

Towards Sustainable Water Management in Taipei - Sponge City

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Public Works Department,
Taipei City Government, Taiwan



31th August 2018



2018, Extremely torrential rain in Japan



2016, Heat wave in India



2017, Torrential rain in Paris



Four-year drought in California

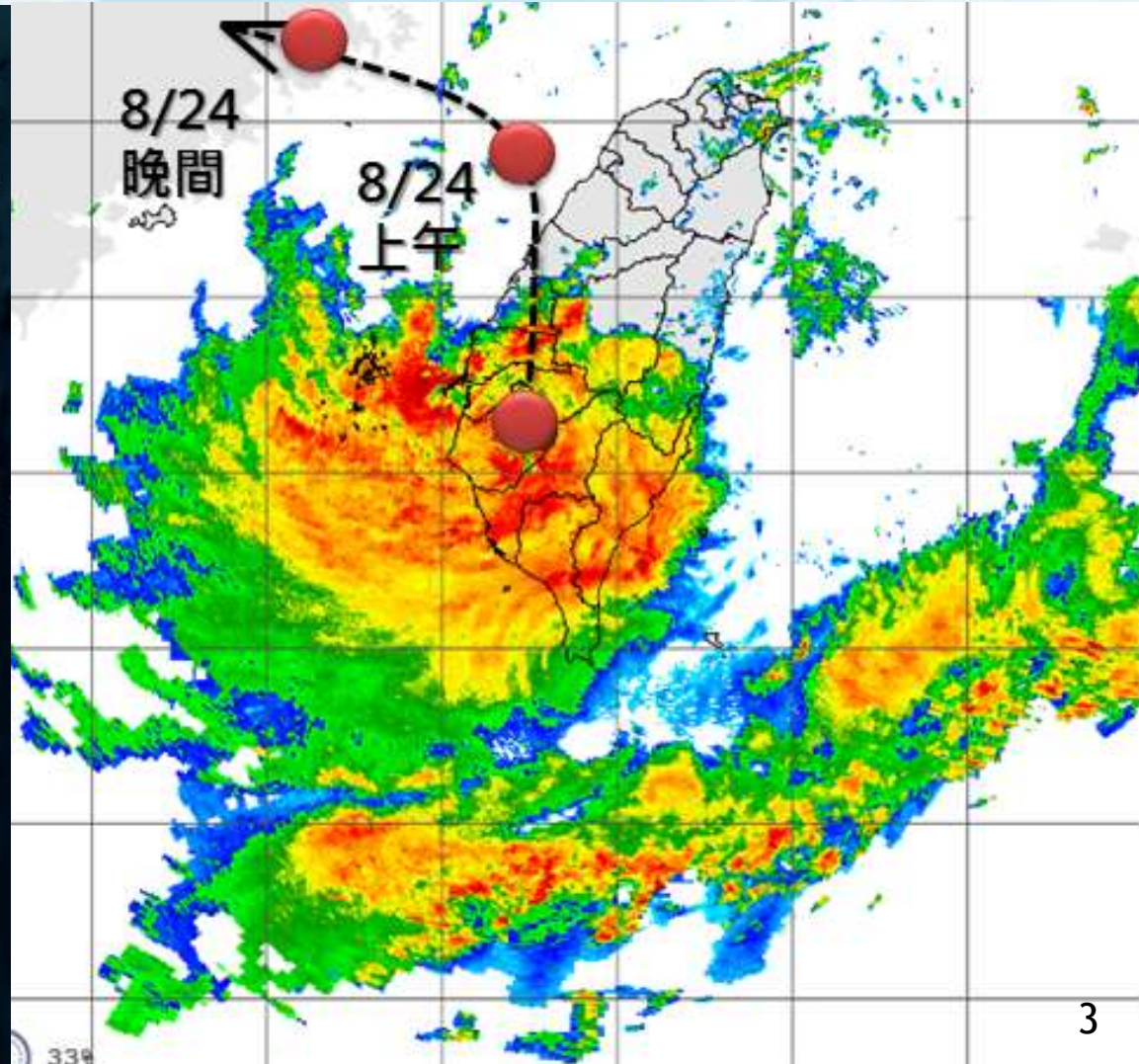
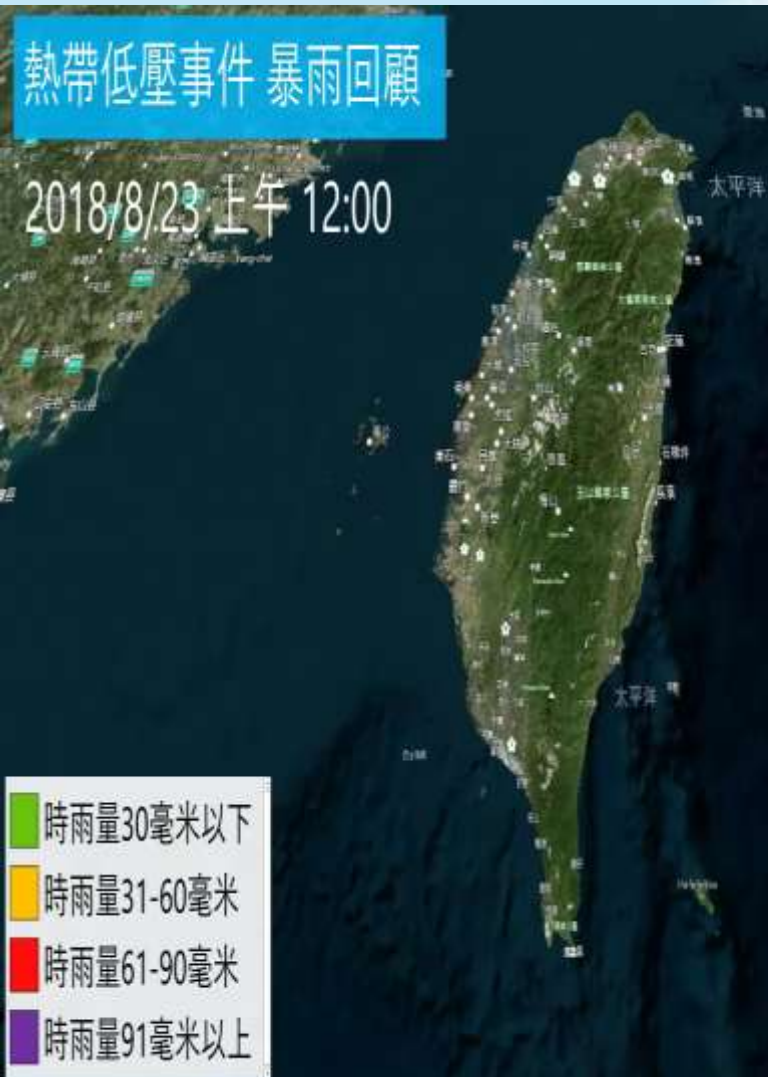
0823 Extremely Torrential Rain

1小時累積雨量：2018-08-23 00:00 至 2018-08-23 14:30

1 111.5 mm 大寮 (C0V730) 高雄市 大寮區 2018-08-23 11:20

24小時累積雨量：資料更新時間 2018-08-24 15:40

1 臺南市 楠西區 曾文 831.5



Taipei City

- Location : North Taiwan
- Population : 2.7 million
- Area : 272 km²
 - 55% mountains
 - 45% plains
- Average annual rainfall :
 - 2,400 mm/yr. on the plains
 - 4,500 mm/yr. in the mountains

Taiwan

Tamsui River

Low-lying areas

Xindian River

Keelung River

Jingmei River



TAIPEI 101

**about 1
million
residents**

**low density
development**

1945



2010

9 million
residents
live in
Greater Taipei,
commuting
to Taipei for
work/school



Highly dense
area

Challenges:

