

Nature-based Climate Adaptation Programme for the Urban Areas of Penang Island

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16 June 2026



thinkCITY

Event:

River Flooding Adaptation and Resilience (RIFAR) Challenge



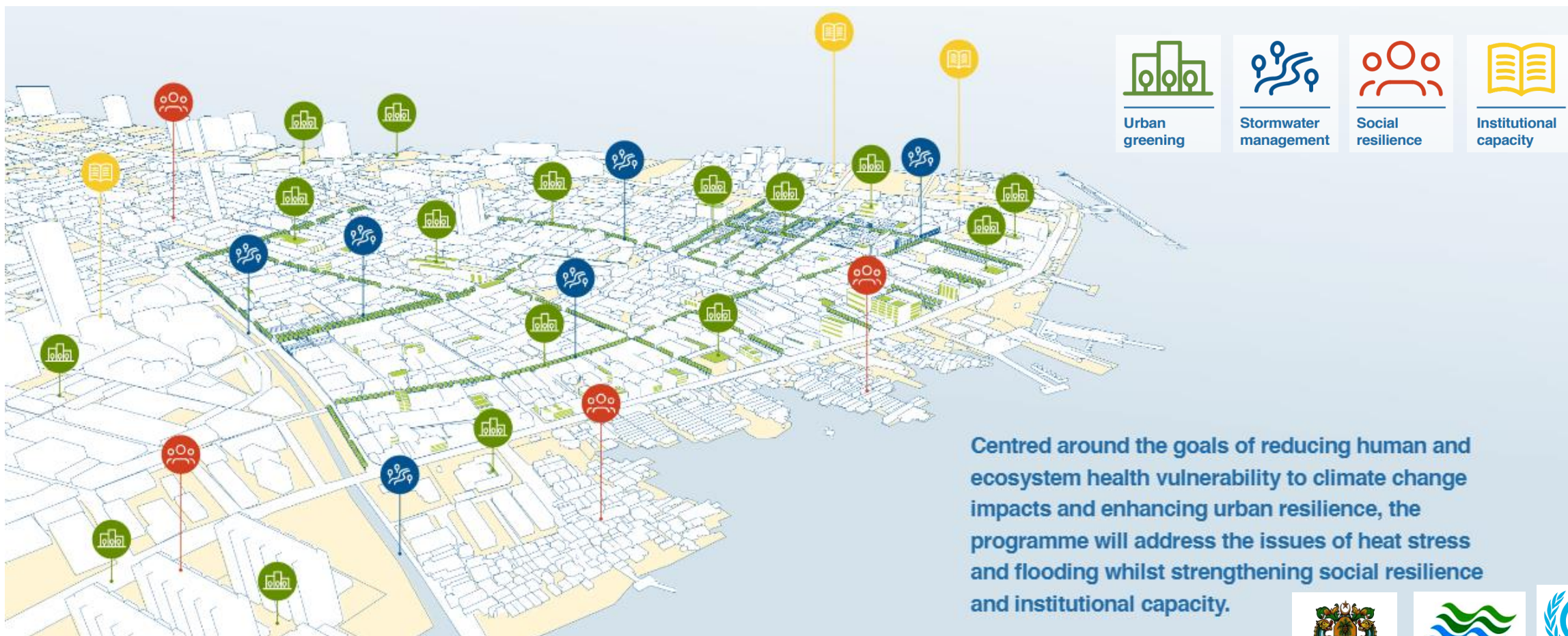
CONTENTS

- 1 The Penang Climate Adaptation Programme
- 2 Climate-related flooding challenges
- 3 The nature-based solutions approach

Initiated in 2019 by Think City, it is the first urban climate adaptation programme in Malaysia

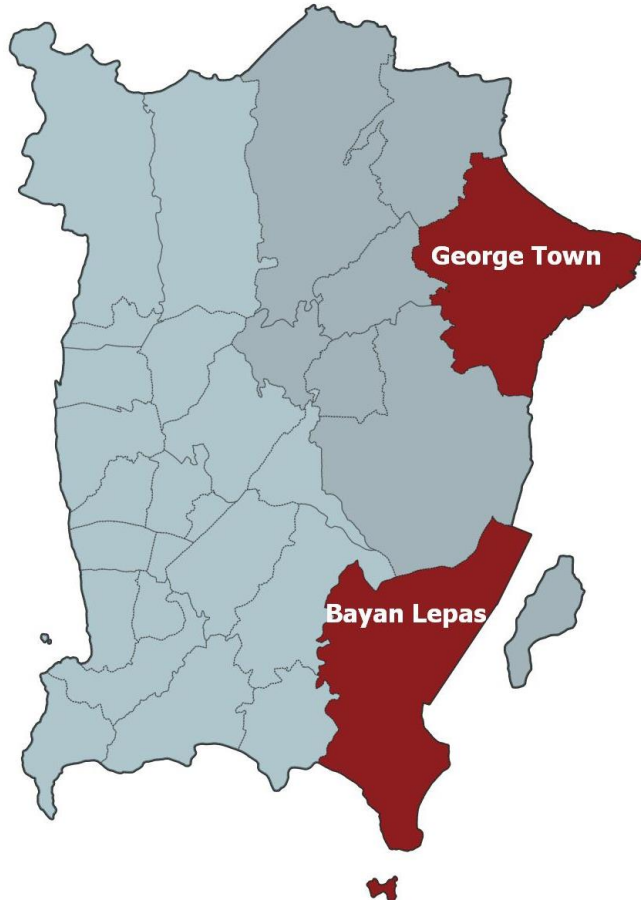
OBJECTIVE : To use nature-based solutions to reduce climate change impacts in Penang, reducing threats to human life, infrastructure and property

