity(mm/hr)	Highest Water Level(m)	Area of Flooding(ha)	Depth of Flooding(m)
Typhoon Lynn (1987.10.24)	79	16.92	916.4	7.5
Typhoon Zeb (1998.10.15)	57	16.02	345.0	0.5～4.0
Typhoon Babs (1998.10.25)	37	16.13	338.0	0.5～3.8
Typhoon Xangsane (2000.10.31)	49	17.98	553.0	0.5～7.5
Typhoon Nari (2001.09.17)	120	19.14	6,640.0	0.3～8.5
註：The highest value of Typhoon Lynn's depth of flooding is used in this table				

Climate Change and Global Warming

過去140年間大氣溫度之變化（以1960-1990年溫度為基準）



資料來源: IPCC, Climate Change 2001: The Scientific Basis, 2001


Annual precipitation trends: 1900 to 2000
Trends in percentage per century
- 50%
- 40%
- 30%
- 20%
- 10%
0
+ 10%
+ 20%
+ 30%
+ 40%
+ 50%

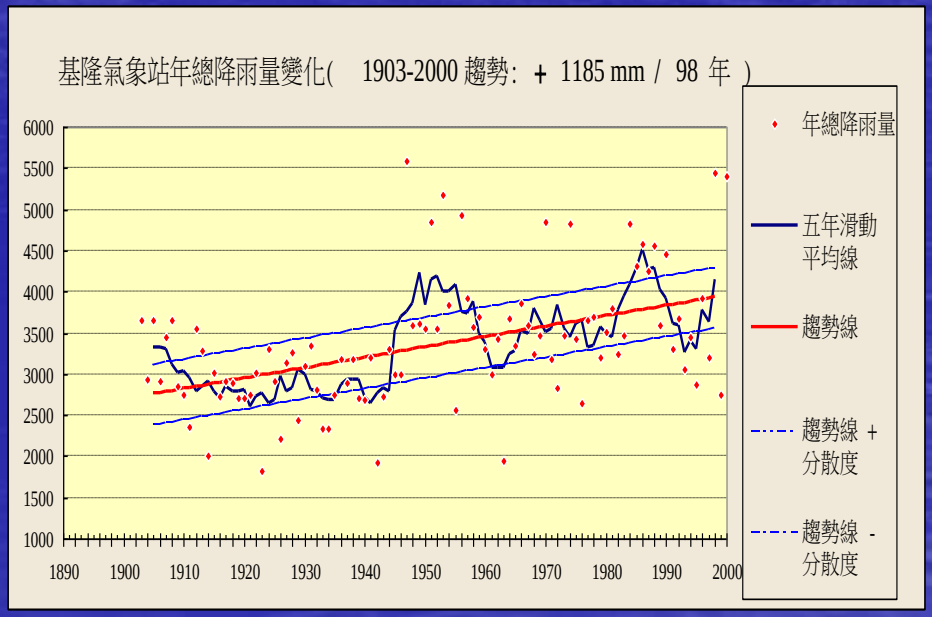
Greenhouse Effect→Global Warming→Rising Average Temperature in the Past 100 Years

In the past 100 years, average temperature in Taipei City increased 1.31℃, 1.11℃ in Taichung City, 1.39℃ in Tainan City. Such numbers are about twice as high compared to the estimation of UN-IPCC.

Changing Rainfall Pattern

→Statistics of Rainfall Collected in Keelung and Taipei Weather Stations in the Past 100 Years

- **Fewer Annual Raining Day**
  （Keelung-14.6 Days）
  （Taipei-27.8 Days）
- **More Annual Rainfall**
  （Keelung+1185mm）
  （Taipei+268mm）



III. Our Flood Management History

- Flood Management Approaches in Different Phases
- Traditional and Comprehensive Flood Management
- Changing Flood Management Ideologies
- Current Comprehensive Management Projects

Flood Management Approaches in Different Phases

High Flow Regulation	1945-1960	➢Scattered projects, use local and natural materials ➢Use soft and simple engineering method, low safety standard ➢Can blend in with surrounding environment
High Flow Regulation	1960-1990	➢Systematic management, Integrated planning for all major rivers ➢Higher standard for flood prevention, public safety, and structure maintenance; using solid Structures ➢Impedes ecological cycles, negative images to the public
Low Flow Regulation Ecological Engineering	1990-2002	➢Low-flow regulation, upland environment building ➢Investigation of river ecology, habitat rehabilitation, conservation, and river conditions
Management of River Environment & Comprehensive Flood Management	2001-Present	➢Flood disasters usually occur at the up- and mid-stream areas of the basin, integrated management is thus necessary ➢Article 27 in Regulations on River Management in 2000: Authority should draft plans for managing river environment based on land development at the local areas, land and water resources, eco-environment, natural settings of the river and other previous river project

Changing Flood Management Ideologies

Transformation in Flood Control and Management Roles

Early Years

- Construction
- Flood Prevention and Mitigation

Primarily Engineering Solution

1999.02

River Management

Both Engineering and Management

Recent Years

Greenification

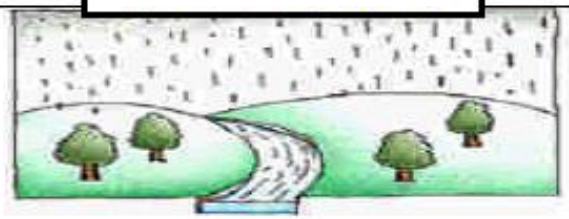
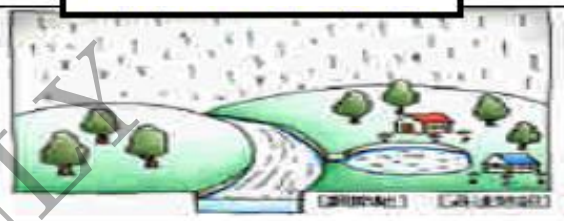
Make Water Space More Accessible to the Public

Present

- Eco-environment
- Water Purification

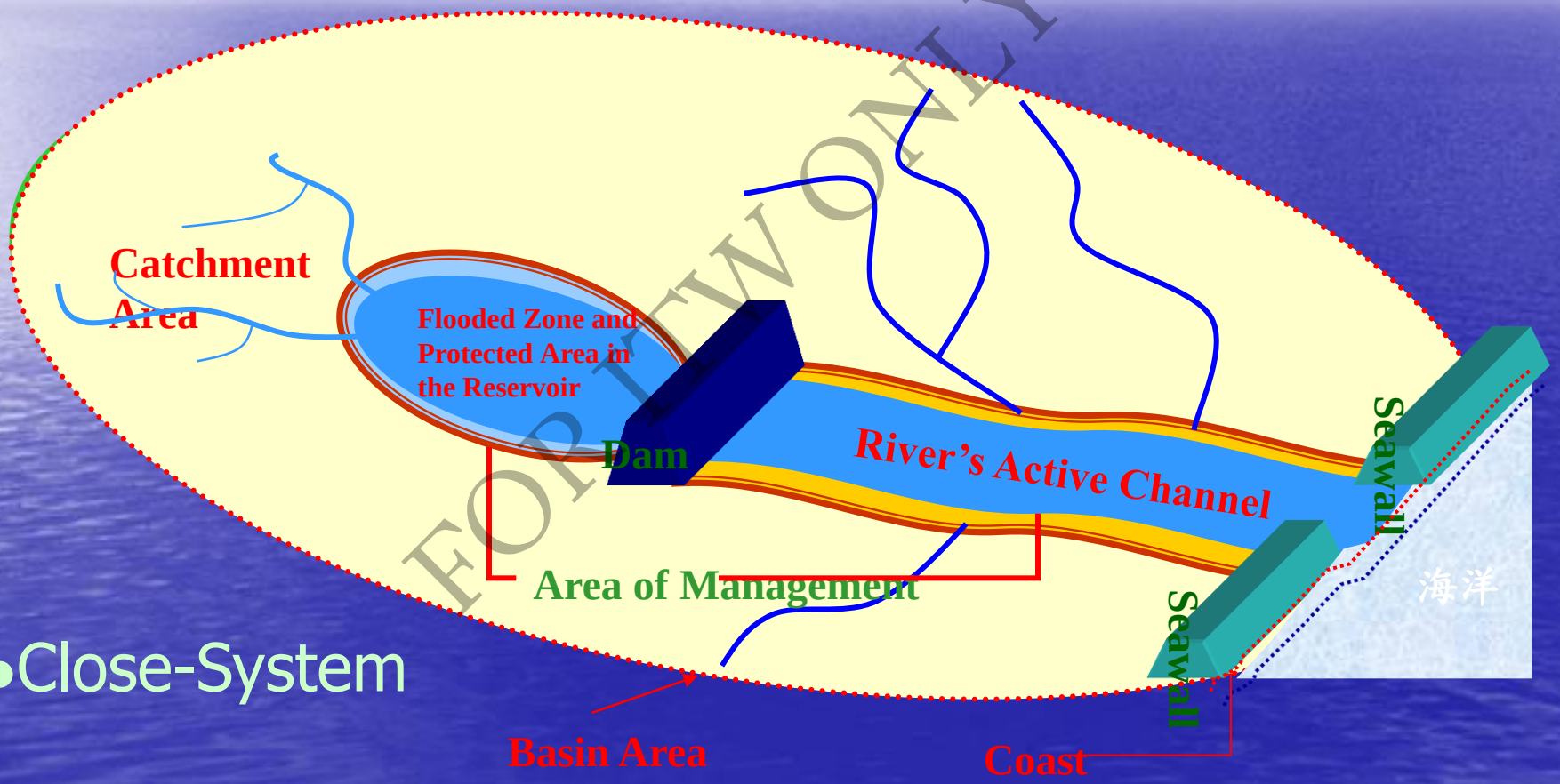
Sustainable Development

Traditional and Comprehensive Flood Management

	Traditional	New
上游	 Rain goes straight into the River	 Increase seepage, reduce runoff
中游	 Widening river channel to lower water level	 Detain, retain, diverge flood to lower water level
下游	 Confine (external) and drain (internal) flood	 Flood control in the entire basin to reduce the over risks

Traditional Basin Management

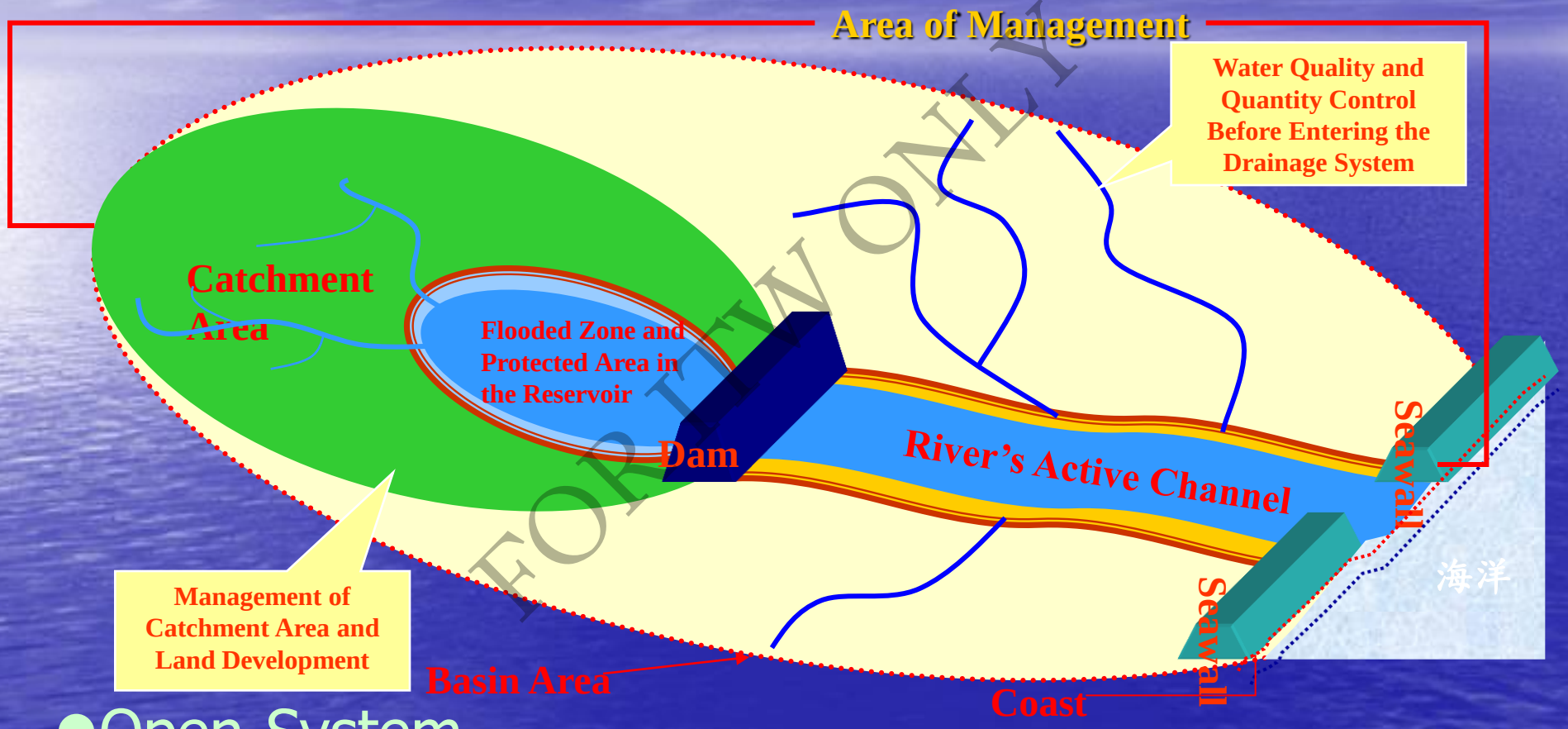
Concerns: Only River Channel and Storage Area within the Reservoir



- Close-System

Improved Basin Management

Concerns: Water, Soil, Forest and Everything within the Basin Area



- Open-System

Current Comprehensive Management Projects

1. Regulation Project of Flood-Prone Areas
2. Land Restoration Strategic Program and Action Plan
3. Land Subsidence Prevention and Treatment Implementation Program

IV. Current Measures

Strategy

Structural

- **Channeling and Confining Flood** — dikes, embankments, dredging
- **Improvement of Regional Drainage** —rebuild and improve drainage canals due to their insufficient cross-sectional area
- **Retention and Detention pond** —detention(Retention) ponds are set up for inside water level which cannot be lowered
- **Flood Diversion** —using channels to divide and diverge the flood to lower the outside water level
- **Improvement of Sewer System and Irrigation Ditches** —making flood-prone areas more flood-proof

Non-Structural

- Restrictions on Land Development
- Restrictions on Total Amount of Drainage
- Flood Warning and Prevention Measures
- Public Awareness Campaigns
- Securing Green Space and Increase Ground Seepage
- Flood Insurance

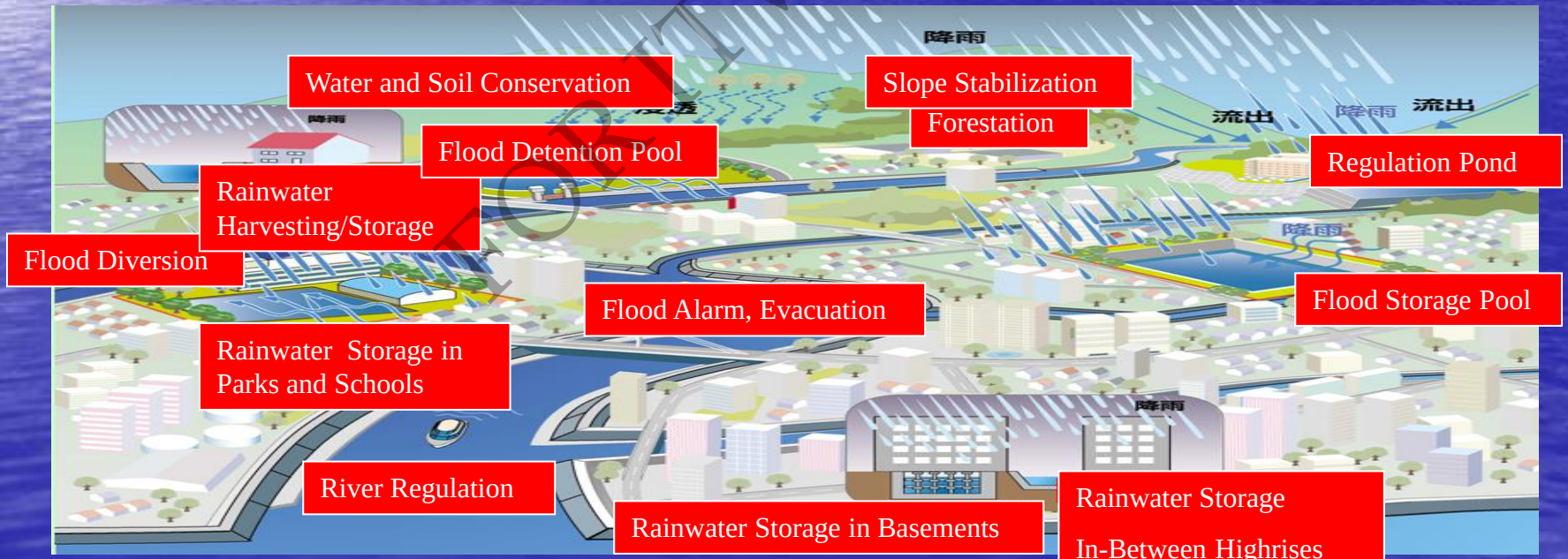
IV. Current Measures

Comprehensive Management in River Basin

- Highland Areas → Control Outflow → Water Storage and Conservation
- Urban Areas → Storm Drain and Flood Prevention
- Lowland Area → Flood Mitigation, Retention, and Discharge

Measures

- Measures
  - Structural
    - Flood Storage (or Routing)
    - Flood Diversion (or Mitigation)
    - Flood Channeling
  - Non-Structural
    - Flood Prevention (or Confinement)
    - Flood Avoiding



Structural Measures

Structural Measures represent structures and projects of every sort which controls flood, utilizes water resources, and securing water and eco-environment.

They also include the control of all land and water resources, management and regulation of sediments and soils, preservation of eco-environment and other structural engineering projects.