1. Highly dense area

*≈ 10,000 people/km² in Taipei City
55% mountains, 45% plains*

2. Heavy and uneven rainfall

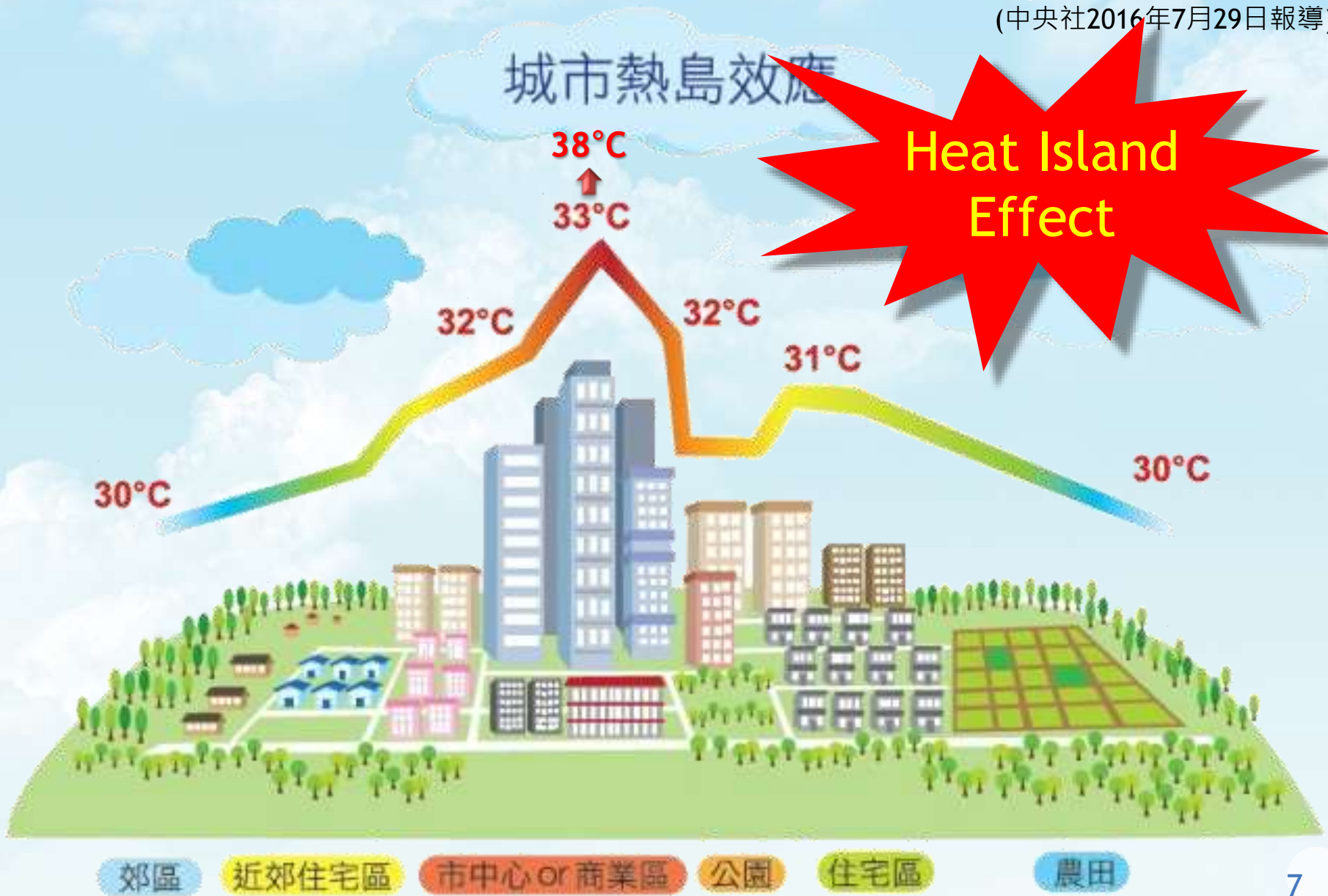
*Fast and highly concentrated both
rainfall and river discharge*

Historical High Record in 2016: Over 38 °C for 5 consecutive days

(中央社2016年7月29日報導)