APPROACH : Science-driven in design and results / impact assessment



PROJECT LOCATION

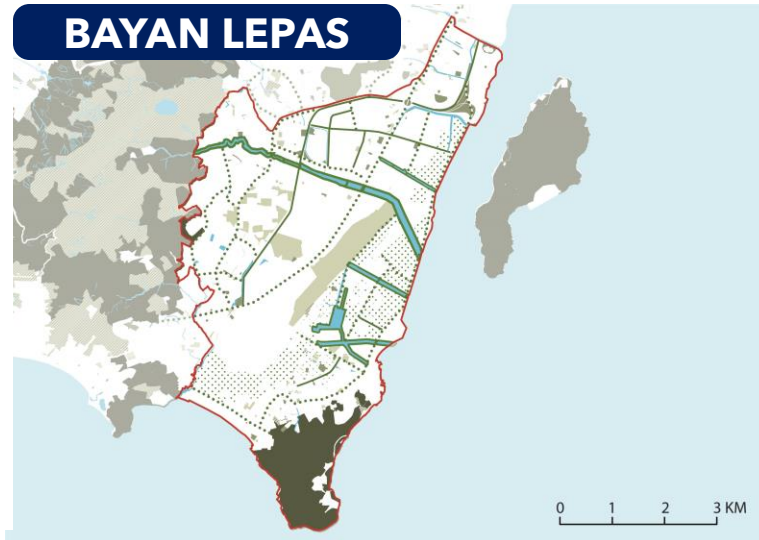
George Town and Bayan Lepas



GEORGE TOWN



BAYAN LEPAS



FUNDING

USD 10 million from the Adaptation Fund

MULTI-LATERAL IMPLEMENTING ENTITY

UN-Habitat

NATIONAL DESIGNATED AUTHORITY

Ministry of Environment and Water (KASA)

EXECUTING ENTITIES

MBPP
JPS Penang
Think City

PROJECT DURATION

5 years

THE PROBLEM

High vulnerability due to location and development stage



HEAT STRESS

Penang is expected to experience a minimum temperature rise of 1.5°C (up to 6°C in heat waves) by 2030, compared to 2018.



FLOODING

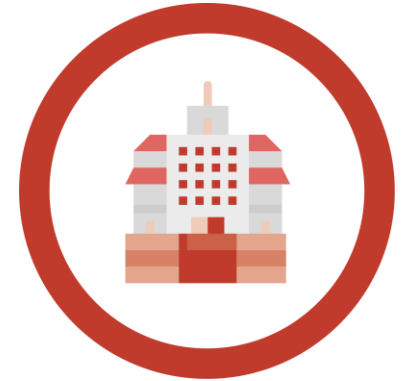
In Nov '17, the heaviest rainfall registered in Penang's history led to flooding causing the loss of 7 lives and more than 1 billion RM in damages.



SOCIAL

Vulnerable communities, women and girls are disproportionately impacted by climate change.

Youth is unengaged.



INSTITUTIONAL

Most hospitals do not identify heat stress/stroke.

No municipality adaptation framework has been developed yet.

There is no unit for disaster risk reduction.