- Dikes
- Embankment
- T-Shaped Dam
- Bed Protection/Weir
- Regulation of River Channel
- Flood Storage/ Routing
- Flood Diversion Project
- Environment Building
- Ecological Engineering
- Other Engineering Projects

Dikes

- ✓ Water-Blocking Structures Along Rivers, Canals, Lakes and Coasts or at the skirt of cultivation, or, flood passage and diversion zones.
- ✓ The most widely used and most important flood prevention measure

Wufong Dike at Wu River

Concrete Cobbles

Fengyuan Dike at Wu River

Cobbles

New Dike at Huwei River

Concrete

Downstream of Neigou River

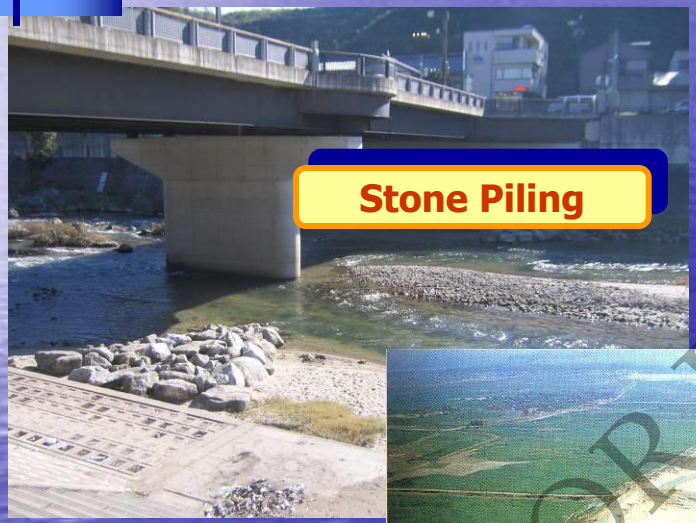
Concrete Wall for Flood Prevention

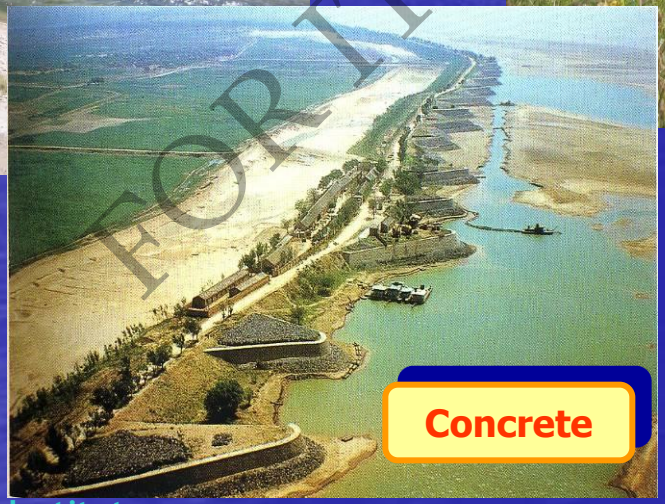
Embankment

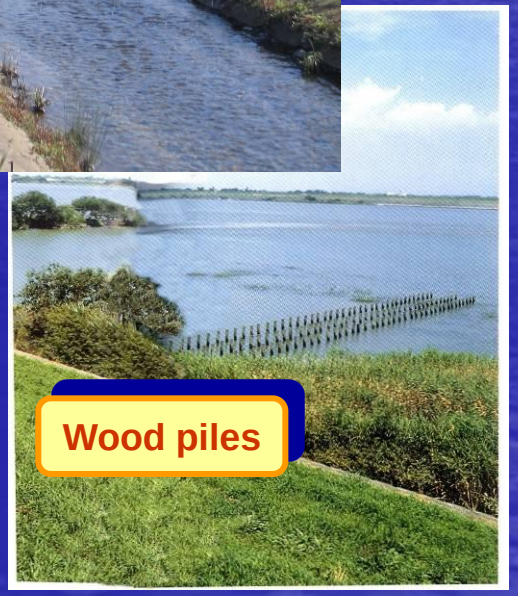
- ✓ To prevent dikes or river banks from the impacts and erosions of currents, wind, waves and other forces
- ✓ It can be categorized as dike embankments, low flow embankments, and high flow embankments.

T-Shaped Dam

- ✓ A type of regulating structure which extends from the land into the river and forms a 'T' shape with the shoreline.
- ✓ It can narrow river bed, guide water back to the channel, adjust flow direction, scour shallow beach, and direct soil and sand, protect river banks and achieve other regulation objectives.







- Bed Protection / Weir

✓ Cross-river structures which stabilize and flatten bed slope, maintain bed height, decelerate flow velocity, and reduce bed scouring.

Chanelization/ River Regulation

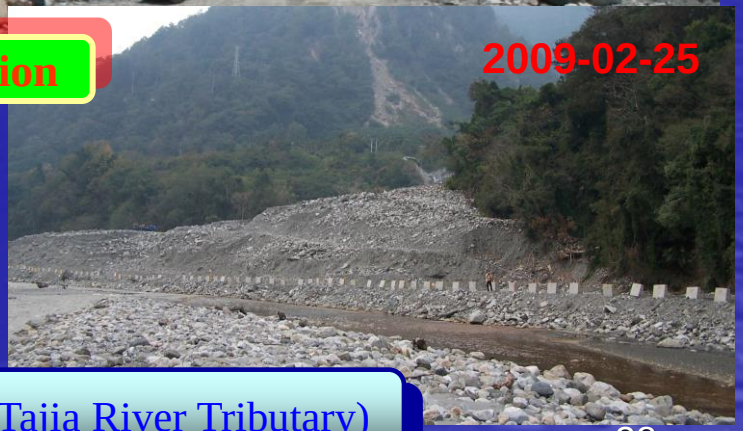
Before Chanlization

Landslide

Landslide

River Chanel Regulation

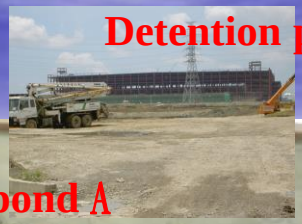
After Chanlization



(Apang River--- Tajia River Tributary)

Flood Storage/Routing Projects


Detention pond E1


Detention pond C


Detention pond E2


Detention pond F

Detention pond A

Detention pond D

Detention pond B

(Detention ponds in Tainan Science Industrial Park)

Multi-objective reservoirs primarily responsible for flood prevention, then irrigation, and public water supply

(Akongdian Reservoir)

➢Flood Diversion Project

✓ River weir and diversion weir can effectively control the amount of flood being diverted and lower the discharge intensity and avoid bottleneck at the main channel.

(Yuanshanzih Flood Diversion Project)

➢Environment Building --- Spatial Planning for People-Friendly Water Space

Greenfication of River Dikes

➢Environment Building --- Create Eco-Friendly Water Space

Establish Habitat using Deep Pond and Shallow Shore

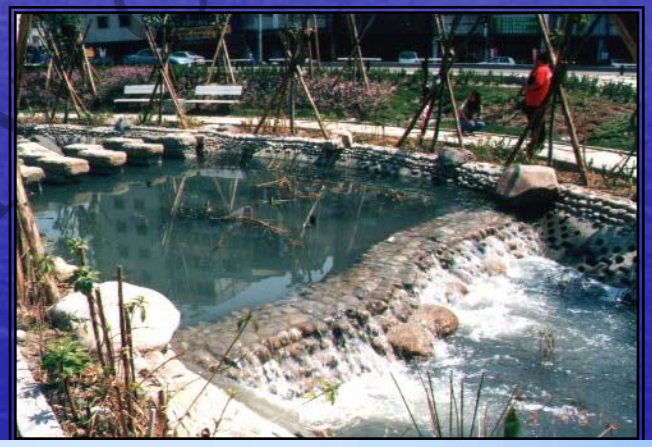
Securing Mangrove At the Estuary

Securing Natural River Meandering

Fish Way

Ecological Engineering—Restoring River Channel Ecology

- Protect the river bed
- Boards with pre-designed holes allows the growth of aquatic plants
- Water quality could be purified through the aquatic plants
- Replenish urban ground water through permeable river bed boards



武洛溪

➢Ecological Engineering- Slope Stablization Using Deep-Rooted Plants

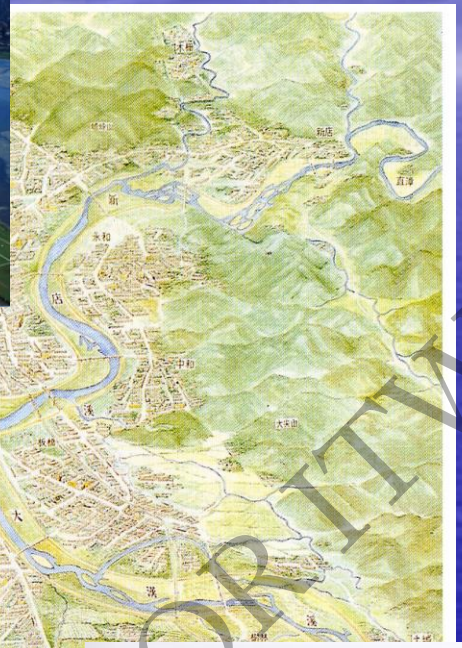
Original River Bank Status

Nature-Mimicking working method (after simulation)

(Fa-Zi River as an example of the landscape planning and design)

Other Structural Measures

Diversion Channel



(Erchong Floodway of Tamsui River)

Water Gate

(Wu-Du Section of Keelung River)

Pumping Station

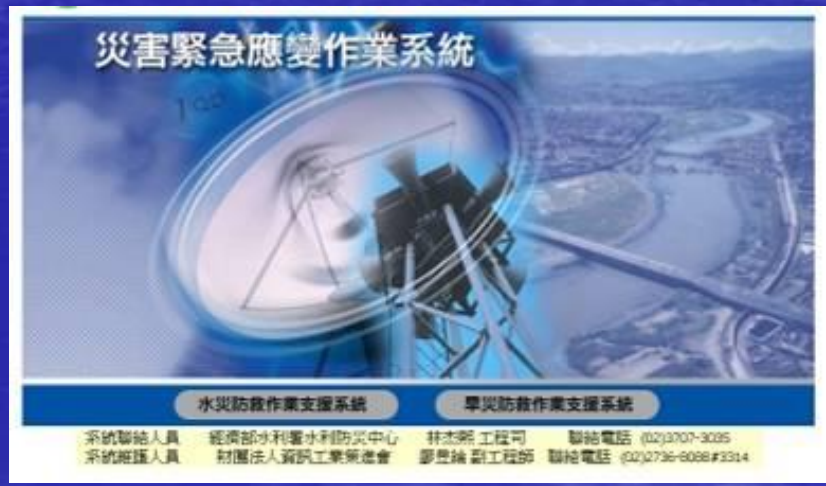
(ChungHsin Pumping Station of Keelung river)

Ground Elevation

(Tainan Science Park)

Non-structural Measures

- Flood Zone Management
- Flood Forecast and Warning System
- Flood Disaster Prevention
- Establishing Shelters
- Pumping Station Operational Management
- Interconnecting Pumping Stations for Backup System
- Flood Insurance
- Making and Promoting Potential Inundation Maps



V. Case Studies

- Integrated Basin Management of Keelung River
- Drainage of Dacheng Area in Changhua County
- Drainage of Southern Yunlin Coastal Area
- Drianage of Southern Chiayi Coastal Area
- Drainage of Yan-shuei River and Ta-chou in Tainan
- Environment Building of Han River

經濟部

Case 1

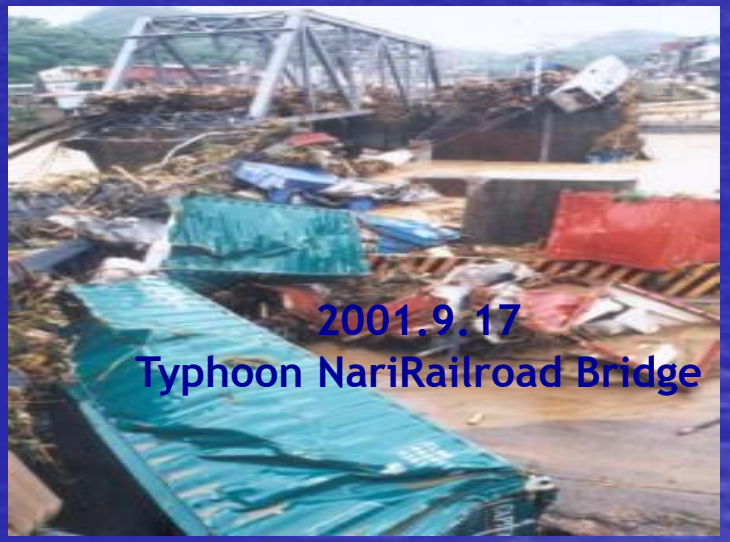
Integrated Basin Management of Keelung River

（Cities and Flood Disasters）

經濟部水利署

WATER RESOURCES AGENCY

- **Frequent flooding along the Keelung River is evident in the aftermath of Typhoon Lynn, Zeb, Babs, Xangsane, and Nari. Thus the Central Government is determined to mitigate flood disasters by instructing the Executive Yuan to prioritize projects that require the least investment, yield the highest outputs, and cause the least environmental impacts. By the use of structural and non-structural measures, the government hopes to protect riparian zones against typhoons and flood as strong and devastating as Typhoon Nari.**



Causes of Disasters at the Basin

Geological Conditions

- Keelung River originates from Pingsi Township in Taipei County, gently meanders across a narrow river valley and has unique hydrological conditions; it flows across low-lying land and has a long tidal reach.
- Drainages are divided into many short branches, yet the flow is normally fast, thus poor efficiency in letting water out.
- Keelung River was not part of the earleierTaipei Flood Prevention Project, cities have already developed and established along the river, thus widening the river is challenging.
- Too many bottlenecks and the bridge pier column in the river, water is blocked and improvement is hard to achieve.

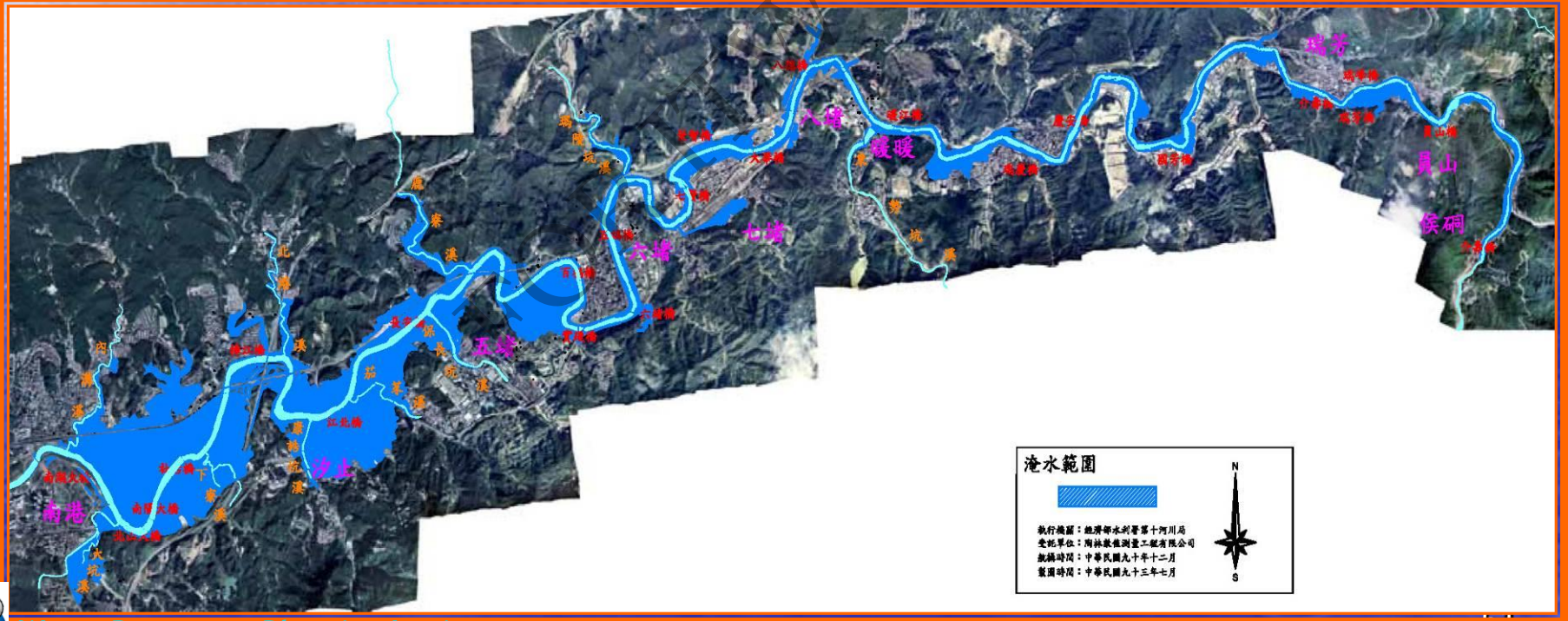
Hydrological Conditions

- Annual rainfall upstream is significant and concentrated. Humid climate implies long raining days and slow project progress.
- Annual runoff is significant and concentrated, high flow velocity make discharging the floodwater difficult.

Flooding

★If the promulgated 200-year return period flood occurs, flood area is about 991.37 hectares.

★Major flooding Hsichih, Nankang,Cidu and Neihu regions, (only partial flooding at upstream region of Bridge Cisian, major flooding will occur in downstream area).



Integrated Management of Keelung River Project

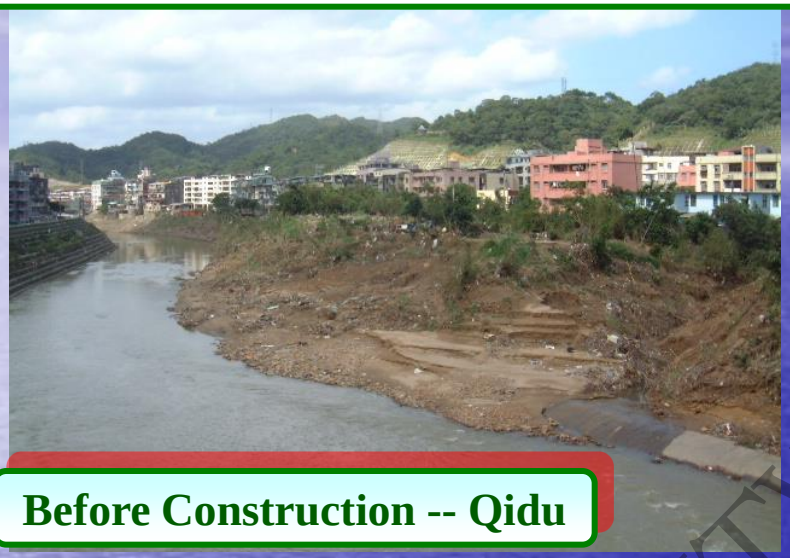
Preliminary (2002.7-2005.12)

- ★Yuan-shan-tsu Diversion Tunnel
- ★Sectional Embankment in Flood Control Zone
- ★Project for Tributaries and Drainage Behind Dikes
- ★Pumping Station and Water Routing Works
- ★Bridge Improvement Works
- ★Conservation Project (Management of Catchment Areas)
- ★Yuanshan Bottleneck Improvement Works
- ★Other Projects
- ★Flood Forecasting and Flood Warning Systems

Post-Project

Before preliminary Projects is completed, initiate assessment of the project, then funding will be allocated accordingly.