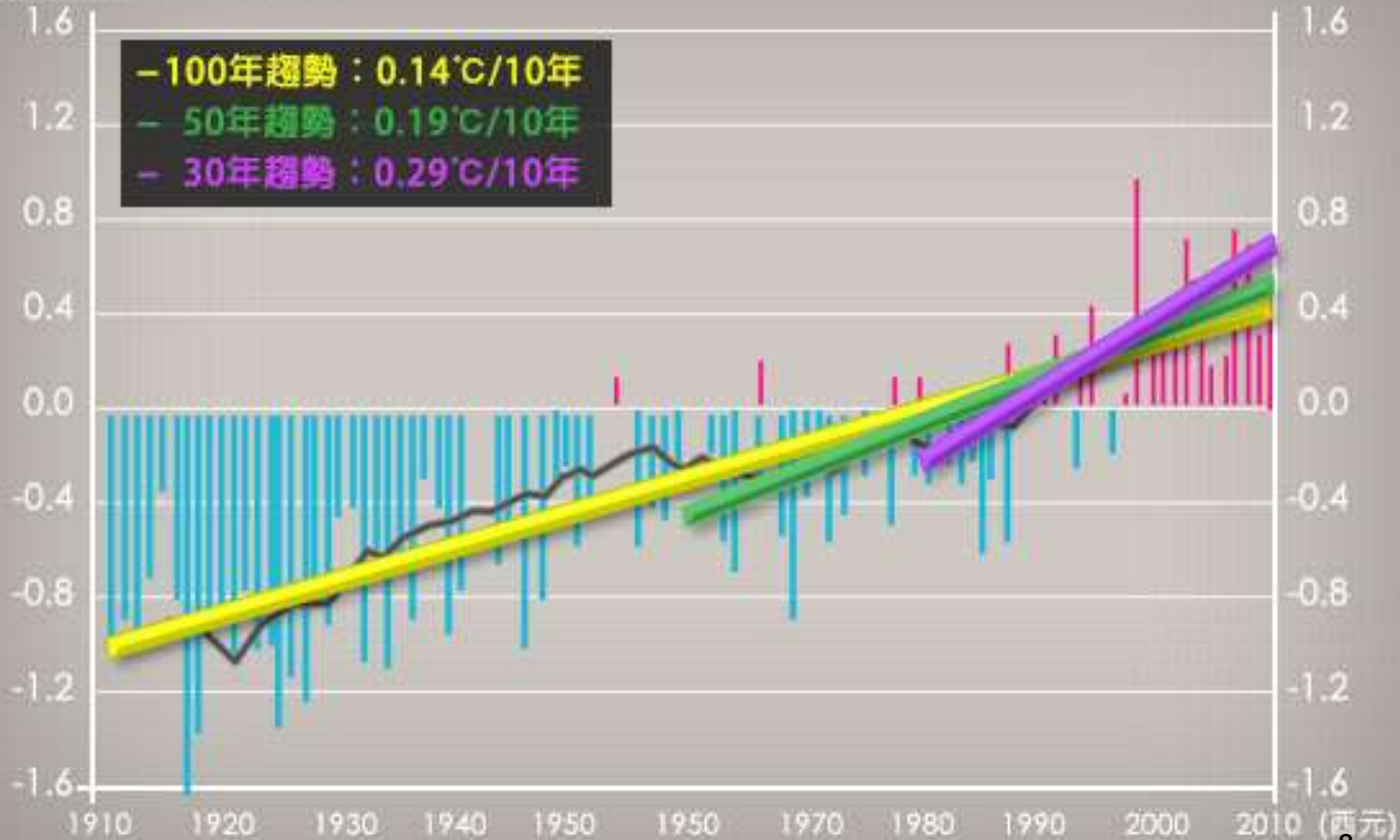
城市熱島效應

Heat Island
Effect

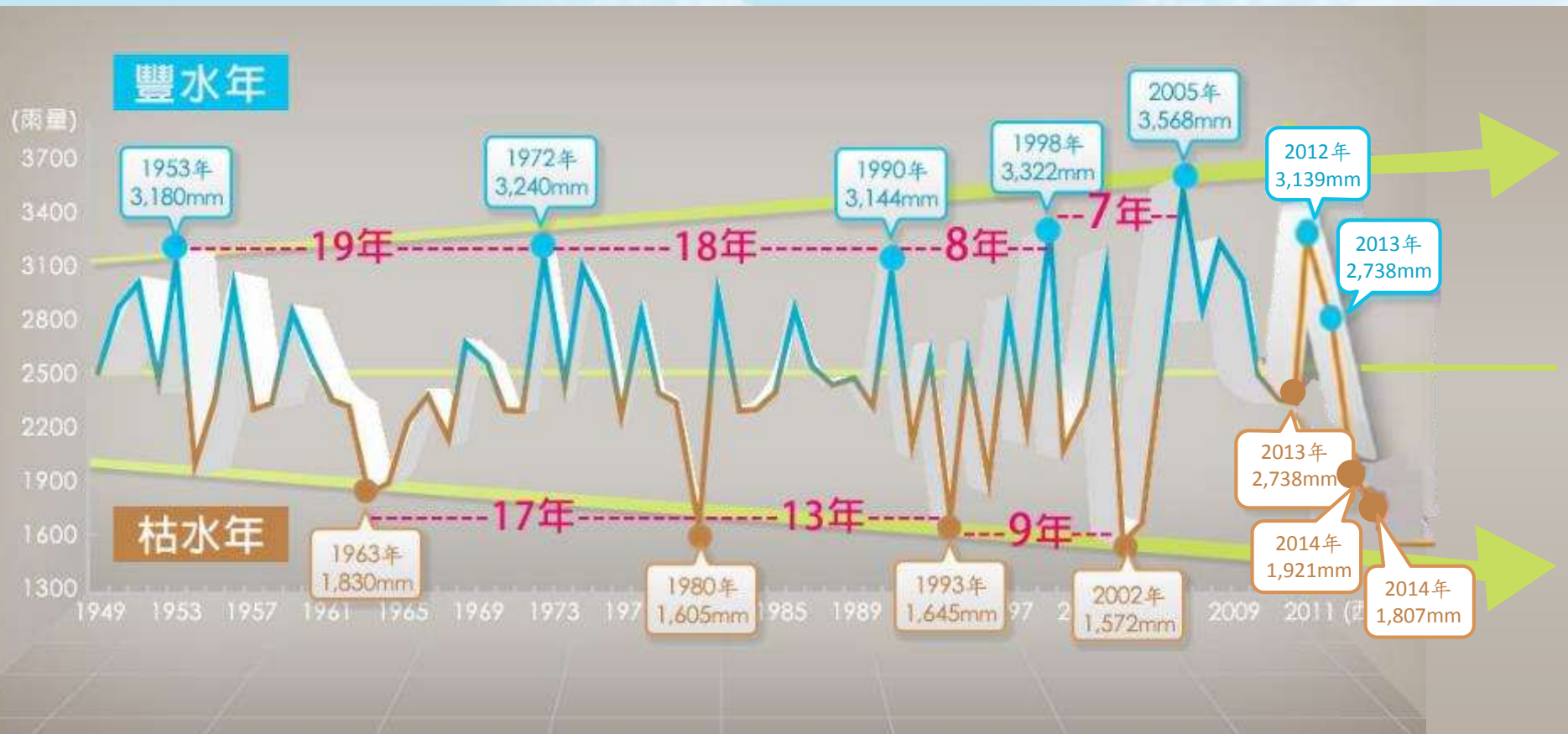


Temperature (°C)

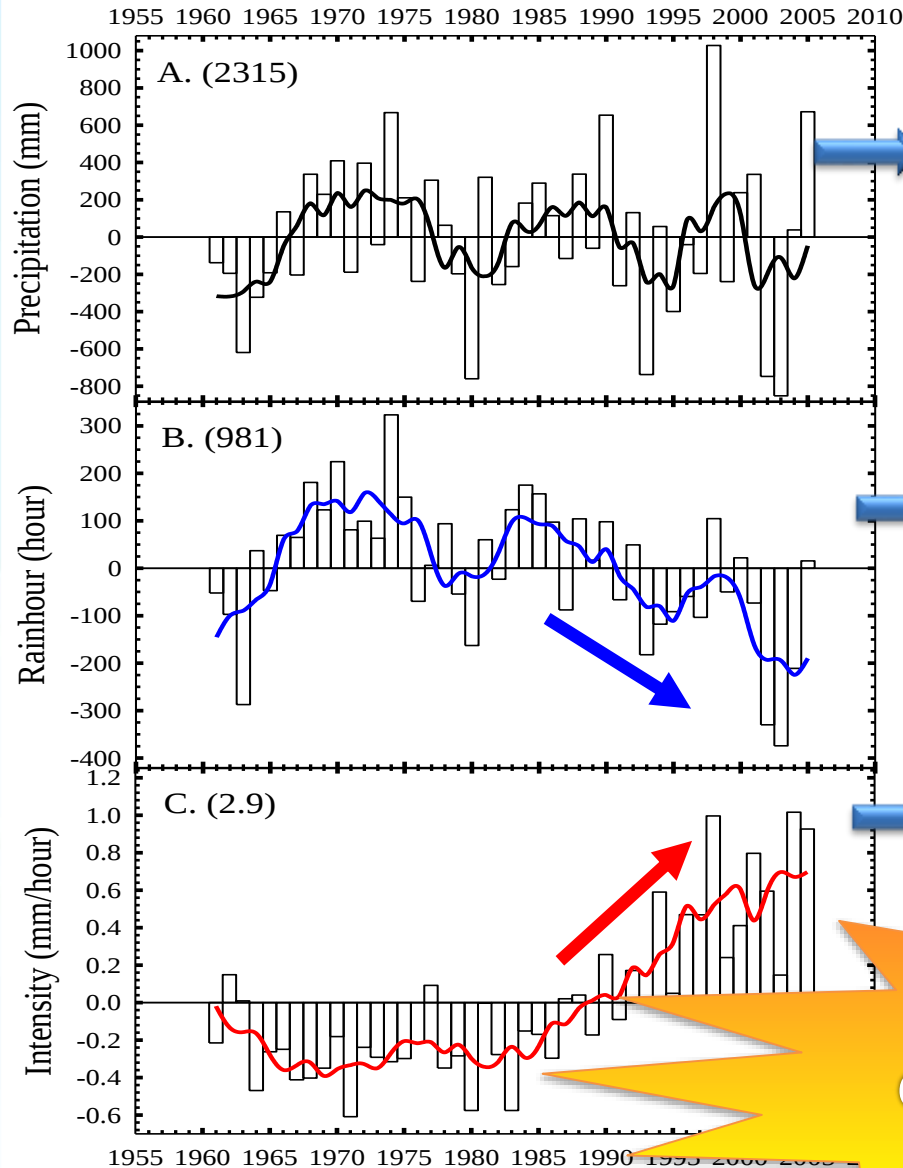
- 100年趨勢：0.14°C/10年
 - 50年趨勢：0.19°C/10年
 - 30年趨勢：0.29°C/10年



臺灣年平均降雨量旱澇加劇之趨勢



Precipitation trend in Taiwan for the past 55 years



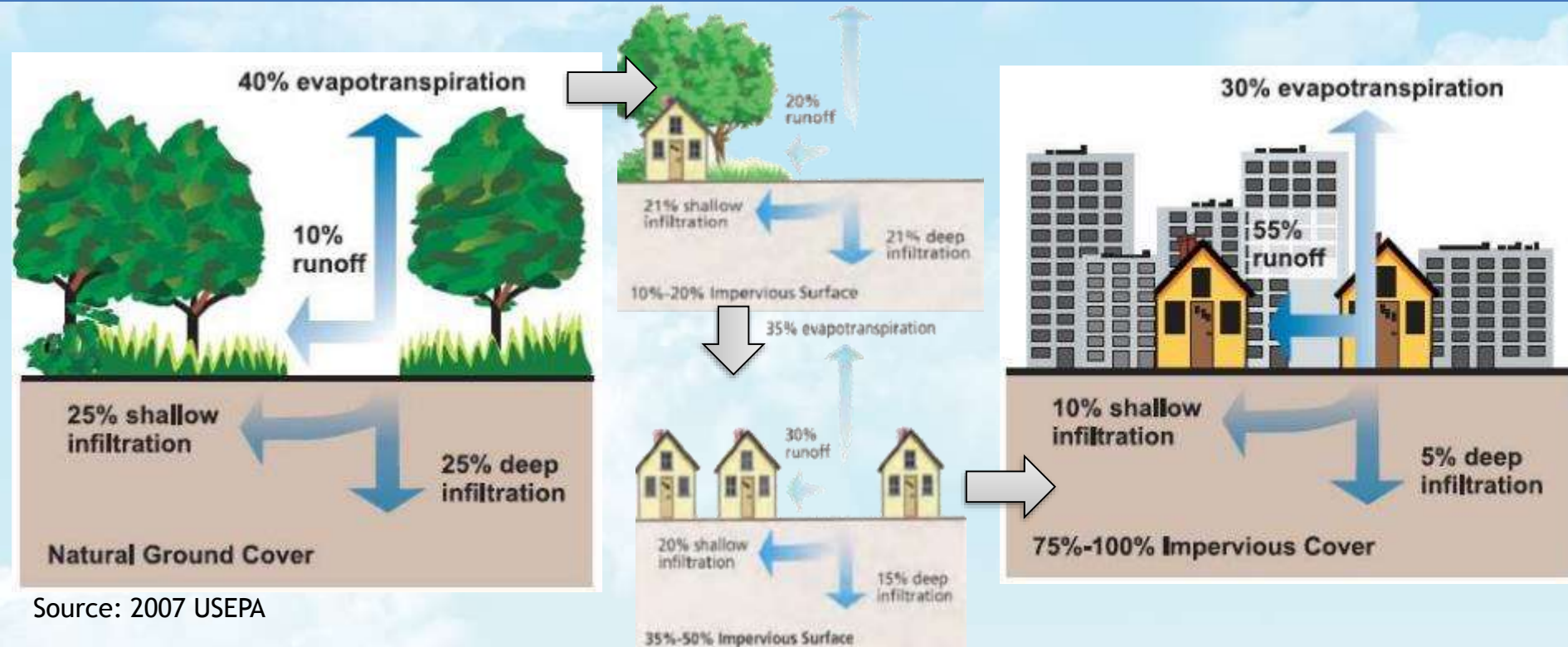
fluctuated but stayed static!

rain hour shortened!

rapid upward trend!