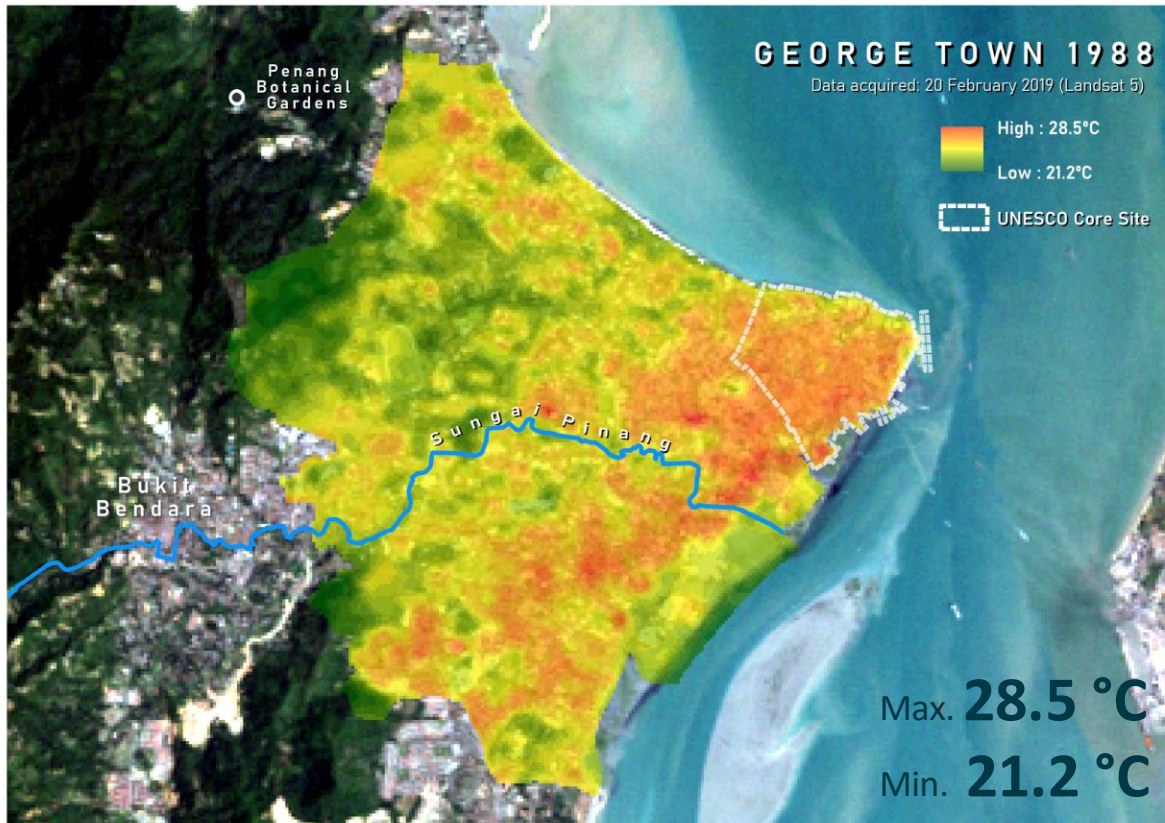
MAIN CLIMATE IMPACTS

GEORGE TOWN

Increase of temperature in the last 32 years
(verified by remote sensing data on surface temperatures - Landsat 8)