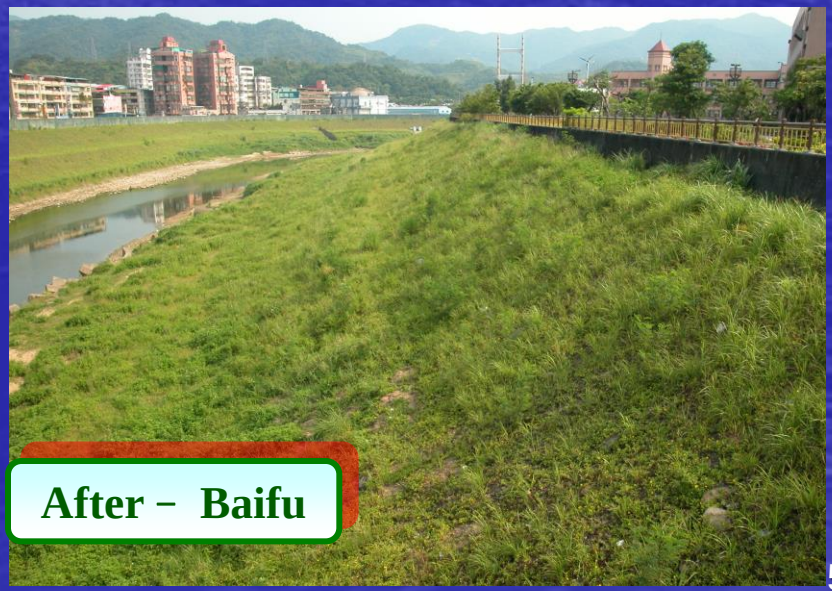
Results-Sectional Embankment in Flood Control Zone



Before Construction -- Qidu

Before Construction --- Baifu

After -- Qidu



After – Baifu

Results-Sectional Embankment in Flood Control Zone

During Construction -- Guogang

Before Construction -- Qiaodong

After --Guogang

After Construction -- Qiaodong

Results-Sectional Embankment in Flood Control Zone

Before Construction -- Qiaodong

Sidewalk

Before Construction -- Beishan

After Construction -- Qiaodong

After Construction -- Beishan

Results-Sectional Embankment in Flood Control Zone

Parks

Qiaodong Scenic Park

Shuifanjiao Ecology Park

Qiaodong Scenic Park

Shuifanjiao Ecology Park

Results-Implementation of the main branches

2nd Bidding of Kanghao River

Midstream Xiangzhang river

Upstream Qietung River

Tunghe Pumping Station in Ruifang

Results-Implementation of the main branches

Baxiho River

Malingkeng River

Chunghsiao Pumping Station

Chunghsin Pumping Station

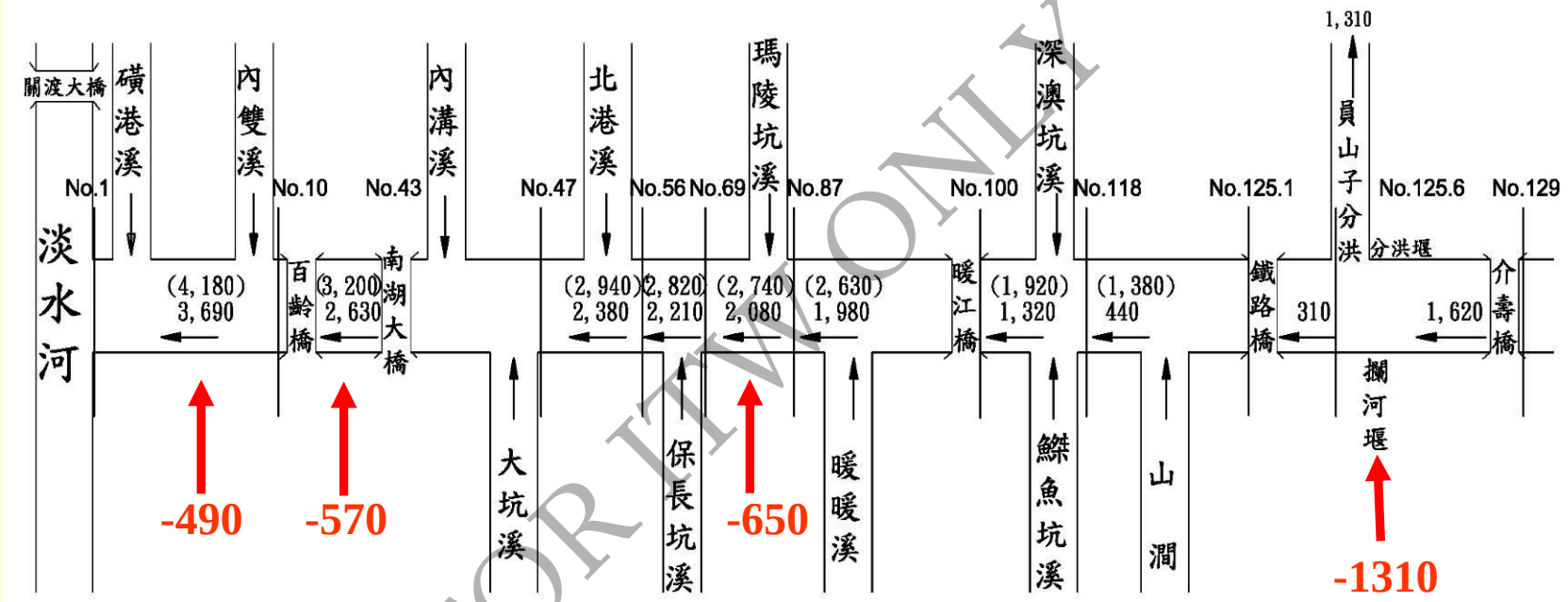
Yuan-shan-tsu Flood Diversion Channel Water Intake

Ruifang Township, Taipei County

Seaside Highway No. 2 -Taipei County

Yuan-shan-tsu Flood Diversion Channel Water Outlet

Performance at Flood Mitigation



Performance

- **Yuanshanzih Diversion can diverge 1310cms of discharge at max, Wudu Station can mitigate 650 cms, Nanhu Bridge can mitigate 570cms，Guandu can mitigate 490 cms。**

Benefits of Lower Flood Level

Name of Bridge (Cross Section No.)	Difference After the Project	
	Lowered Water Level (m)	Average Water Level(m)
Chungshan Bridge~Nanhu Bridge (16~43.1)	-0.44 ~ -0.95	-0.76
Nanhu Bridge~Interchange Bridge(43 ~ 55.8)	-3.43 ~ -0.63	-2.14
Interchange Bridge~Chungshan Overpass (55.8 ~ 73.2)	-4.08 ~ -1.78	-3.66
Chungshan Overpass ~Wudu Bridge (73.2 ~ 80)	-4.40 ~ -3.99	-4.19
Wudu Bridge~Chongzhi Bridge (80 ~ 92)	-4.25 ~ -3.11	-3.53
Chongzhi Bridge~Badu Bridge (92 ~ 98.3)	-3.88 ~ -2.86	-3.35
Badu Bridge~Qingan Bridge (98.3 ~ 108.2)	-3.66 ~ -1.67	-2.67
Qingan Bridge~Rueifang Bridge (108.2 ~ 120.2)	-2.51 ~ -1.05	-1.82
Rueifang Bridge~Railroad Bridge (120.2 ~ 125.4)	-4.22 ~ -0.98	-2.62

Note: If consider only Yuanshanzih flood diversion, the the average water level is lowered 1.5m

Historical Records of Flood Diversion

	Year	Name of Tyhpoon	PeakDiversion (CMS)	Total Diversion (thousand M3)
Emergency Diversion	2004	09.11 Torrential Rain	200	970
		10.25 Nock-ten	600	4420
		12.03 Nanmadol	450	7390
Normal Diversion	2005	07.18 Haitang	211	3300
		08.04 Matsa	78	2290
		08.31 Talim	382	13620
		10.02 Longwang	115	530
	2006	09.10 Torrential Rain	140	2120
	2007	06.15 Torrential Rain	35	100
		09.18 Wipha	76	1050
		10.06 Krosa	636	16130
		11.26 Mitag	91	2500
	2008	07.28 Fung-wong	75	970
		09.12 Sinlaku	247	10650
		09.27 Jangmi	351	9030
15 Diversions in total				75,070

Case 2

Drainage of Da-Cheng Area in Changhua County

（Drainage Problem in the Area with the Highest Land Subsidence Rate）

Case 2

Drainage of Da-Cheng Area in Changhua County

The Drainage Problem

Clam aquaculture industry requires large amount clean water; people have been pumping groundwater for supply and caused land subsidence in the past years. Over years, drainage using gravity is no longer feasible. The potential risks for flooding is increasing each year.

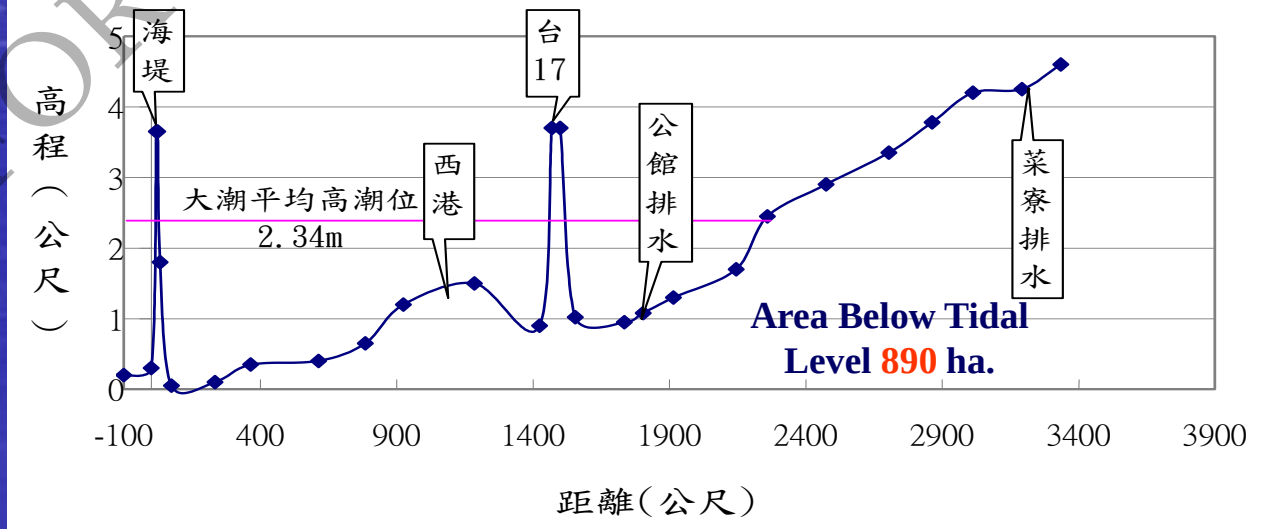
Case 2

Drainage of Da-Cheng Area in Changhua County

Catchment Conditions

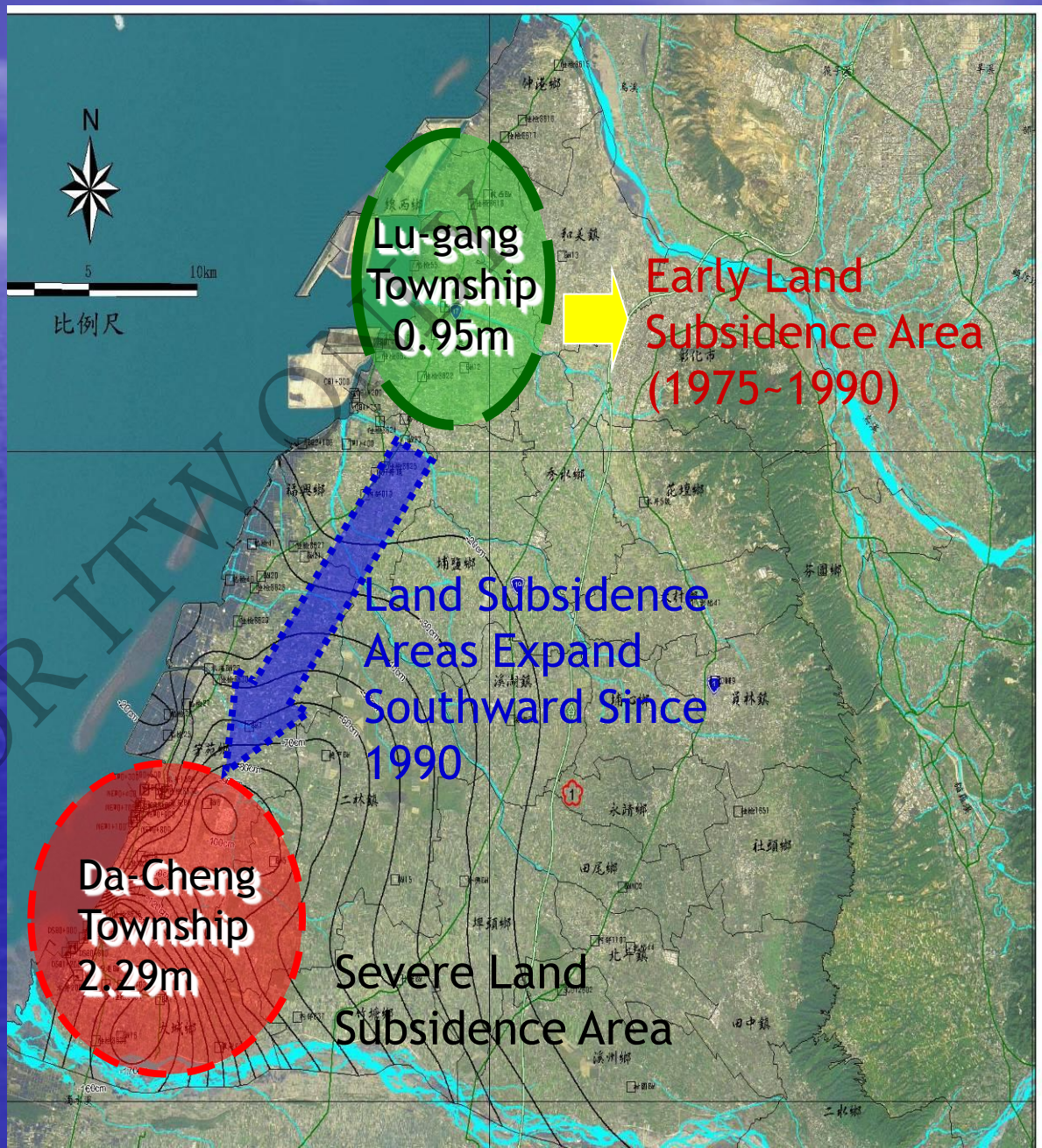
- Land is slanted from east to west
- Average slope is 1/850
- Lowest Elevation 0.2m
- Costal Areas are mostly low-lying land and have poor drainage conditions

圖3-2大城沿海地區地表高度東西向剖面圖(A-A)



Land Subsidence

Before 1990, land subsidence happened mainly in Lu-gang Township area; however, after that year, land subsidence area gradually moves to Da-Cheng Township, causing an average of 14-cm land subsidence between 1992 to 2004.



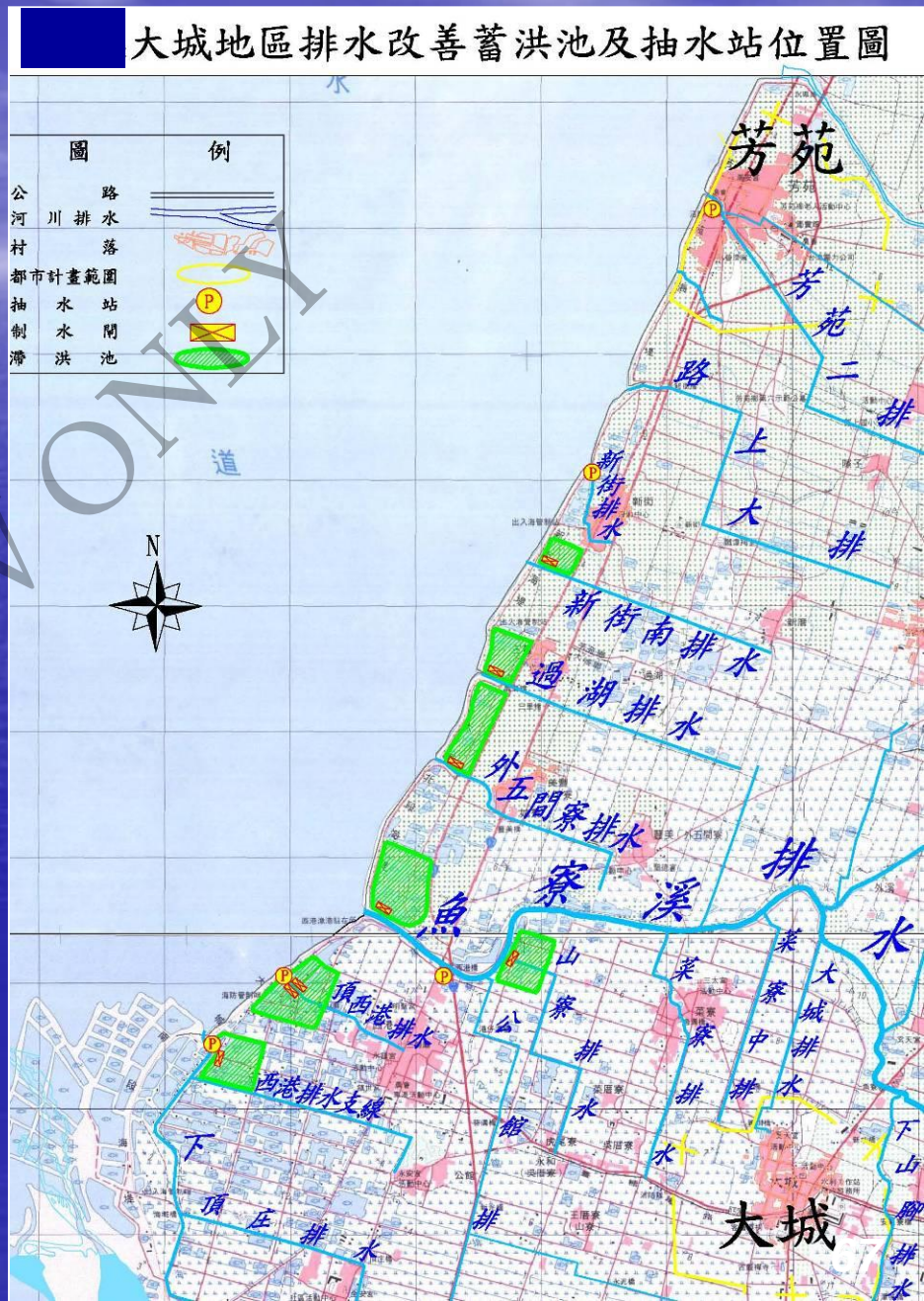
Case 2

Drainage of Da-Cheng Area in Changhua County

◆Disaster Mitigation Mesures

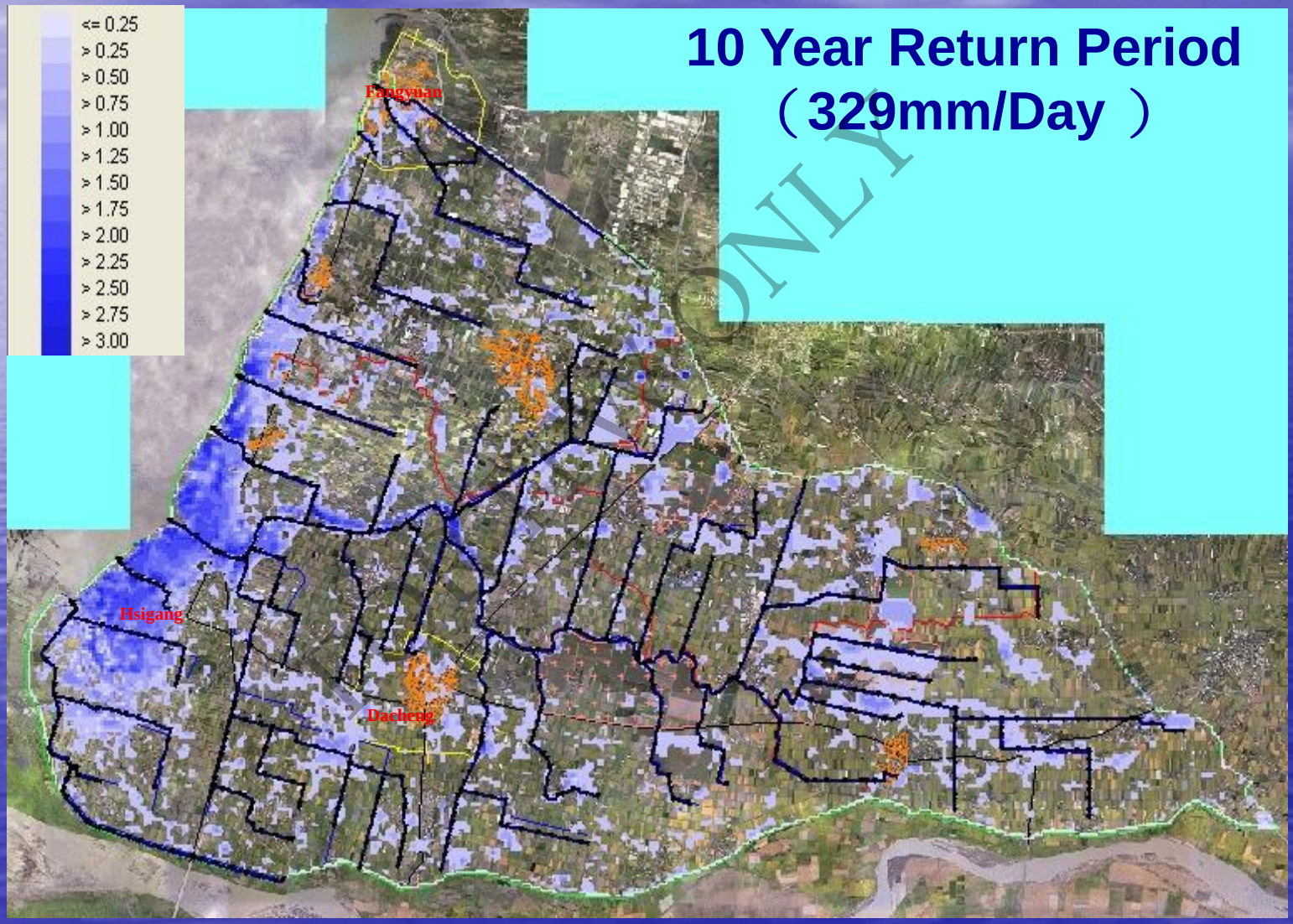
Improve Drainage Waterway＋Pumping Station＋Flood Detention in Low Land

In those areas that have their waterway improved yet still experience flood disasters, pumping stations and detention ponds were installed. Detention ponds take 94 hectares and stores 2.68 million m^3 of water; they can used for clam aquaculture, detain flood, reduce overpumping groundwater, and slow down land subsidence.