**Facing more
challenging future!!!**

Urban Expansion → Grey Infrastructure (Impervious Surface)



Natural Ground Cover:

50% infiltration, **10%** runoff



75%~100% impervious Surface:

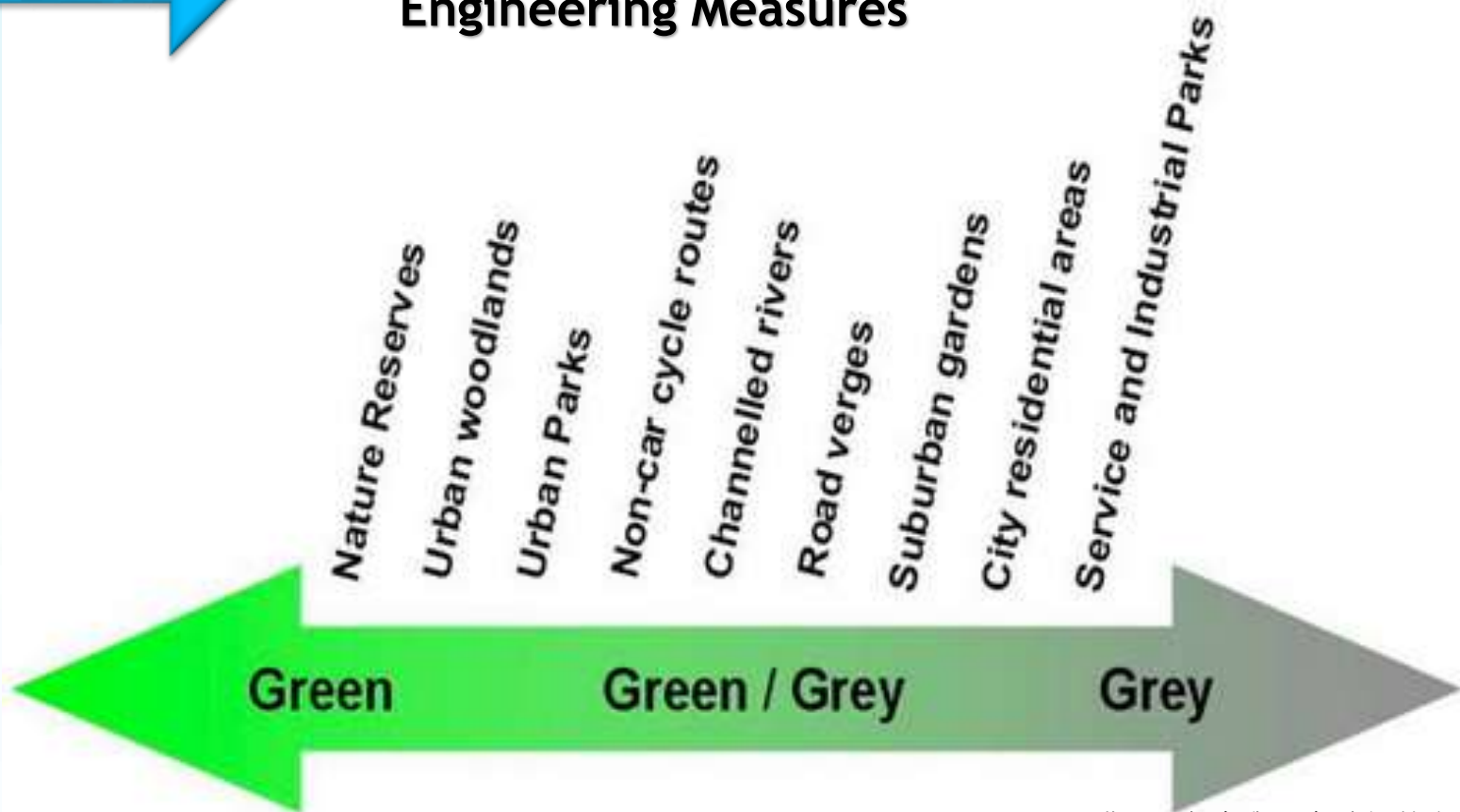
15% infiltration, **55% runoff**

- 💧 Losing water conservation capacity in city,
- 💧 Water comes and goes very quickly.

Does Green Infrastructure totally take the place of Grey?

NO!

- Replacing the Design and Management Principle
- Cooperating and Integrating with Traditional Engineering Measures



Water & Green Taipei City



植樹造林
afforestation

溪流整治
Stream management

翡翠水庫
Emerald Reservoir

雨量站
Rainfall Station

沉砂池
Settling Basin

調洪池
Settling Basin

公園生態化
Ecological Park

河濱公園
Riverside Park

生態濕地
Ecological wetland

抽水站
Pumping Station

污水處理及再利用
Sewage Treatment and recycling

綠屋頂
Green Roof

雨水再利用
Rainwater Recycling

雨撲滿
Rainwater Tank

透水鋪面
Water-Permeable Pavement

雨水花園
Rainwater Garden

都會區地下滯洪池
Urban underground detention facility

透水鋪面
Water-Permeable Pavement

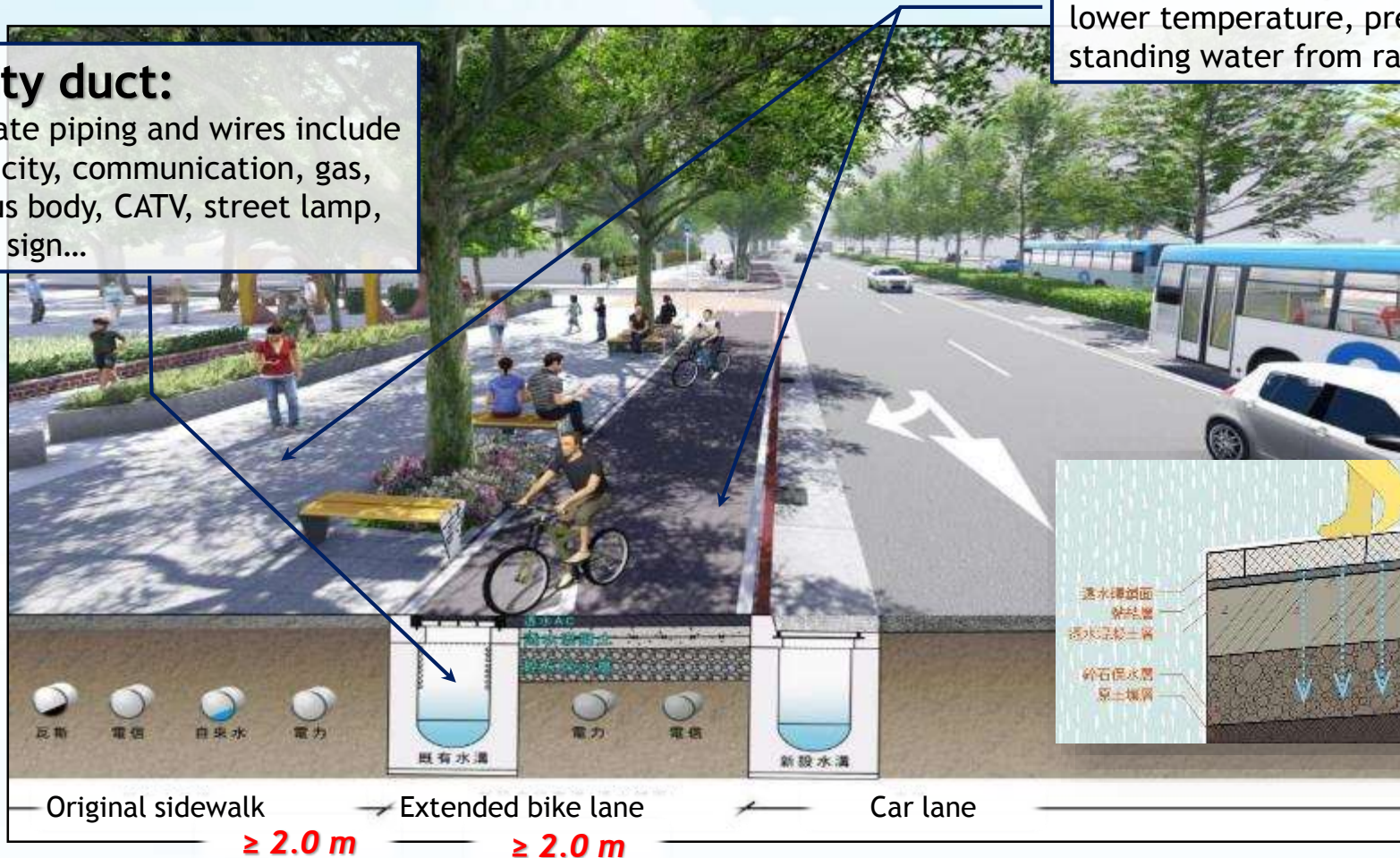
Over **170,000 m²** permeable **sidewalk** is constructed until the end of 2018. Except sidewalk, **schools, parks, squares, parking lots** and other **open spaces** are also considered.

Utility duct:

integrate piping and wires include electricity, communication, gas, gaseous body, CATV, street lamp, traffic sign...

Permeable pavement:

lower temperature, prevent standing water from raining.