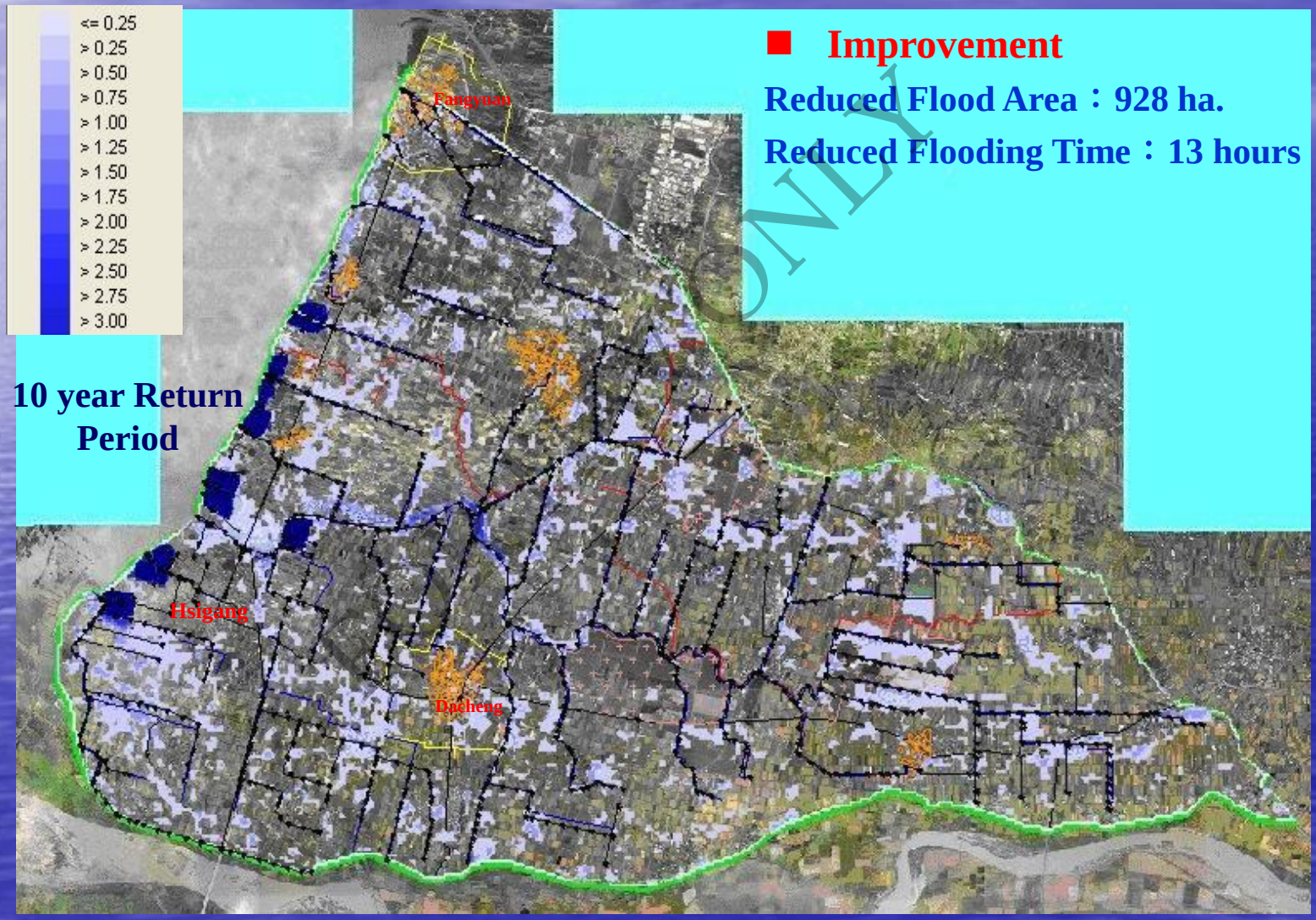
Case 2

Drainage of Da-Cheng Area in Changhua County



10 Year Return Period （329mm/Day ）

Improve Drainage Waterway＋Pumping Station＋Flood Detention in Low Land --Area after Improvement



經濟部

Case 3

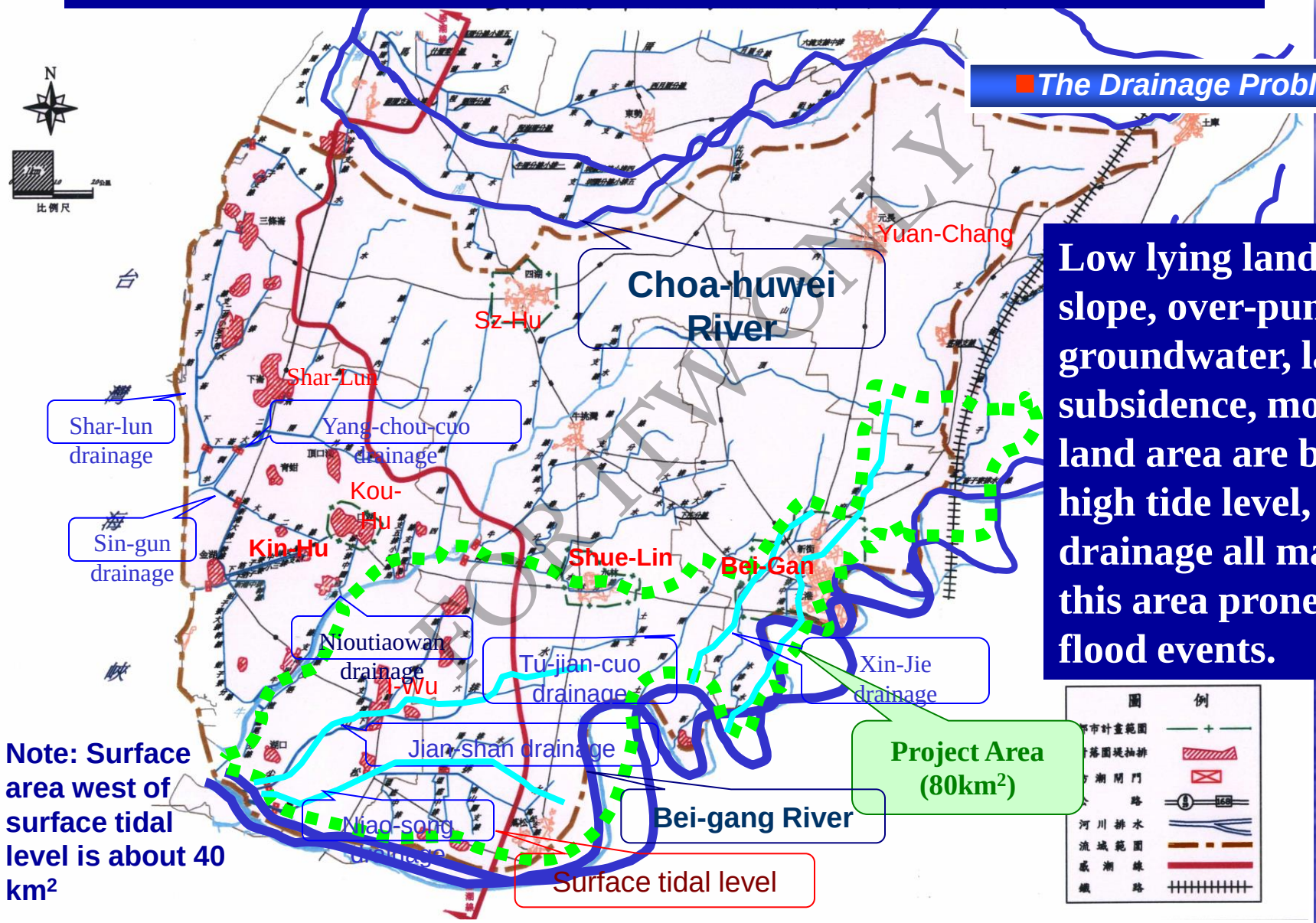
Drainage of Southern Yunlin Costal Areas

(Mitigation of Land Subsidence and the Plan of National Land Reclamation)

經濟部水利署

WATER RESOURCES AGENCY

Regional Drainage Map of Southern Yunlin Coastal Area

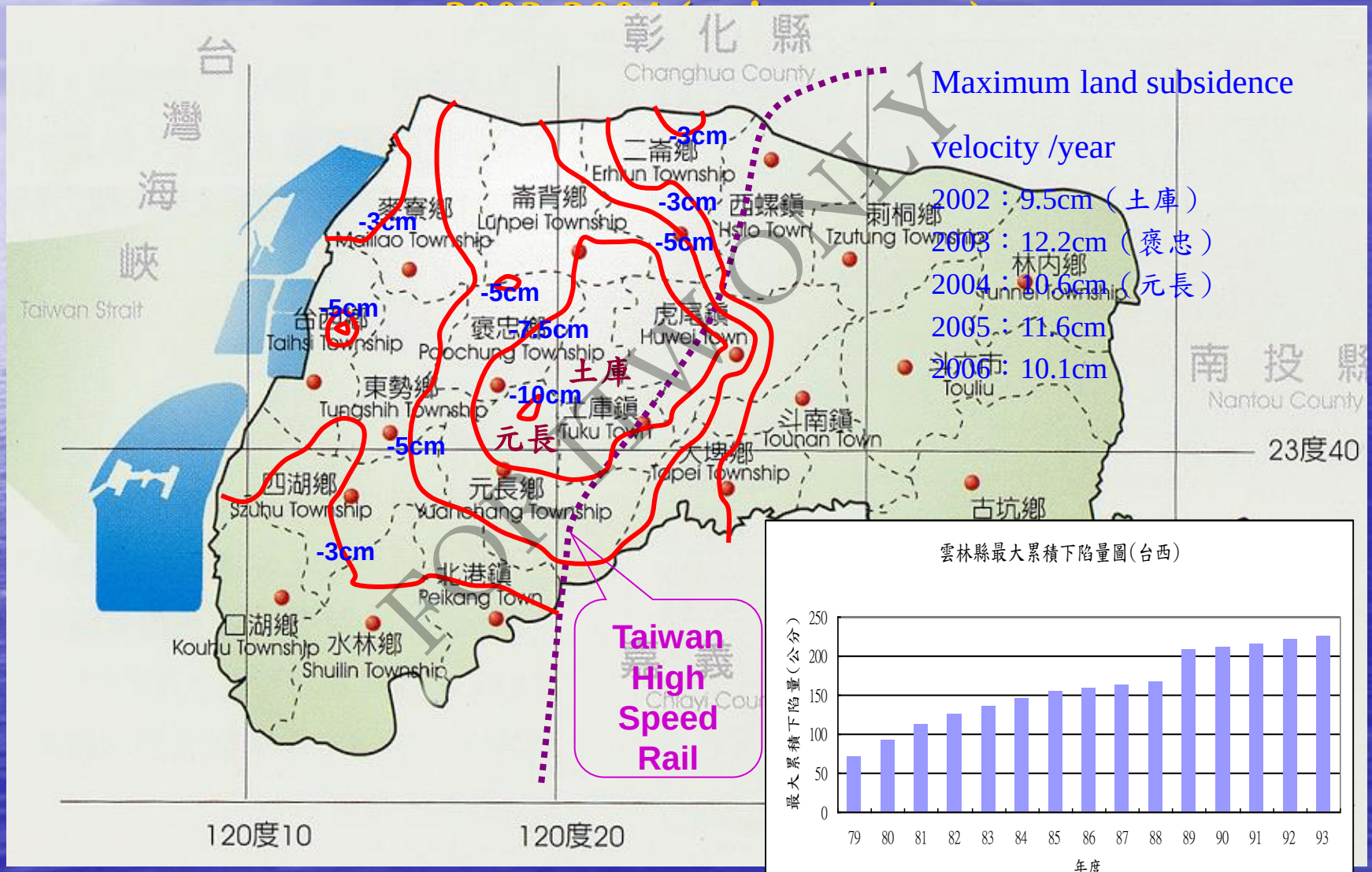


The Drainage Problem

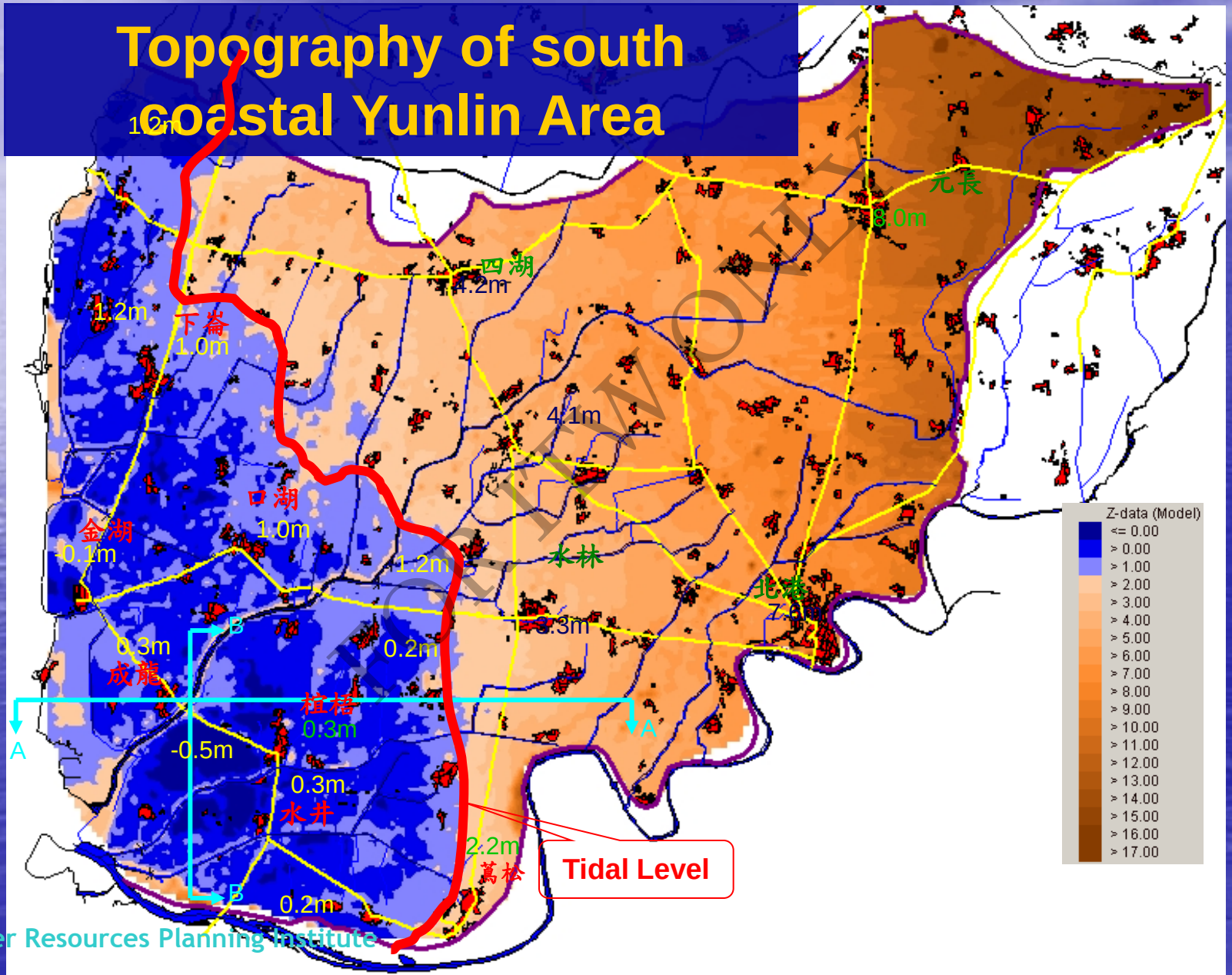
Low lying land, flat slope, over-pumping groundwater, land subsidence, most land area are below high tide level, poor drainage all make this area prone to flood events.