羅斯福路5、6段



新生南路3段



復興南路(大安高工)

Monitoring and Modeling



Permeable pavement + underground rainwater storage + strip planting zone

大安高工前SWMM水理模式地表逕流消削減效益評估

透水鋪面衰減效益監測場址(南港經貿園區港後公園旁監測面積10m²)

監測場址配置圖

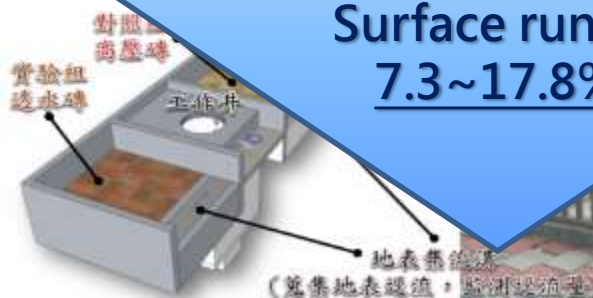
- ❖ 降雨入滲分析：降雨
- ❖ 溫度效益分析：不同
- ❖ 環境因素：風速、風

Monitoring results:

Peak temp.
2.05~3.53°C

Surface runoff
7.3~17.8%

百葉箱
(內設溫度及濕度計)



監測場址3D示意圖

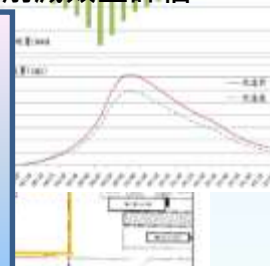


監測場址現場照片

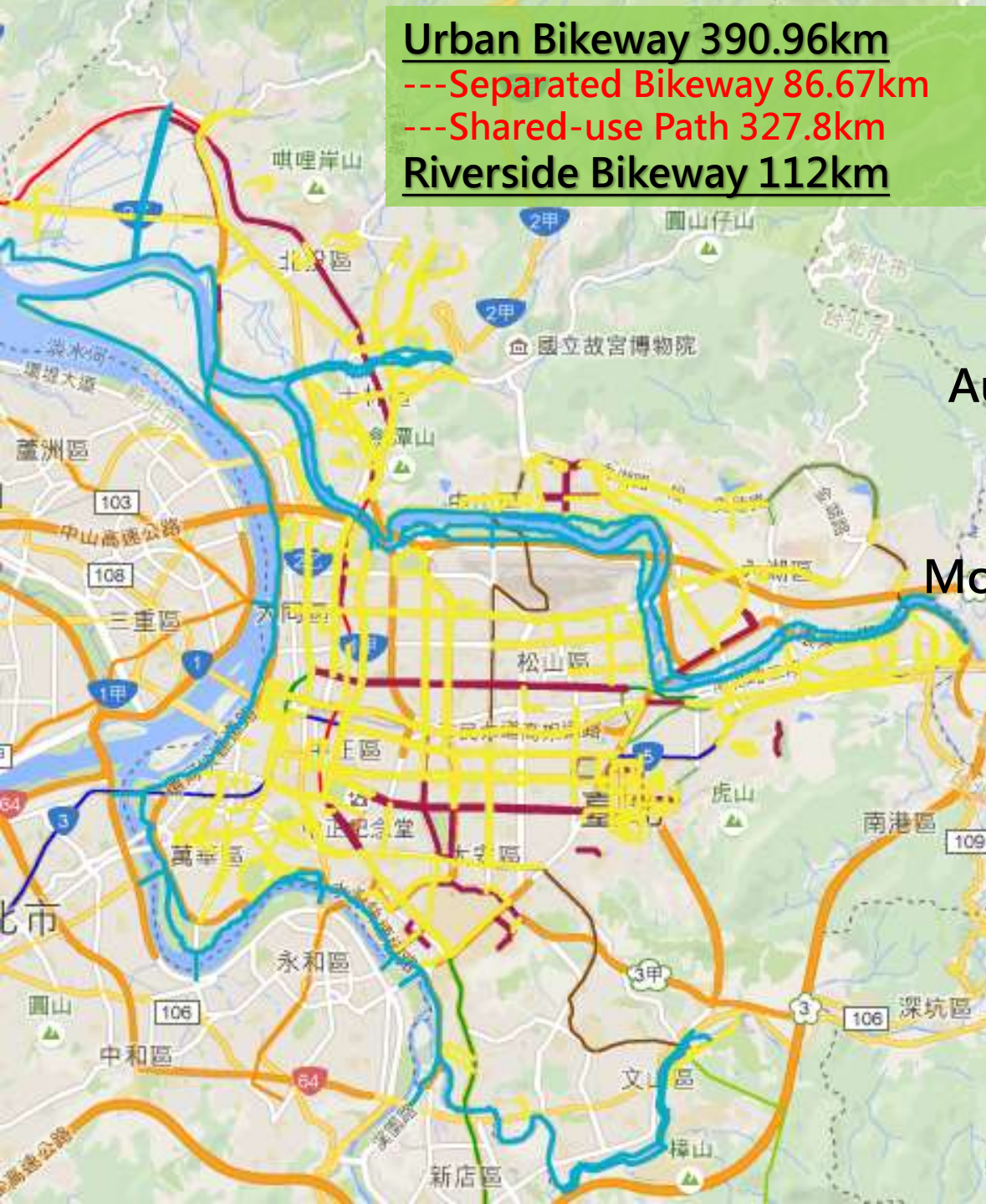
資料來源:2017/3/29臺北水環境論壇-臺北市政府簡報

Modeling results:

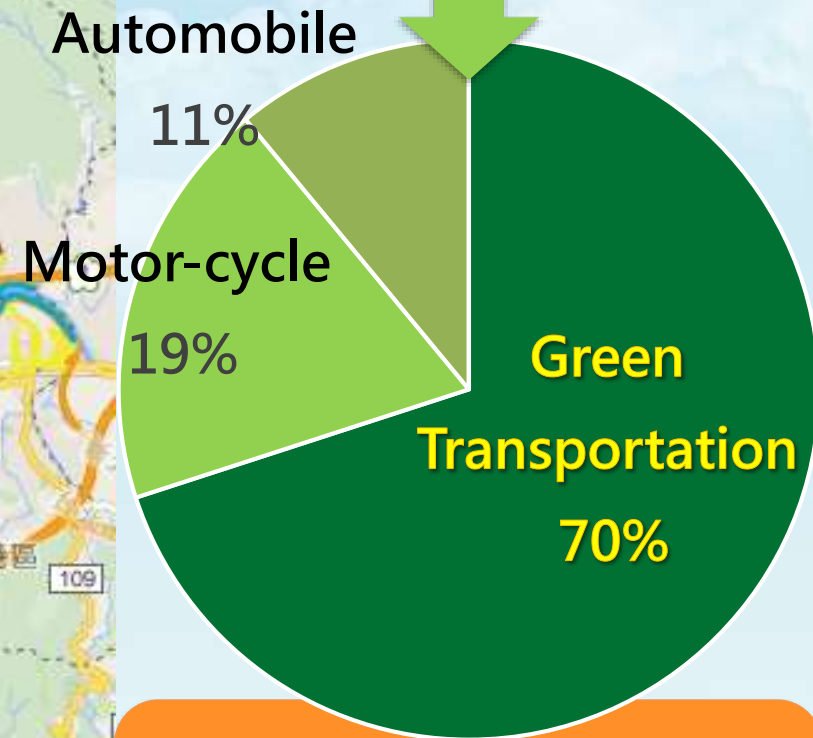
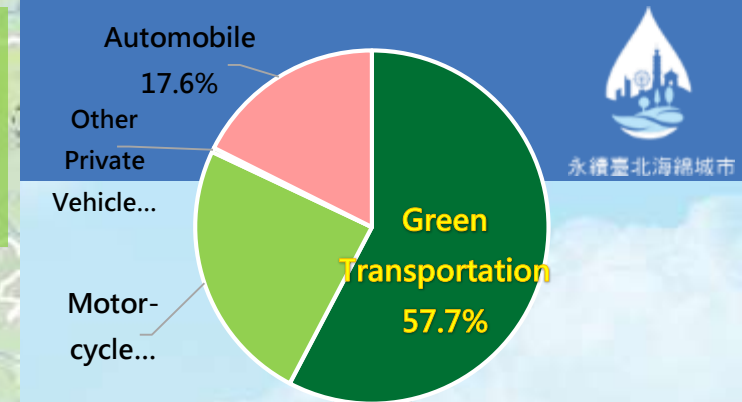
Reduce surface runoff
18.2~37.6%



2016/8/8現地透水試驗地點



Urban Bikeway 390.96km
 ---Separated Bikeway 86.67km
 ---Shared-use Path 327.8km
Riverside Bikeway 112km