Note: Surface area west of surface tidal level is about 40 km²

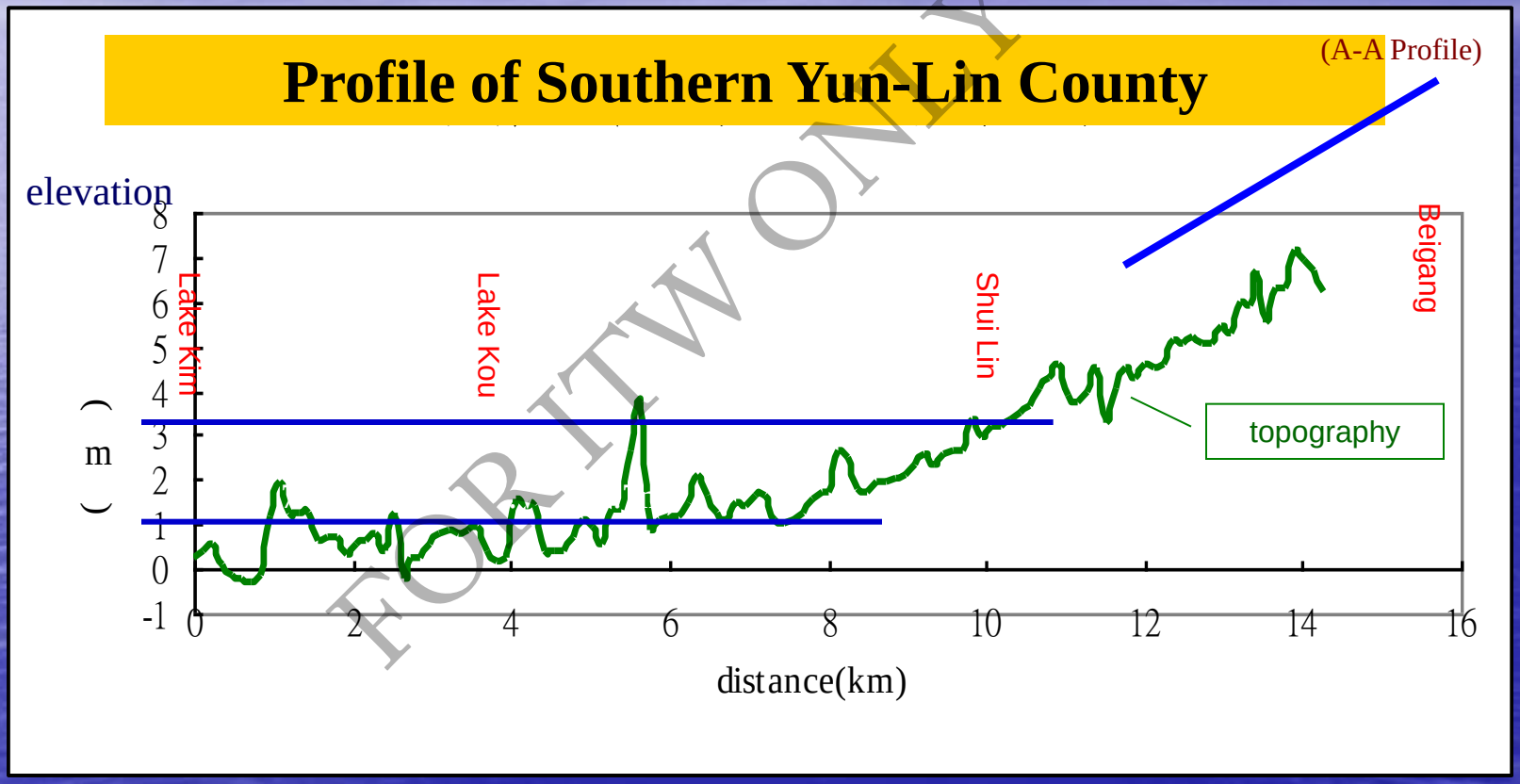
Average Land Subsidence Rate in Yunlin Area



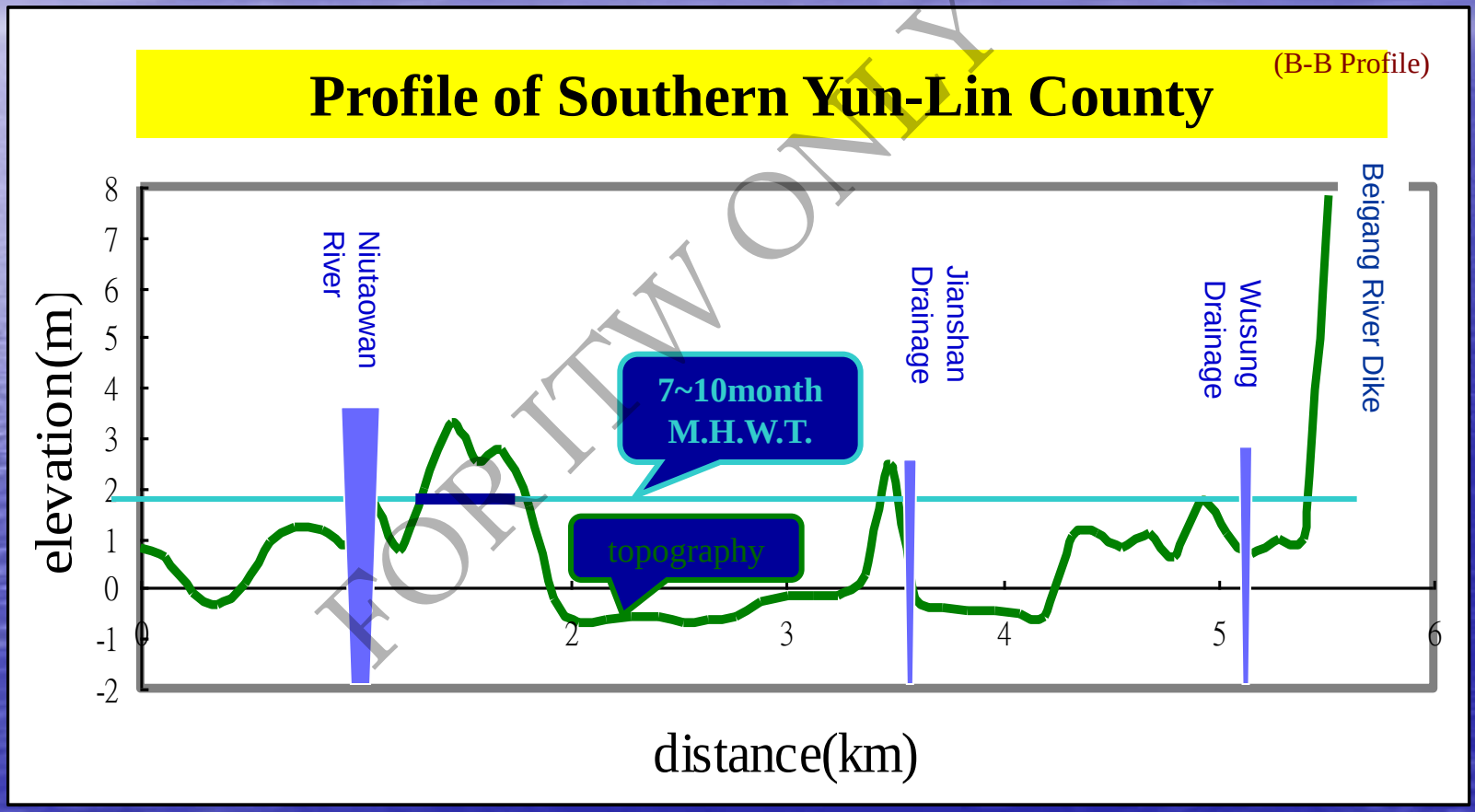
Topography of south coastal Yunlin Area



Topography, Tidal Level, and River Level



Topography and Drainage



Overall Strategy

Case 3

Drainage of Southern Yunlin Coastal Areas

Integrated Flood Mitigation

Increase the return period for regional drainage to 10 years

- Comprehensive secondary canal drainage rectification (dikes and flood gates), pumping stations
- Multi-objective artificial lake (I-WU and Bei-gang artificial lake)
- Farmland Retention ponds using fallowed land
- Improve flood prevention capacity at villages→Set as priority
- Flood Avoidance

Landscape Renovation

Landscape Renovation Materials Can Be Obtained from the Products of Excavation from Retention and Detention ponds

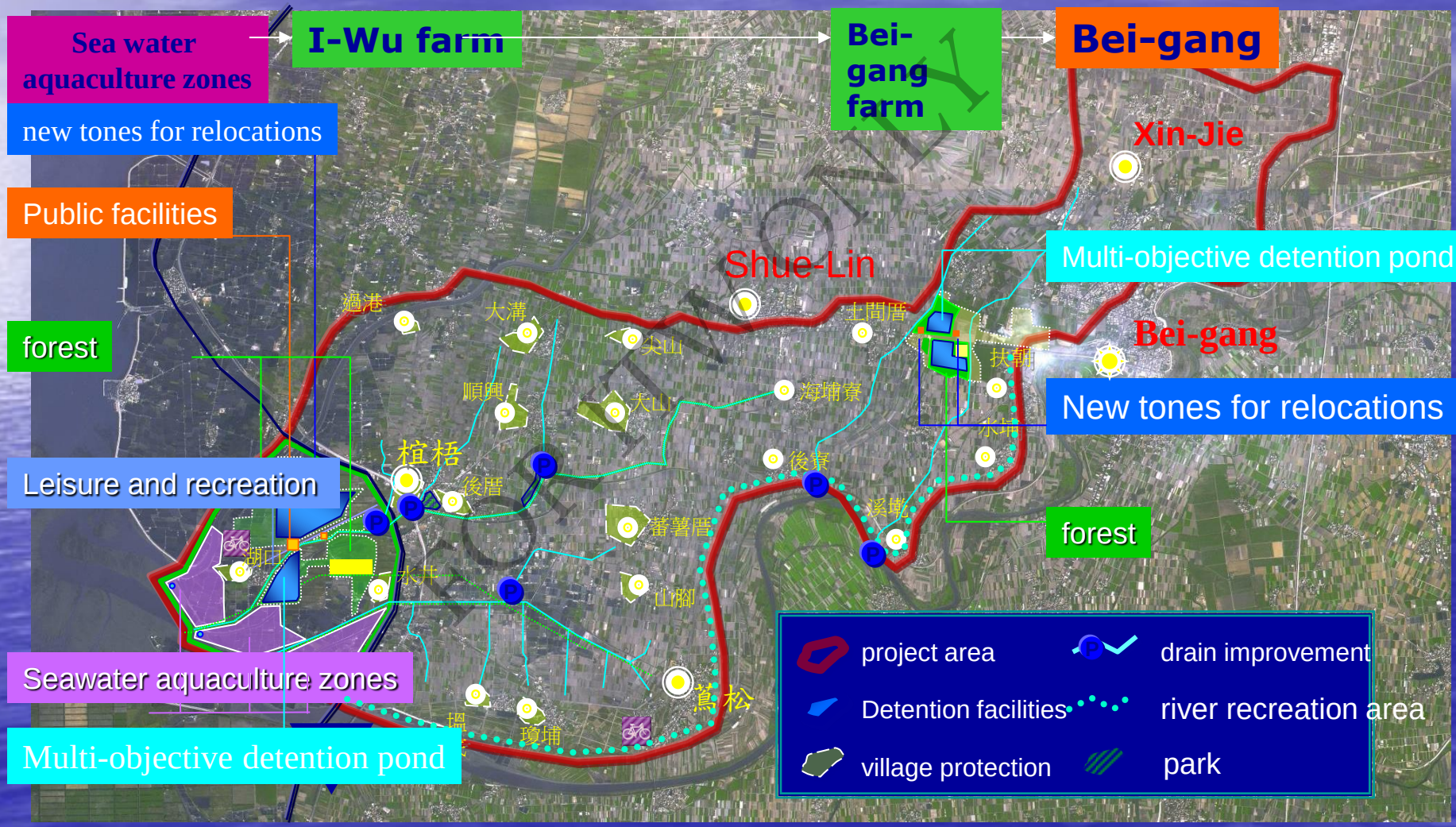
- Village settlement including dike drainage improvements, village building base elevation, relocation measures
- Raise and improve regional roads
- Graves improvements including increase graves elevation and the relocation of graves to hide urn towers
- Terrain transformation (using artificial lake earthwork)

Industrial Restructuring

Integrating Service and Agricultural Industry

- Overall planning for seawater supply in aquaculture zones
- Land Use Change→Rehabilitation, Fallow, and Reforestation
- Demonstrating cultivation of economic crops.
- Tourism, wetland industry promotion

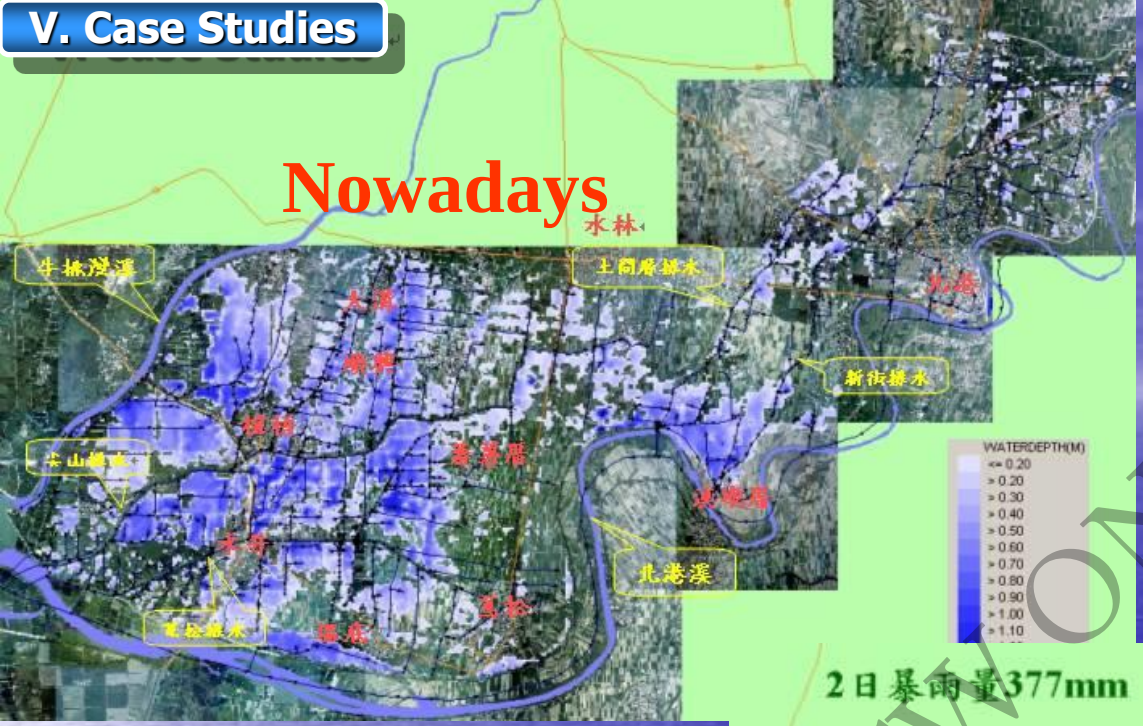
Proposed plan of southern Yun-Lin area



Case 3

Drainage of Southern Yunlin Coastal Areas

Nowadays



For 10 Years Return Period

Approach

Drainage+Pumping Stations+
Bei-gang & I-Wu Detention ponds
+Farmland Detention ponds
+Fallowed Land Detention ponds

In Planning

Bei-gang Multi-Objective Detention pond (Artificial Lake)

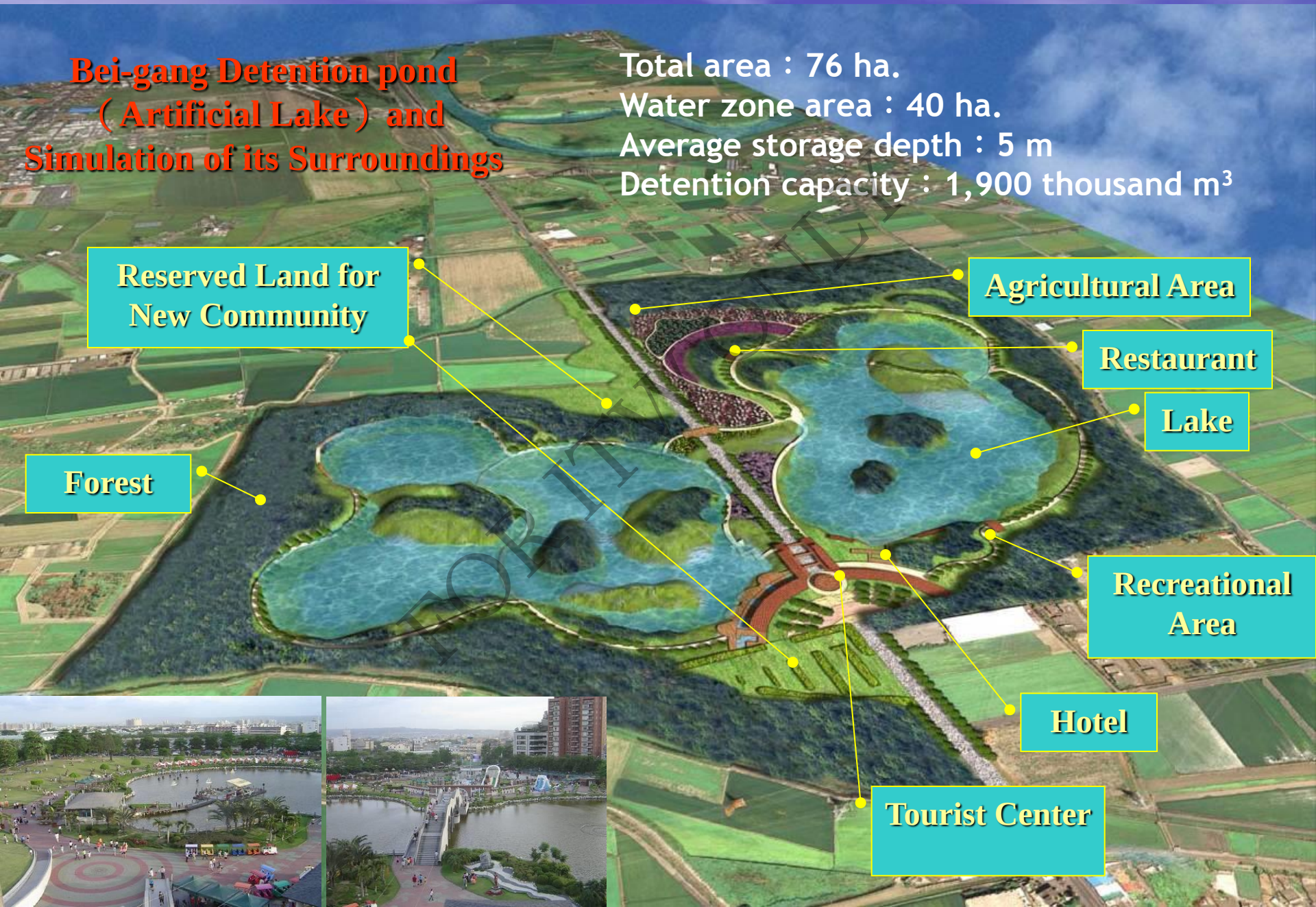
To mitigate flooding at downstream reach of Bei-gang River, WRA plans to install detention pond at mid-stream reach of the river as well as pumping stations. In addition to its flood detaining function, the pond can also act as a source for meeting irrigation and aquaculture needs. Lastly, because the pond is also close to the town center, it is designed to be a multi-objective detention pond for scenery, fitness, tourism and others.