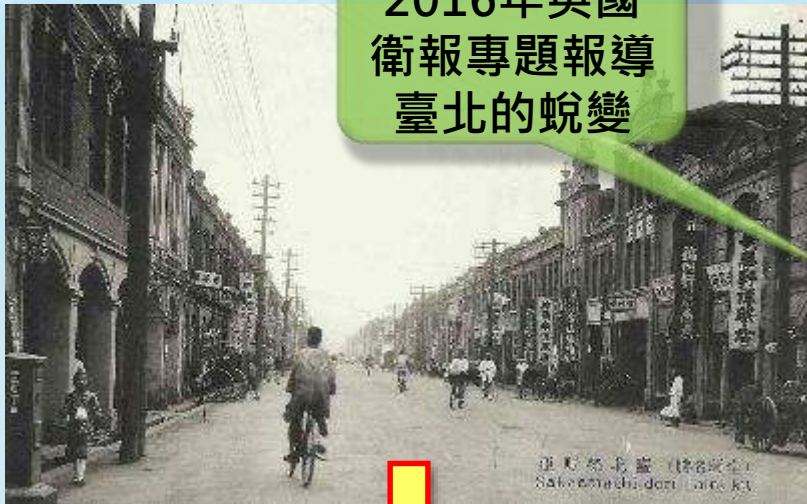
By 2020 —
 Green Transportation: 70%
 Cycling: 12%

2016年英國
衛報專題報導
臺北的蛻變

Tuesday 15 March 2016 10.07 GMT

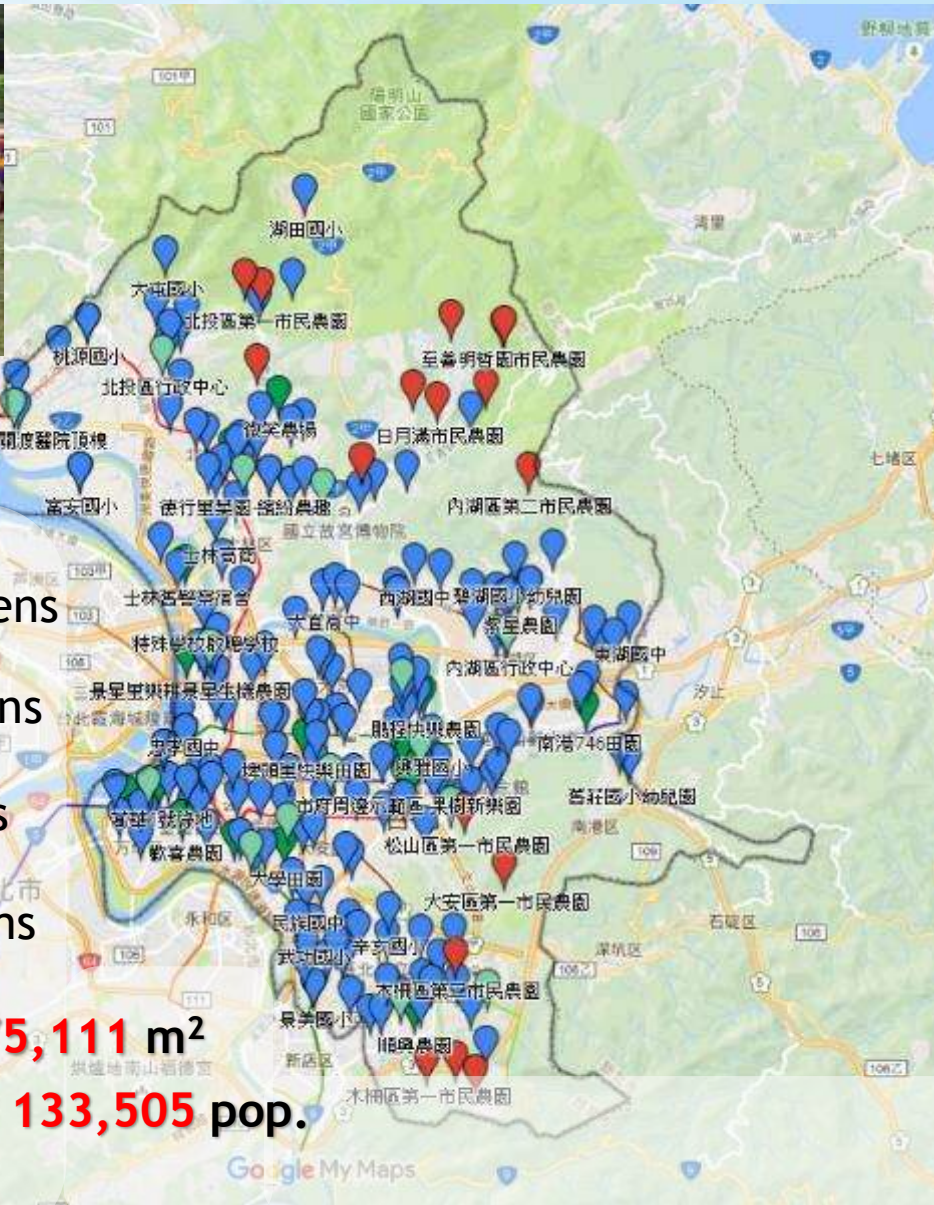


透過綠色基礎設施建設，促進綠色運輸發展！
透水、保水、蒸發 → 環保、健康、永續



Resilient and Adaptive City -Restore Urban Water Cycle

Garden City



Before Comprehensive Urban Watershed Management

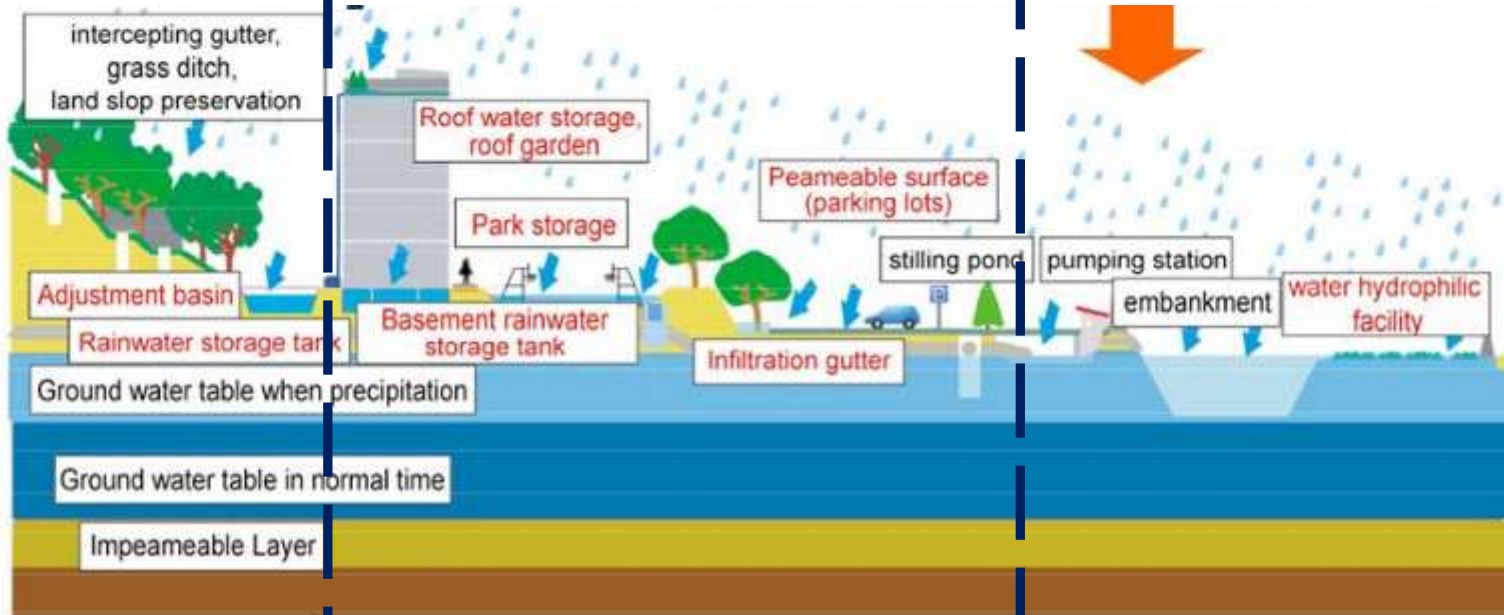


Conservation Zone

Detention Zone

Flood-proof Zone

After Comprehensive Urban Watershed Management





上游保水 Upstream water conservation
山坡地水土保持 slopeland water and soil conservation



中游減洪 Midstream flood detention
金瑞治水園區 Jinrui flood management park



下游防洪 Downstream flood prevention
堤防 抽水站 dike and pumping stations

Urban Watershed Management (Jin-Rui Flood Management Park)

Watershed of the drainage system: 750 ha

- **Conservation (upstream):**
Jin-Rui flood management park (detention/sedimentation pond)
27,000 m³, manage 28% of the total watershed.
- **Retention (midstream):**
Bihu lake (retention pond)
- **Flood-proofing (downstream):**
pumping Station/
pressure box culvert/flood wall

Flood Management

Leisure & Education

Ecological Environment



Resilient and Adaptive City

-Increasing Flood-Resisting Capacity

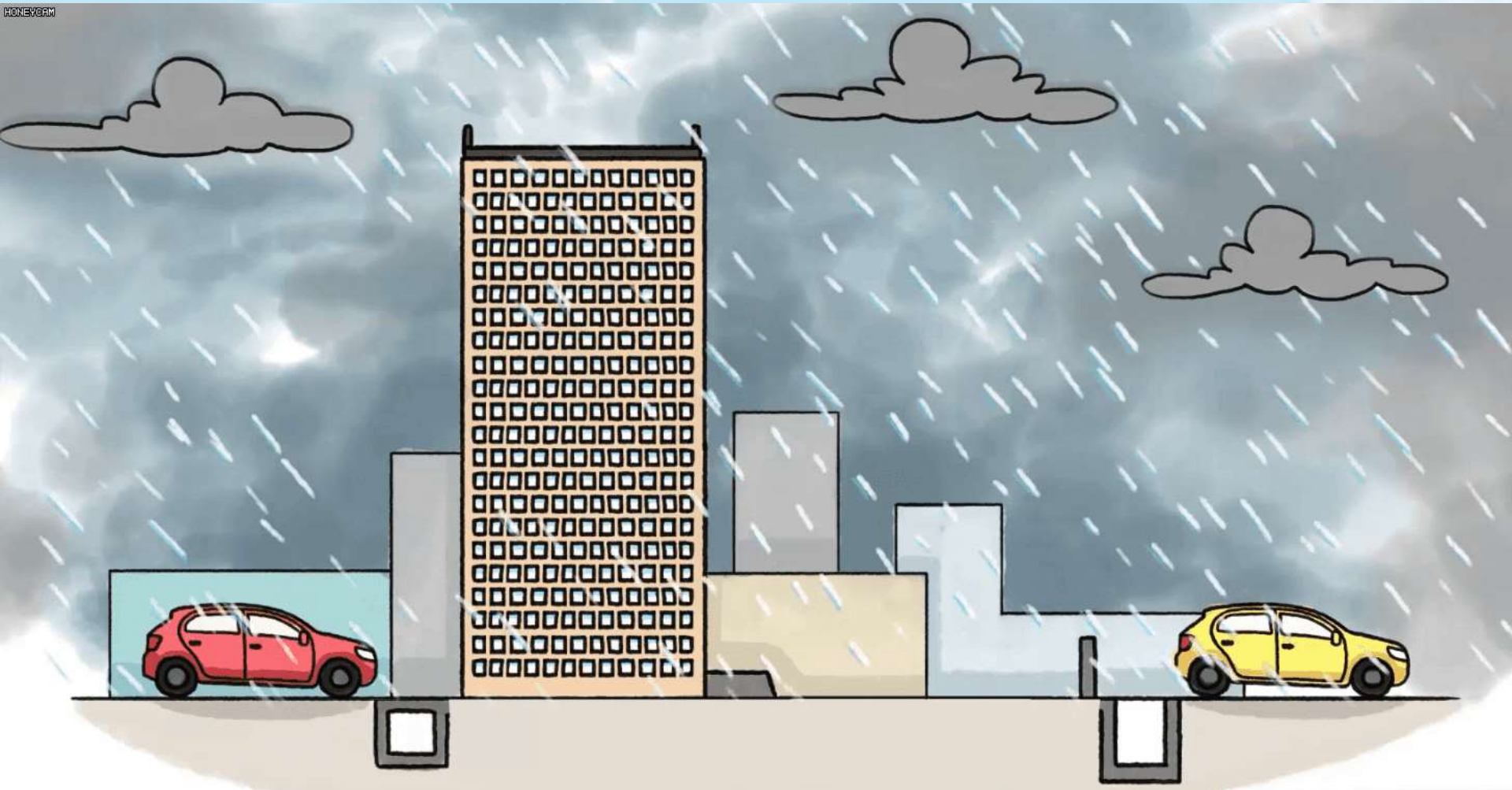
- "On-site rainwater runoff discharge standard for urban land development in Taipei City" issued in 2013
- Rainwater runoff discharge of a development site should **NOT** greater than the its original discharge.
- Both public and private sector totally **507** projects were accomplished and contributed over **100,000 m³** detention volume.

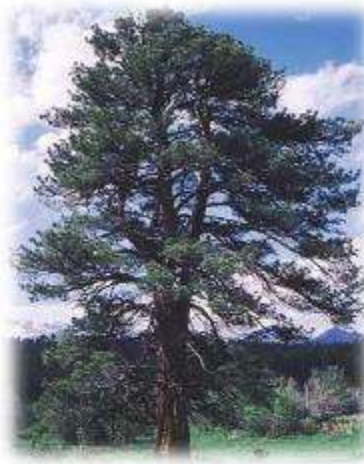


Minimum conservation volume: $0.078 \text{ m}^3/\text{m}^2$
 Maximum discharge volume: $0.0000173 \text{ cms}/\text{m}^2$

Infiltration + ~~Conservation~~ + ~~Detention~~ + ~~Retention~~ + ~~Evapotranspiration~~

Traditional Grey Infrastructure





將每棟建築變成一顆樹

To transform each building into a tree



將城市變成森林

Then turn city into a forest

Sustainable Water Usage -Diverse Water Reuse

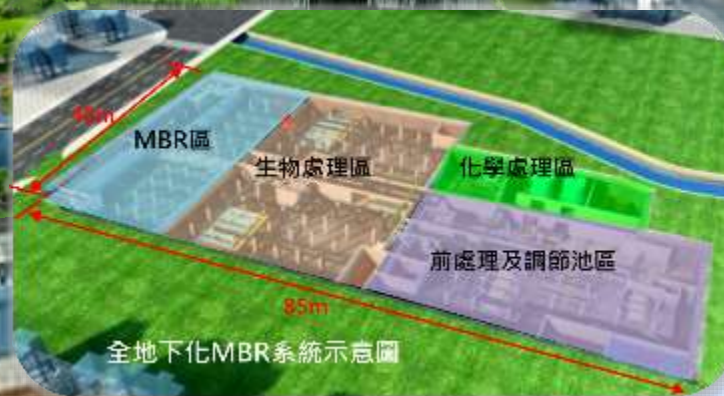
Decentralized Sewage Treatment System - Promoting the use of Reclaimed Water

智慧、生態、節能、綠建築

Water Education Park

- 整合撫遠公園環境景觀
- 改造及活化民生廠環境

Multifunctional
Commercial Office
Building



Underground Sewage Treatment Plant

- 分擔污水下水道系統污水量
- 提供再生水 20,000CMD

Promoting Reclaimed Water

Cooling, Watering and Landscaping

Producing and collecting

Education and Participation

Wetland Number : 33 sites
Total Area : 2799.831ha

夢幻湖濕地



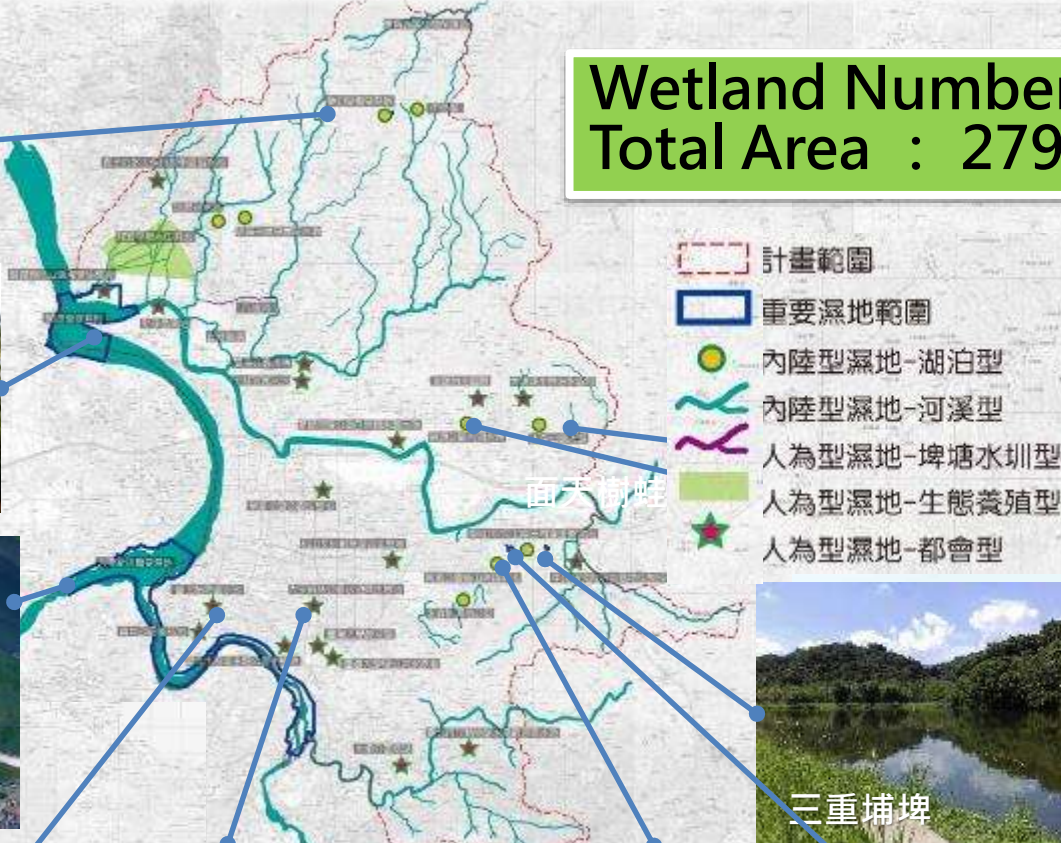
關渡濕地



大漢新店濕地



臺北植物園



大湖公園



三重埔埤



碧湖公園



大安森林公園生態池



後山埤



新庄仔埤

Biodiversity



wetland management



community participation



environment education



Sustainable wetland

Important Wetlands in Taipei

新庄仔埤
(Xinzhuangzi wetland)