Case 3

Drainage of Southern Yunlin Coastal Areas

Bei-gang Detention pond (Artificial Lake) and Simulation of its Surroundings

Total area：76 ha.
Water zone area：40 ha.
Average storage depth：5 m
Detention capacity：1,900 thousand m^3



I-Wu Multi-Objective Detention pond

Taiwan Sugar Corporation's I-Wu ranch area situated in low-lying and salinated land. It is mostly abandoned wetland at present. Thus, this project uses such space to set up an 100 ha. (70 ha. at the north and 30 ha. at the south) multi-objective detention pond, with an average storage depth of 2.5m, storage capacity of 2.5 million m^3. Rainwater at nearby areas is collected and stored. Pumping stations with 6 and 10cms capacity are also installed to regulate the water level of the detention pond. The detention pond or artficial lake can alleviate the flood disasters at surrounding areas, stimulate tourisms, and provide materials for the elevation of roads, graves, and low-lying villages.

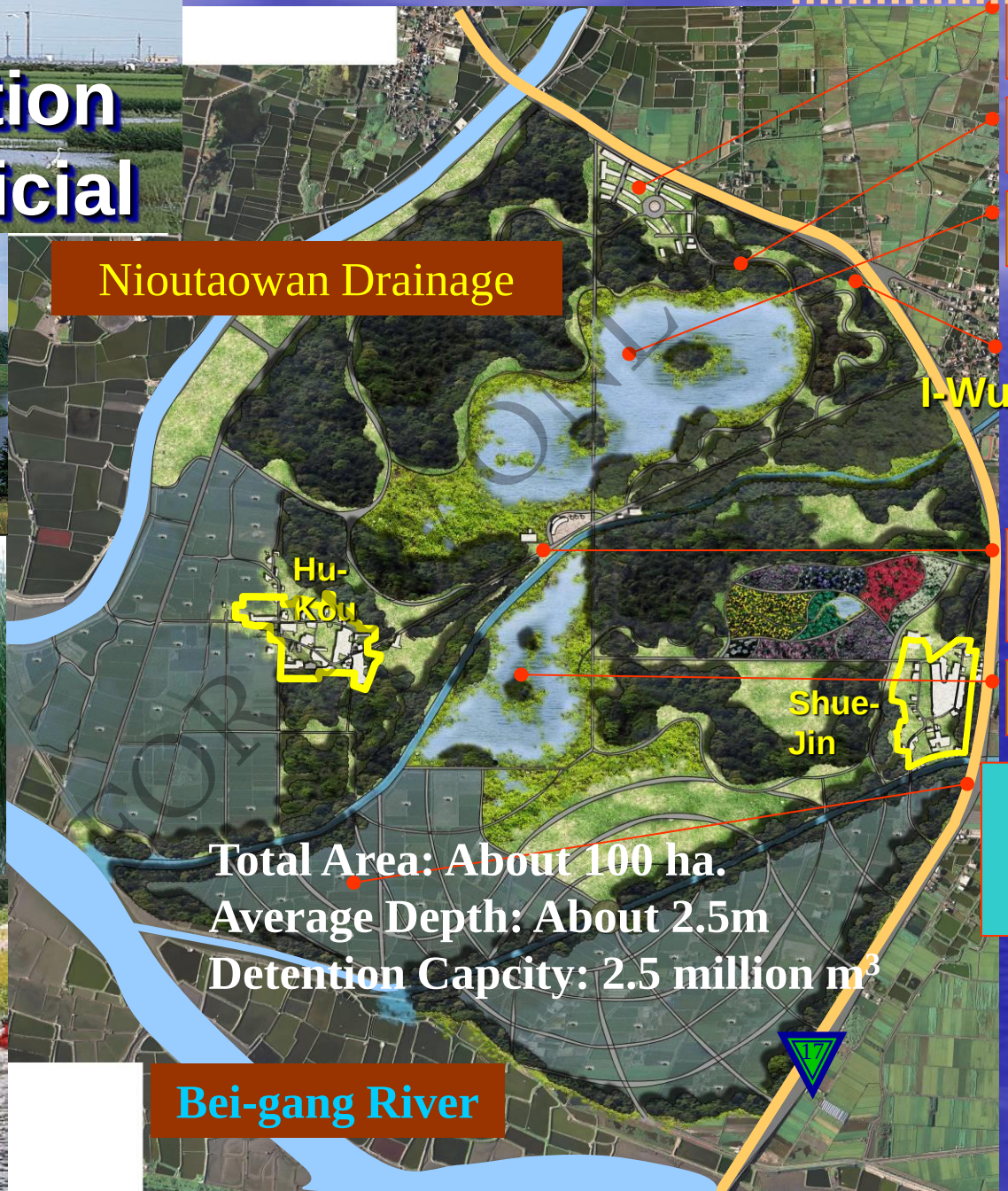
I-Wu Artificial Lake

Current

Case 3

Drainage of Southern Yunlin Coastal Areas

I-Wu Detention Pond（Artificial Lake）



New Community

Forest

Lake

Demonstration Center

Pumping Station

Lake

Seawater Aquaculture Area

Southern Yunlin Project --- Restructuring Industry

- Integrating Service and Agriculture Industry
  - ✓ Aquaculture→Ranging,Overall Planning for Seawater Supply
  - ✓ Land Use Change→Rehabilitation, Fallow, and Reforestation
  - ✓ Wetland Eco-Industry
  - ✓ Demonstrating Cultivation of Economic Crops → Chinese herbal medicines, biodiesel plants and other economic crops
  - ✓ Sightseeing and Industry Promotion →Tourist Center

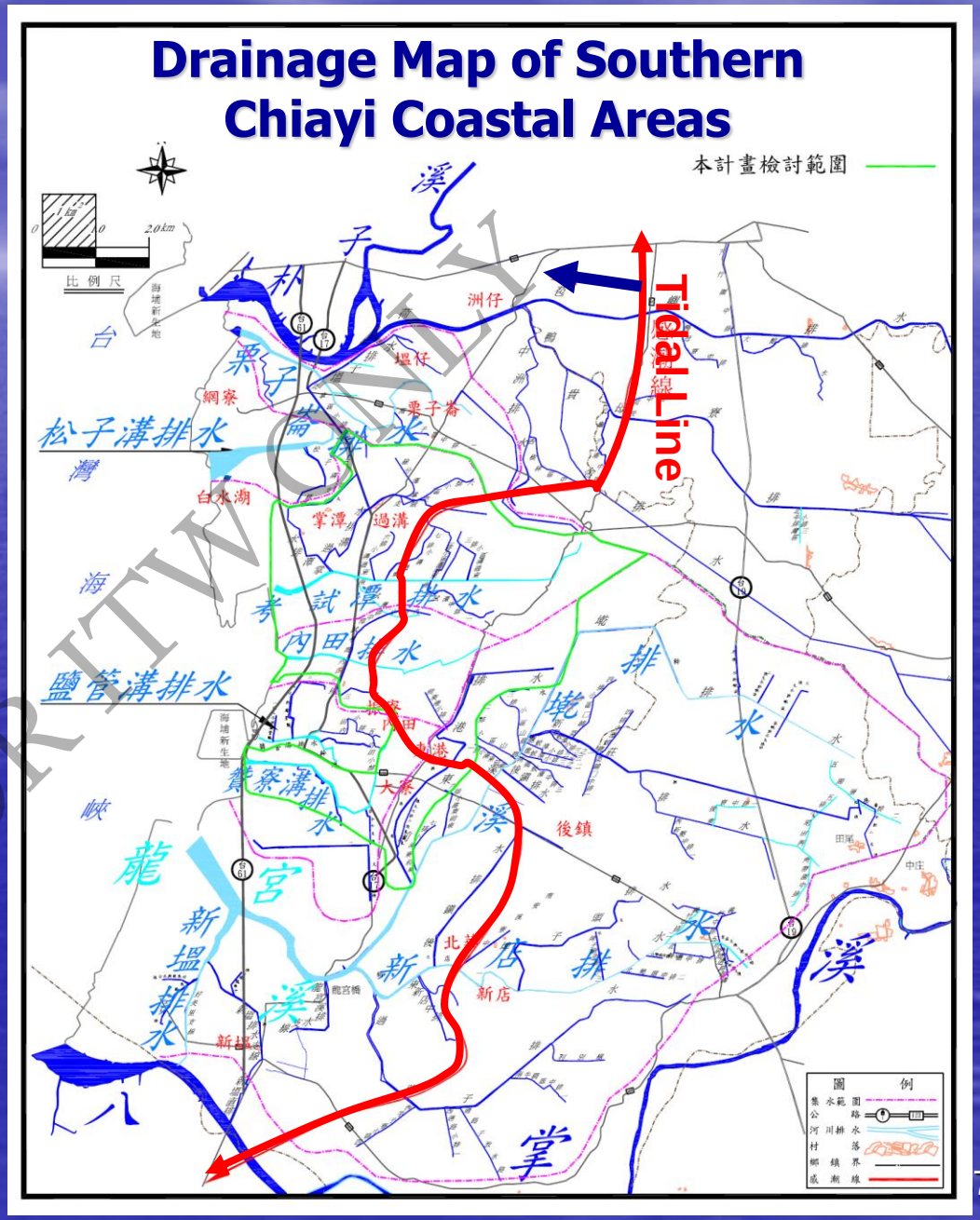
Case 4

Drainage of Southern Chiayi Area

（Reuse Deserted Salt Evaporation Ponds as Detention Ponds）

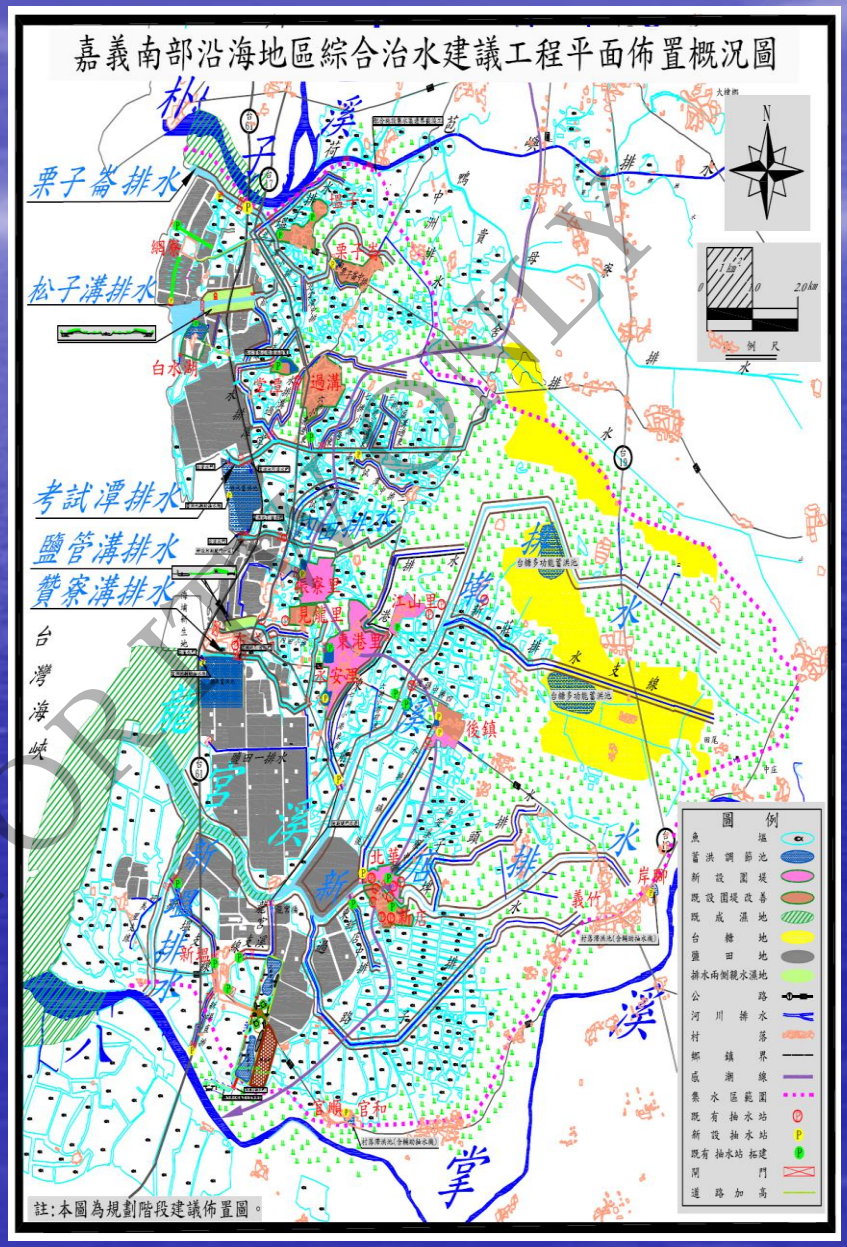
Main Drainage Problem

Chiayi has similar driange and disaster mitigation problems to Yunlin; however, Chiayi have more coastal salt evaporation ponds. Thus, this project focuses on how to transform these ponds into detention ponds.



General Layout

Integrated Flood Regulation at Southern Chiayi Coastal Areas



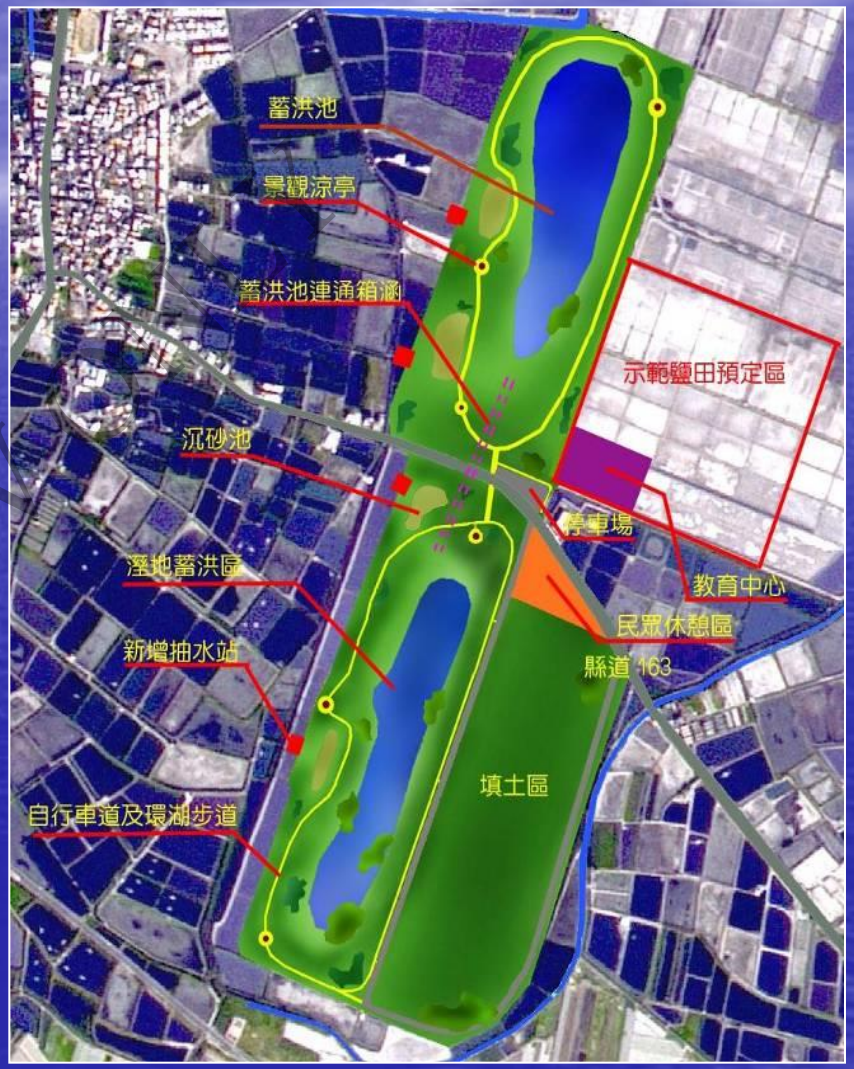
Village Flood Disaster Protection （Wangliao）

Village Wangliao Flood Disaster Protection Layout

Environment Building in Wangliao

Village Flood Disaster Protection （Hsinwen）

Drainage Improvement in Hsinwen



Environment Building in Hsinwen

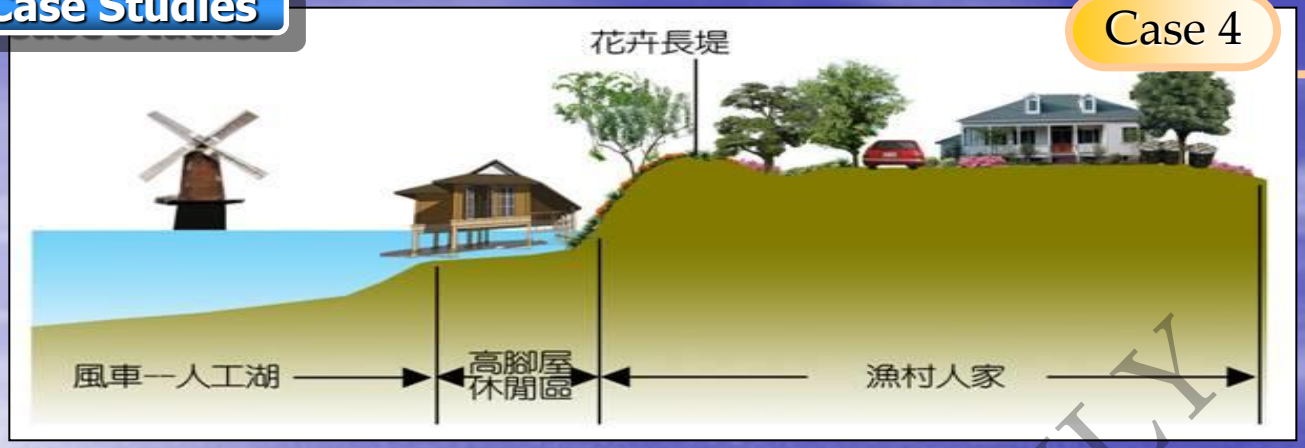
Retention Pond Design at Kaoshitan

Simulation- Normal Level

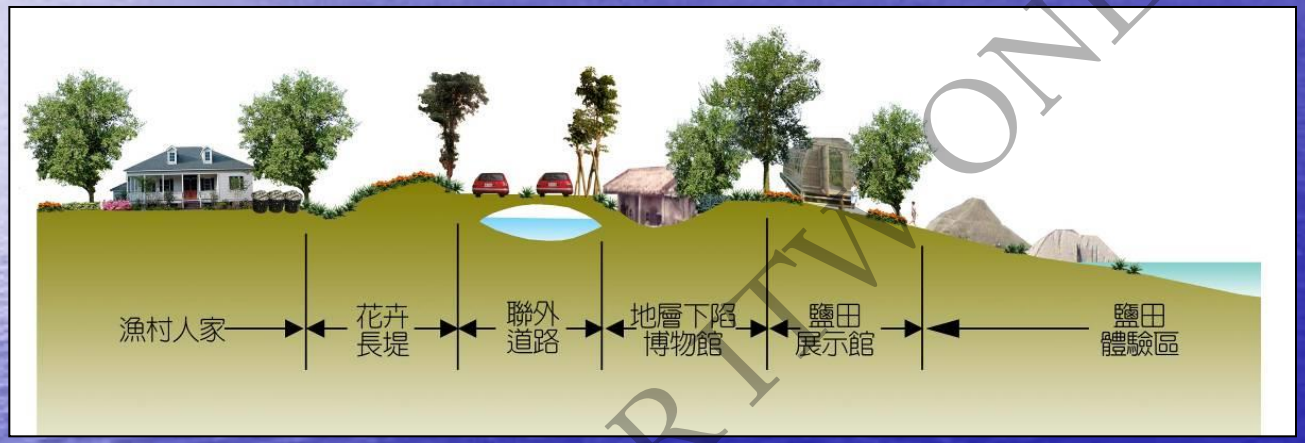
Simulation- Full Capacity

Planning of Different Section for Eco-Industry at White Water Lake in Chiayi County