三重埔埤
(Sanchongpu wetland)



臺灣藍鵲
(Taiwan blue magpie)



面天樹蛙 (Kurixalus idiotocus)



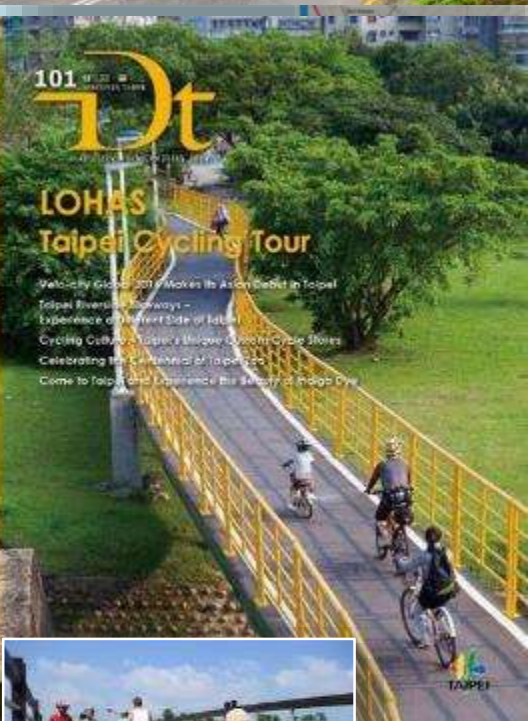
南港周邊重要濕地
(地方級)

面積：2.5公頃
核心區域：新庄仔埤
三重埔埤



23 protected wild species were found in Nangang District, such as butterflies, amphibians, civet (麝香貓), pangolin (穿山甲) and masked palm civet (白鼻心).

Riverside Bikeway Satisfaction reached 97% in 2016



項目	單位	數量
自行車道總長度	公里	101.2
自行車道總面積	公頃	1,112
自行車道總經費	億元	1.1
自行車道總管理費	萬元	111.2
自行車道總維護費	萬元	111.2
自行車道總使用人數	萬人	111.2
自行車道總滿意度	百分比	97%
自行車道總安全率	百分比	97%
自行車道總舒適度	百分比	97%
自行車道總便利度	百分比	97%
自行車道總可及性	百分比	97%
自行車道總可持續性	百分比	97%
自行車道總社會效益	億元	1.1
自行車道總環境效益	公頃	1,112
自行車道總文化效益	萬元	111.2
自行車道總健康效益	萬元	111.2
自行車道總教育效益	萬元	111.2
自行車道總娛樂效益	萬元	111.2
自行車道總其他效益	萬元	111.2

Vibrant Water Environment

-Promote Waterfront Activities



Kids Water Festival



Music Festival



Dragon Boat Festival



Picnic



Sports



Fireworks

臺北市水綠地圖

Taipei Water & Green Map

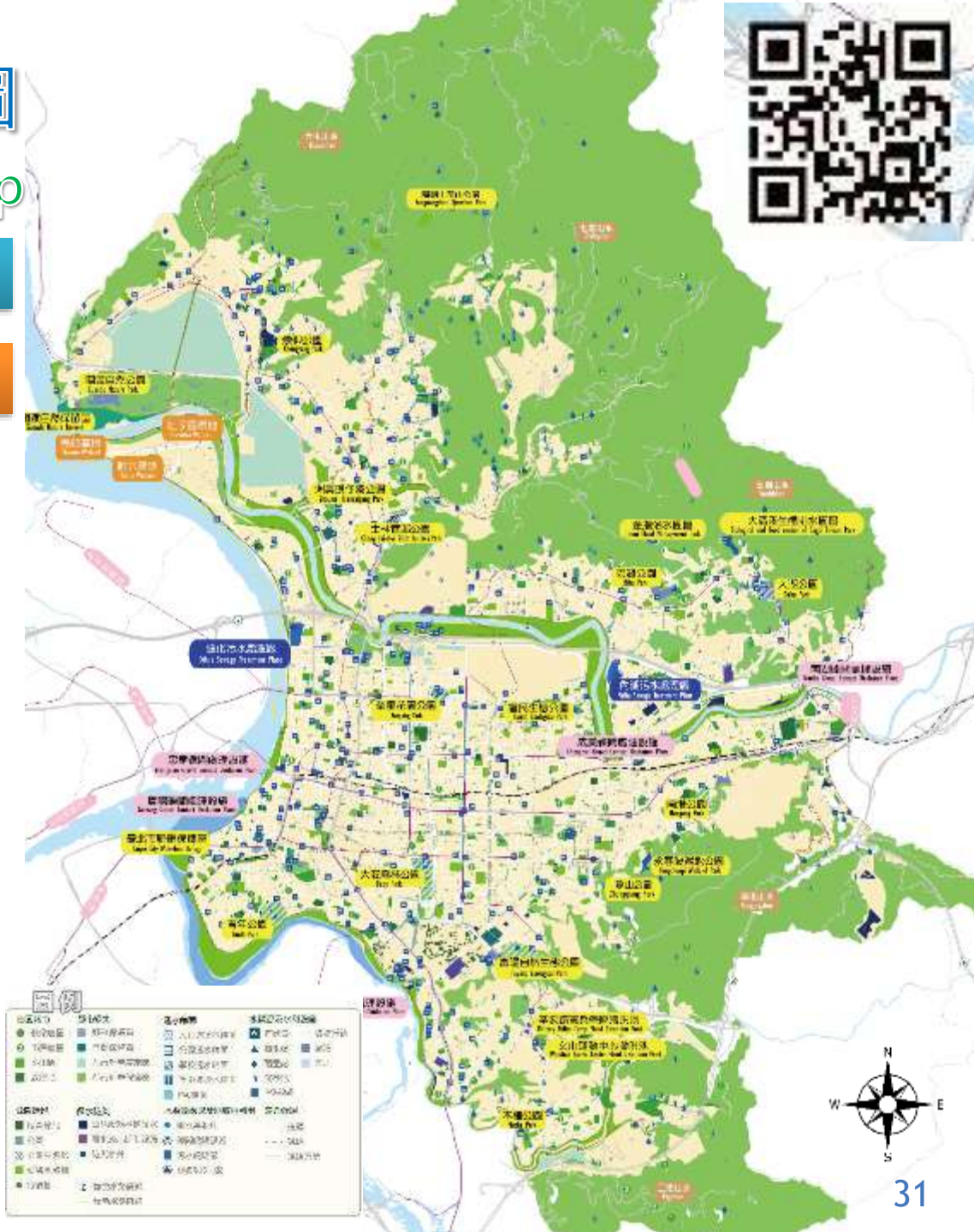
120,000 Digital Big Data

Feedback to Policy Design



水環境占全市面積
4.63%

綠環境占全市面積
54.2%



2030 Water & Green Taipei City

Vision 1: Building a Sustainable City

Goal: Green Infrastructure Area reaches 80%
of all City Public Works

Ecology Parks (12座生態公園)

Sidewalk Improvement Project

(透水鋪面效益：溫度 $2.05\sim 3.53^{\circ}\text{C}$ 、地表逕流 $7.3\sim 17.8\%$)

Garden City & Green Roofs

(515處田園基地、面積13萬8,547 m^2)



2030 Water & Green Taipei City

Vision 2: Resilient City under Public-Private Partnerships

Goal: Torrential Rainfall Resisting Capacity reaches
88.8mm/hr.

Stormwater Sewer (522公里延壽)

Comprehensive Urban Watershed Management

(分流導洪隧道、金瑞治水園區、地下滯洪池)

Public-Private Rainwater Runoff Discharge Suppression

(507建案保水量100,000m³)

Parks Rainwater Detention (780m³/hectare)

Open Data+ Community-Based Risk Management

(淹水模擬圖、防災APP、防水閘門、落葉垃圾清掃)

2030 Water & Green Taipei City

Vision 3: Enhancing Water Resources Reusing

Goal: Recycled Water reaches 16% of all the Treated Wastewater

Decentralized Sewage Treatment System

(民生、濱江水資源中心、水質提昇、環境教育、民眾休憩)

Reuse & Recycle of Energy & Resources from Wastewater Treatment

(再生水再利用、污泥乾燥、沼氣回收)

Welcome to Taipei



***Resilient
Adaptive***



***Sustainable
Reusing***



***Vibrant
Livable***



Thank you for Listening!