Case 4



Scenic Section at White Water Lake



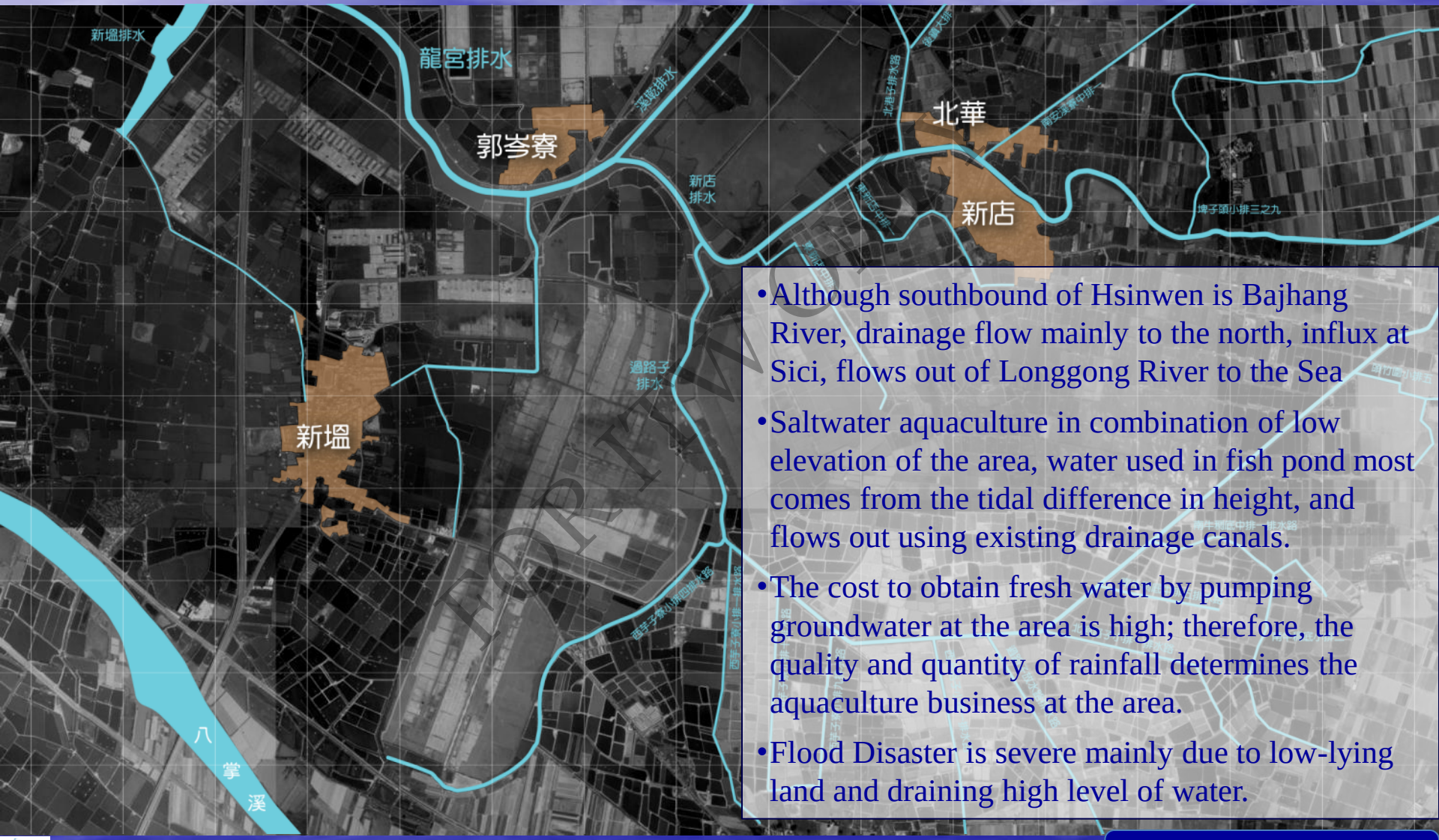
Demonstration and Public Education Section at White Water Lake

Activities and Sports Section at White Water Lake

National Land Restoration of Coastal Areas at Chiayi County

Hsinwen Demonstration Zone

Environmental Conditions



- Although southbound of Hsinwen is Bajhang River, drainage flow mainly to the north, influx at Sici, flows out of Longgong River to the Sea
- Saltwater aquaculture in combination of low elevation of the area, water used in fish pond most comes from the tidal difference in height, and flows out using existing drainage canals.
- The cost to obtain fresh water by pumping groundwater at the area is high; therefore, the quality and quantity of rainfall determines the aquaculture business at the area.
- Flood Disaster is severe mainly due to low-lying land and draining high level of water.

Case 4

Regional Drainage of Southern Chiayi

Hsinwen Demonstration Zone

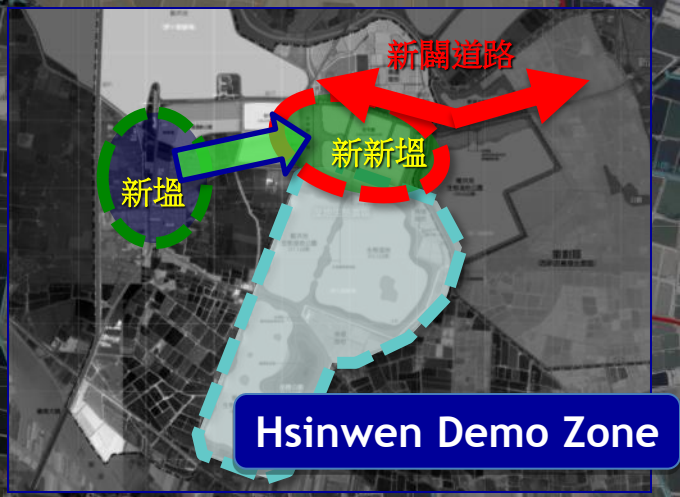
Chia-Nan New Scenic Area, New Hsinwen Community

Project Theme

- By building "New Hsinwen", land development can be adjusted in the long run
- Change this area to regional recreational center for Chiayi County
- Maintain current flood regulation project benefits, and allow integrated development

Development Strategy

- Find solution for the regional flood problems by discussing community relocation and New Hsinwen Project
- Using the existing salt evaporation ponds to create quality eco-environment and unique scenic attractions
- By rebuilding the environment and provide new opportunities for businesses, Hsinwen can be transformed into regional recreational industry center.
- Improve existing retention ponds projects and achieve the goal of multi-source water environment.



Case 4

Regional Drainage of Southern Chiayi

Hsinwen Demonstration Zone

Chia-Nan New Scenic Area, New Hsinwen Community

Spatial Planning

- Promote “New Hsinwen” Community Space Project
- Integrate eco-environment in lakes, shallow water, and forests to create a eco-environment both scenic beautiful and multi-purpose. It can also become one of Chiayi’s regional wetland ecology parks.
- Promote eco-tours and regional bicycle industries to prepare for the leisure industry in this area in the upcoming years

Hsinwen Demo Zone

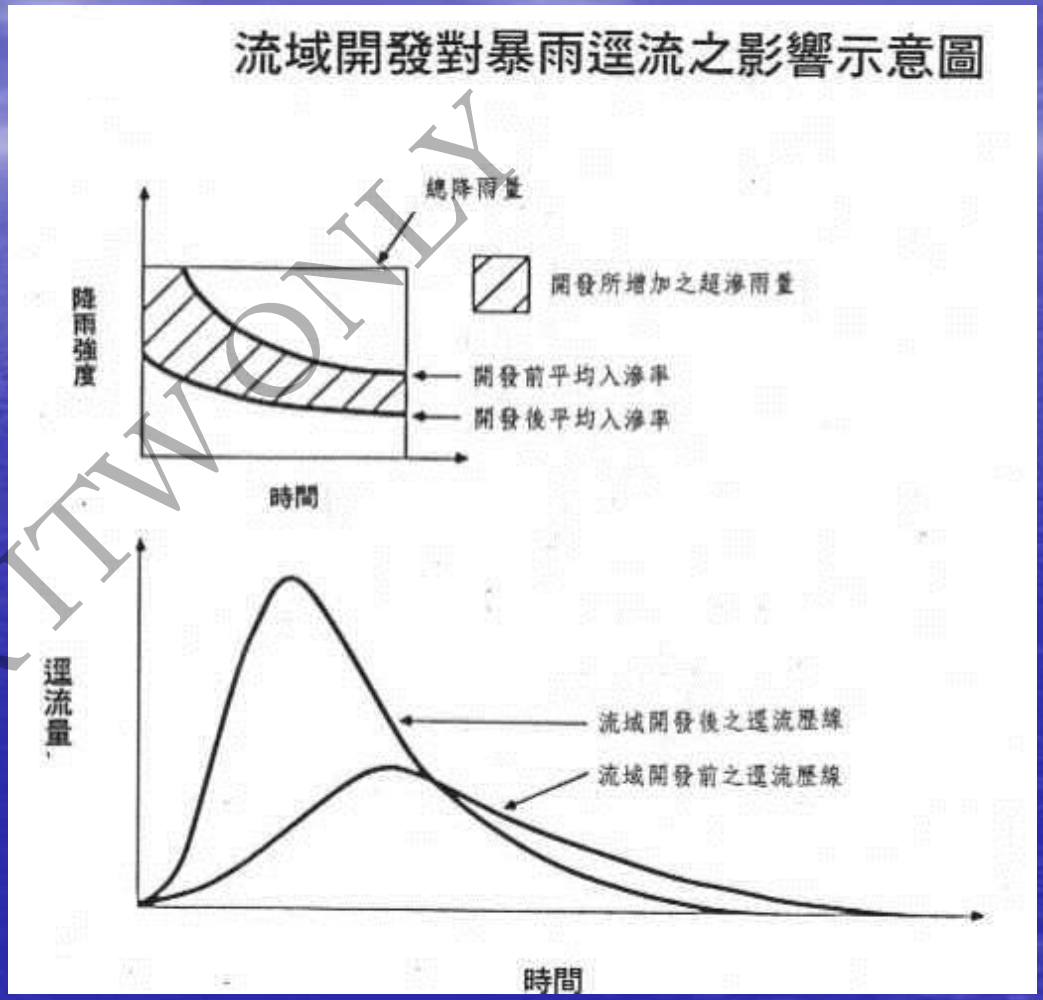
Case 5

Drainage of Yan-shuei River and Ta-Chou in Tainan

（Set up Detention Pond to Mitigate Impacts of Surrounding Development at Drainage Facilties and Set up Retention Ponds to Mitigate Flood Disasters at Low-Lying Land）

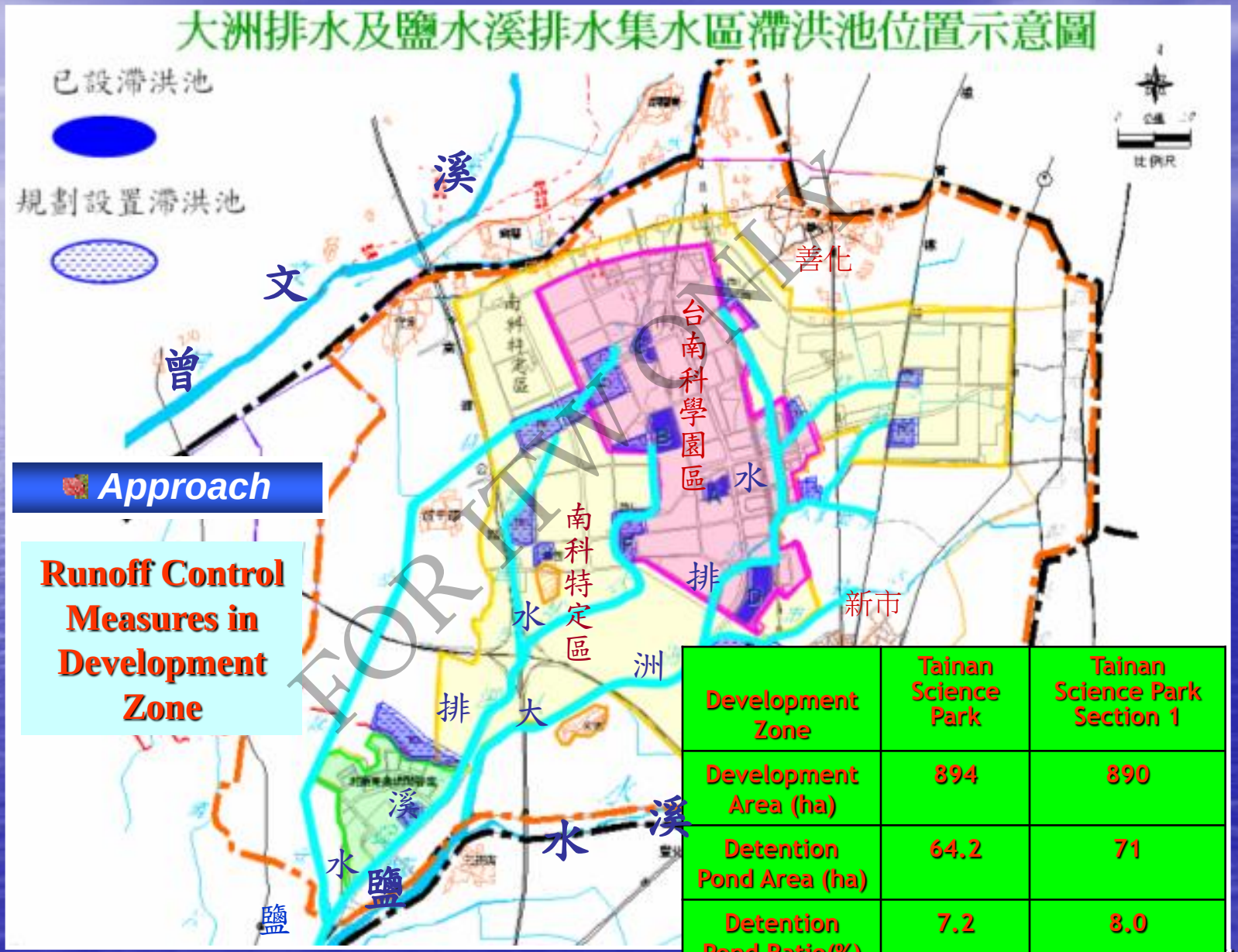
Main Drainage Problem

Science Parks, Assigned Regions, Industrial Zone and other land development areas. They have high run-off, low flood retention area, and high risk of flooding along drainage system.



Case 5

Drainage of Yan-shuei River and Ta-Chou in Tainan

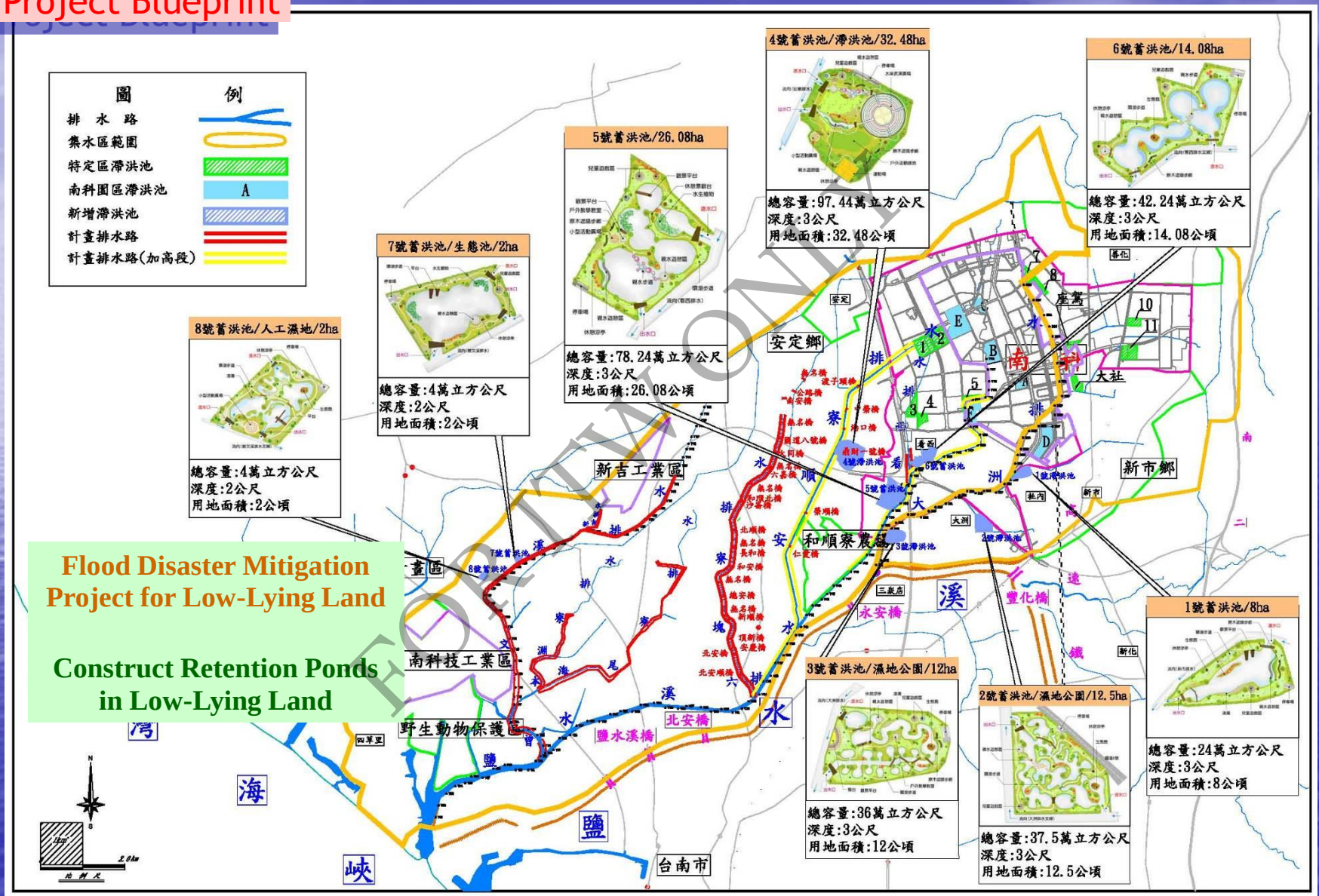


Approach

Runoff Control Measures in Development Zone

Development Zone	Tainan Science Park	Tainan Science Park Section 1
Development Area (ha)	894	890
Detention Pond Area (ha)	64.2	71
Detention Pond Ratio(%)	7.2	8.0

Project Blueprint



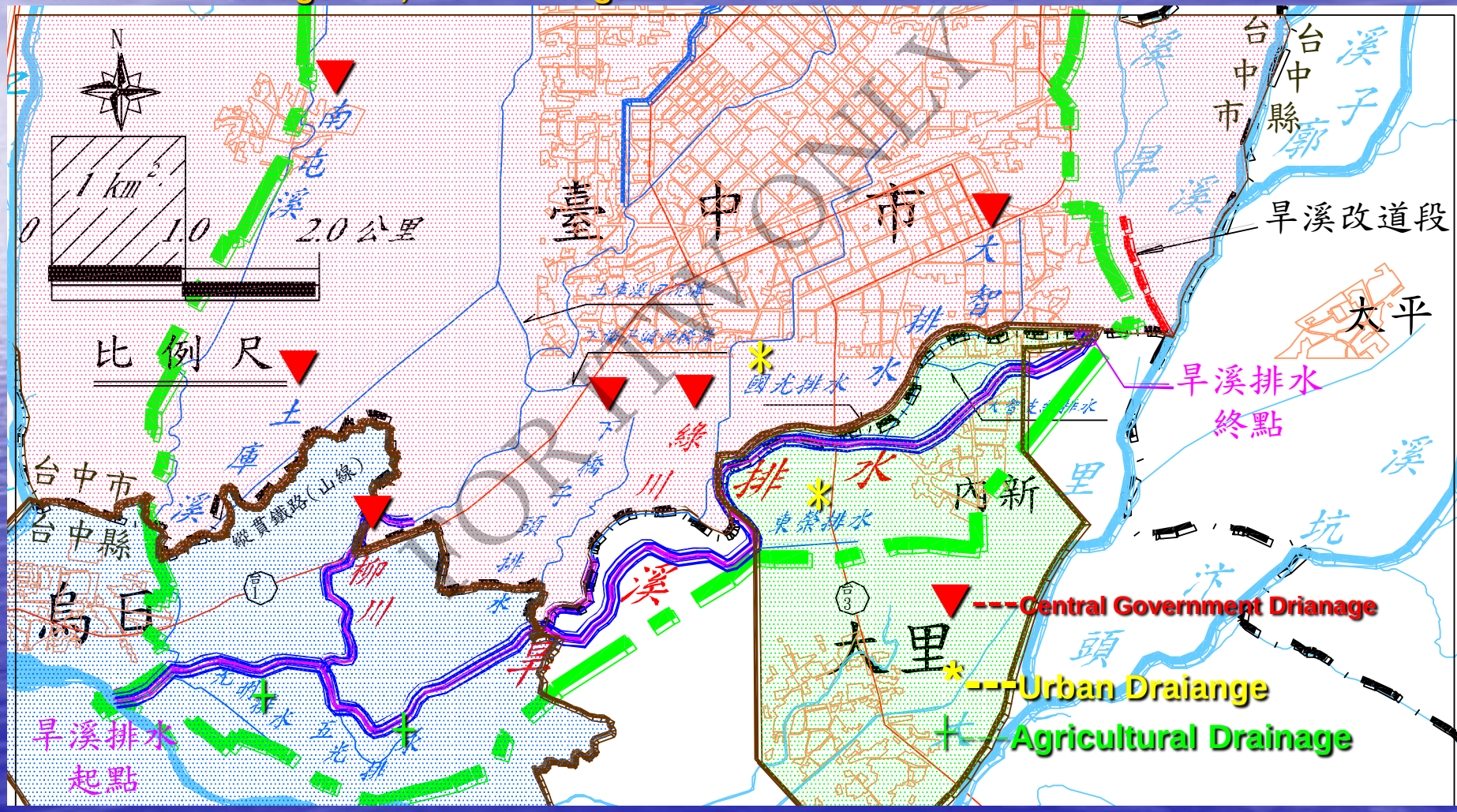
Case 6

Environment Building of Han River Drainage

（Environment Building of Urban Drainage Waterway）

Area Background

- Han River Drainage is at the influx of multiple urban drainage system (Dali City, Taichung City, WuRih Township and etc.)
- Han River Drainage is 9,230m in length and its catchment area is about 68 km².



Drainage Improvement and Environment Building

Based on different objectives and goals, community heritage and development, and parks in urban planning in each river section, the drainage is divided into 3 distinct development sections :

(Including 4 Key Sites)

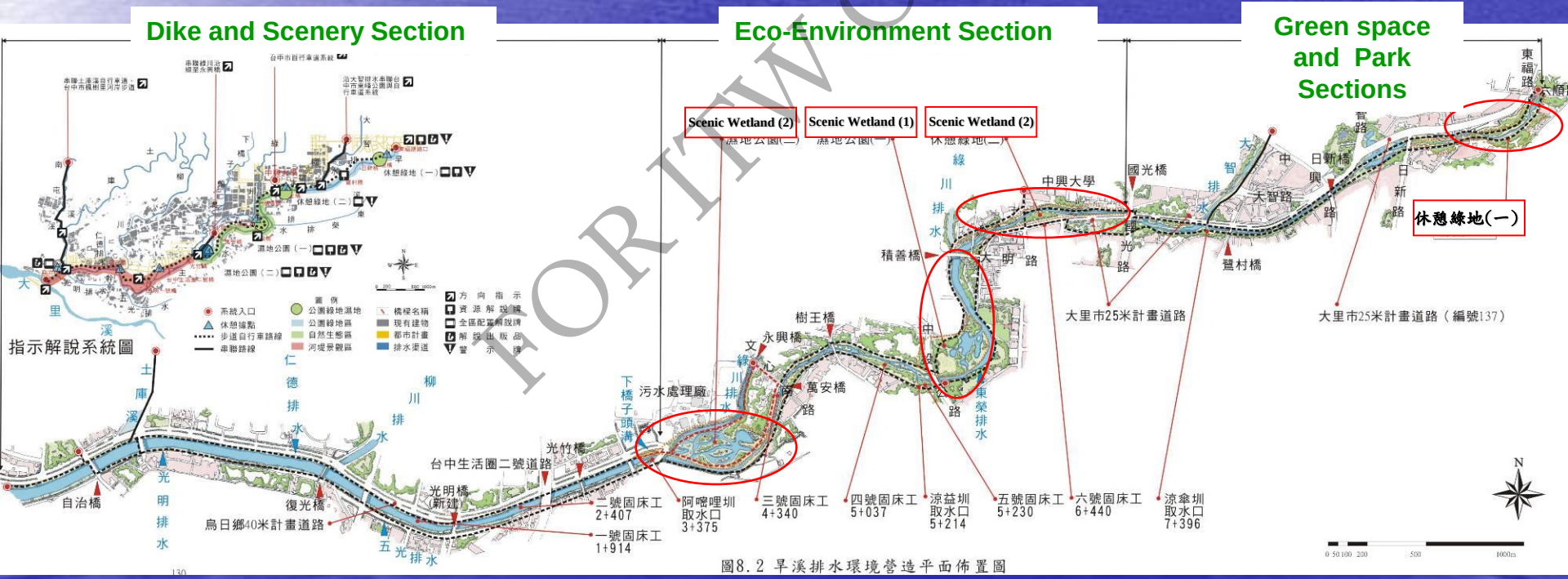
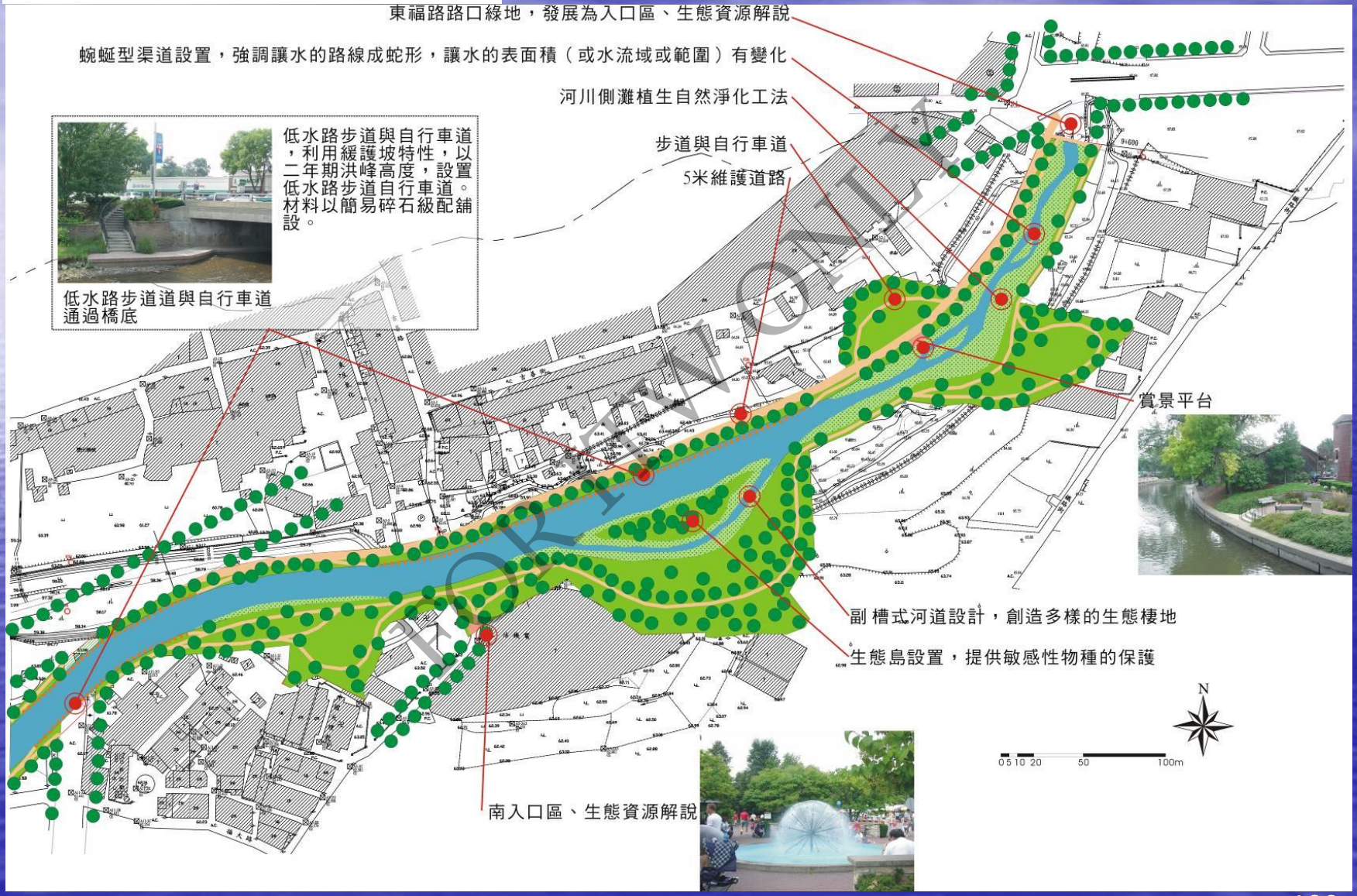
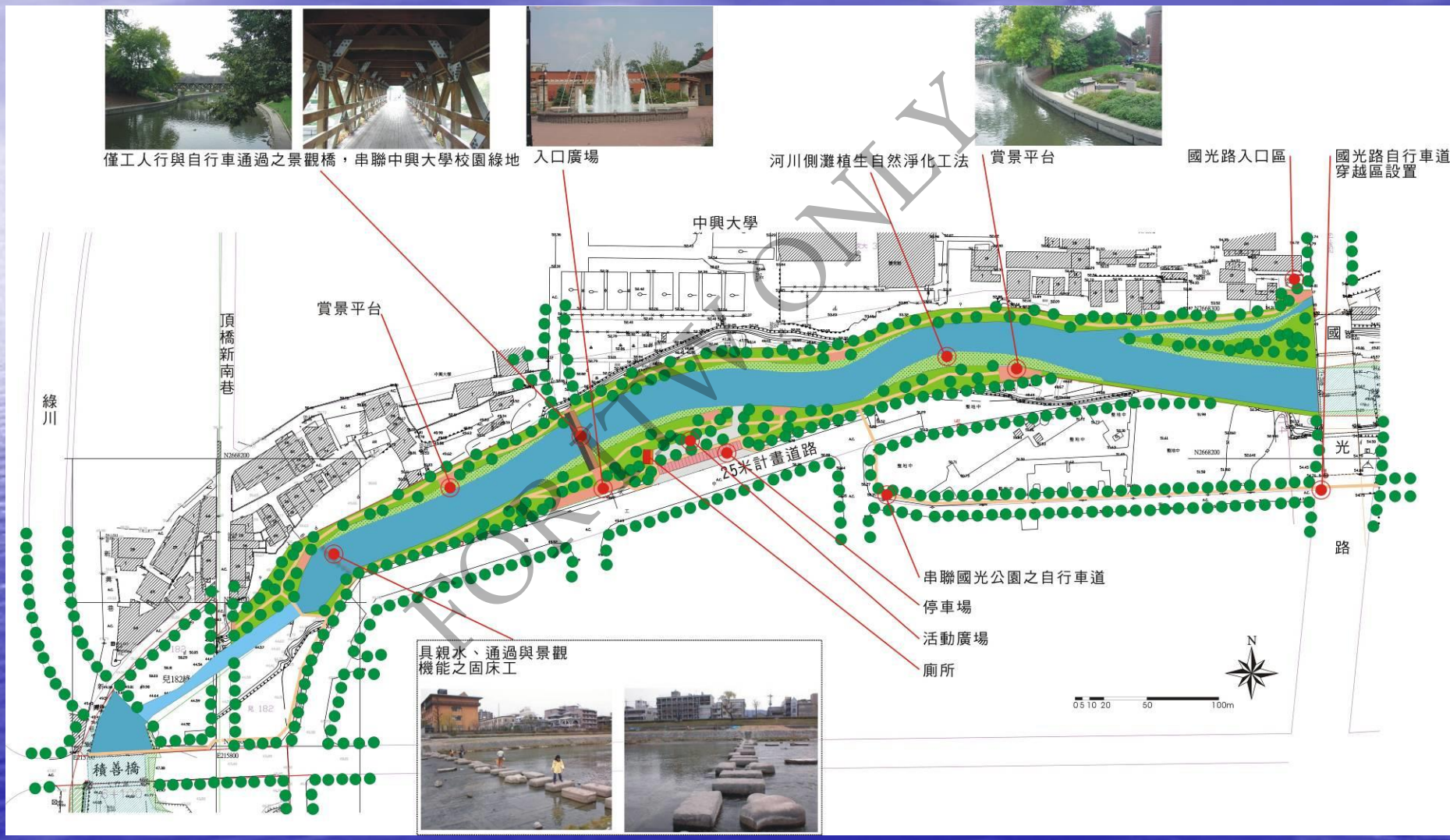


圖8.2 旱溪排水環境營造平面佈置圖

Recreational Greenland(1)



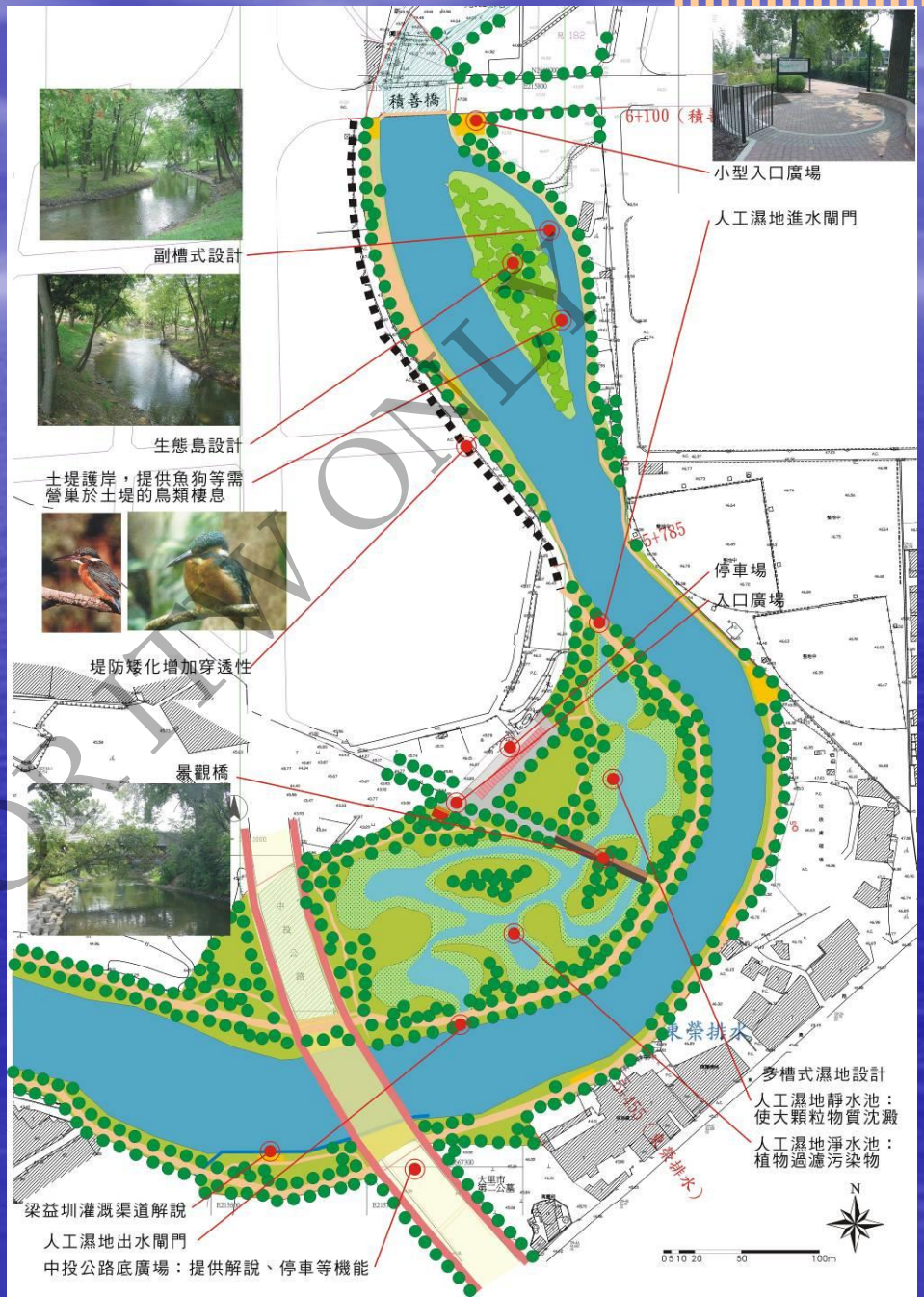
Recreational Greenland(2)



Case 6

Environment Building of Han River Drianage

Scenic Constructed Wetland(1)



Scenic Constructed Wetland(2)

VI. Conclusion

- Flood prevention projects do have limits of protection, thus lifting public awareness in recognizing that "human shall not enslave and exploit nature and exhaust its resources because we are not its master"
- Ecological Engineering is not merely the greenification of the dykes nor establishing river habitats using man-made structures ; The restoration of river habitats should consider natural surroundings of the target river, find the environmental needs of the habitats, and complete projects with minimal disturbance to eco-environment.
- The trend of the future is to avoid rather than prevent floods and to adapt more non-structural measures instead of initiating more construction projects. However, successful implementation and outputs of these non-structural measures still requires the understanding and participation from both government and the public to protect our society from flood disasters.
- River management and regulation should be implemented on a basin-by-basin basis; Planning for the entire basin can facilitate the integration of goals and resources and come up with functional plan that can best protect the society.


Thank You for Your Attention!
Any Questions?
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