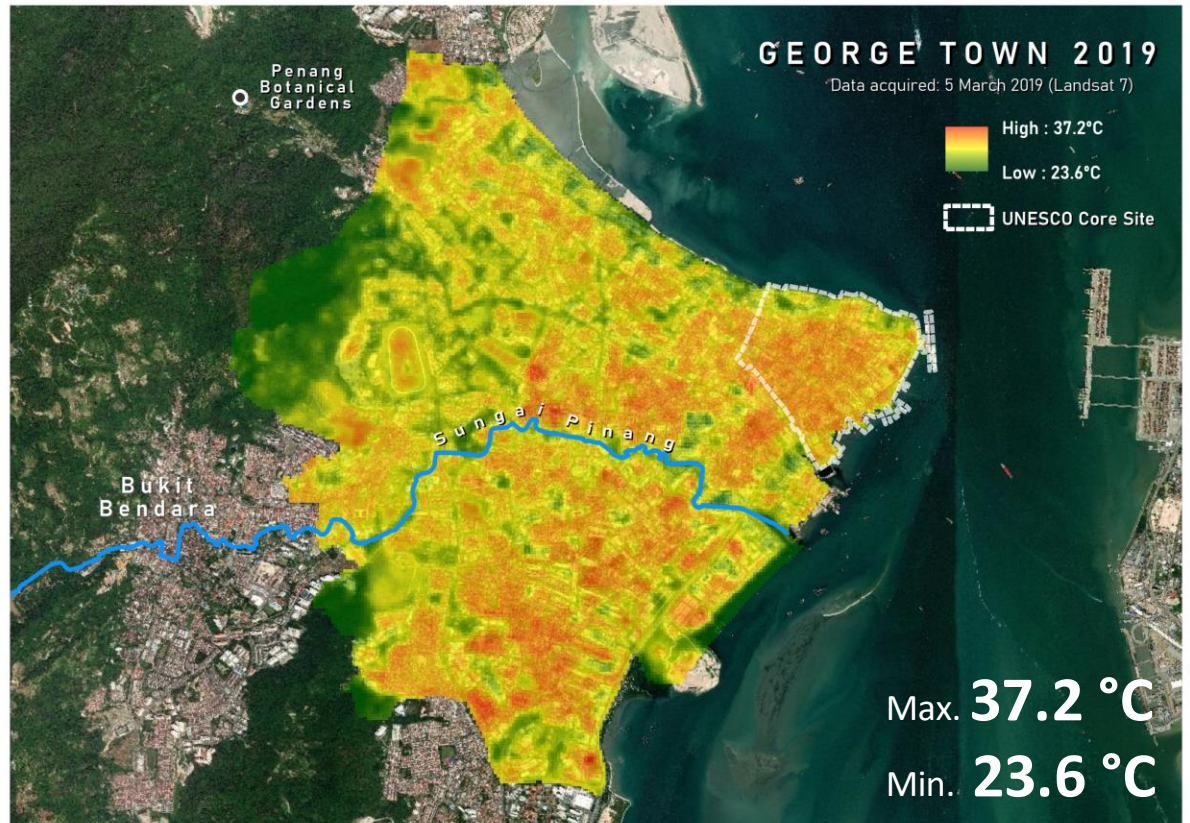
↑↑ **Max. 8.7°C**
↑↑ **Min. 2.4°C**

1988



George Town - Land Surface Temperature, 1988

2019



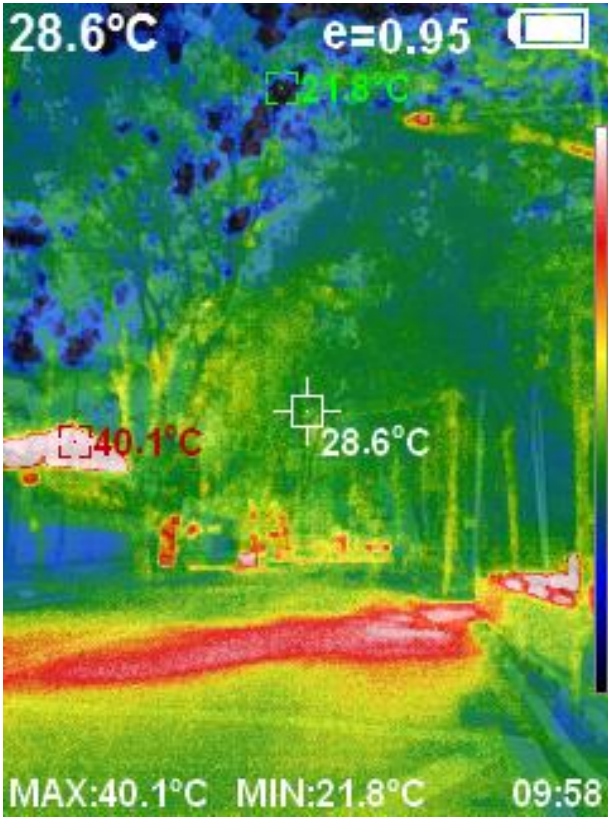
George Town - Land Surface Temperature, 2019

MAIN CLIMATE IMPACTS

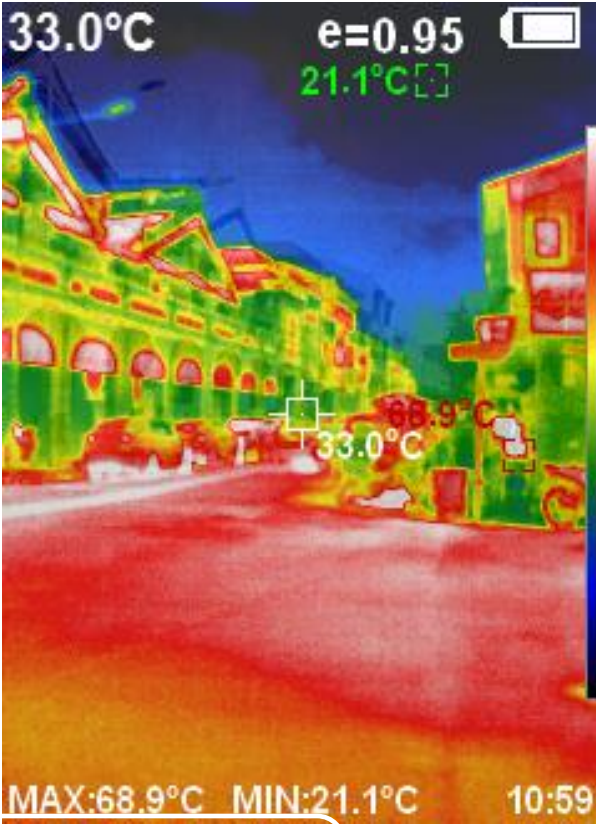


MAIN CLIMATE IMPACTS

Thermal imaging reveals up to almost 30C° degrees in difference in surface temperatures between the coolest and the hottest areas of the city. The difference is due to the existence of green spaces.



Jalan Brown
12.07.2019
9.58am



Lebuhraya Gereja
12.07.2019
10.59am

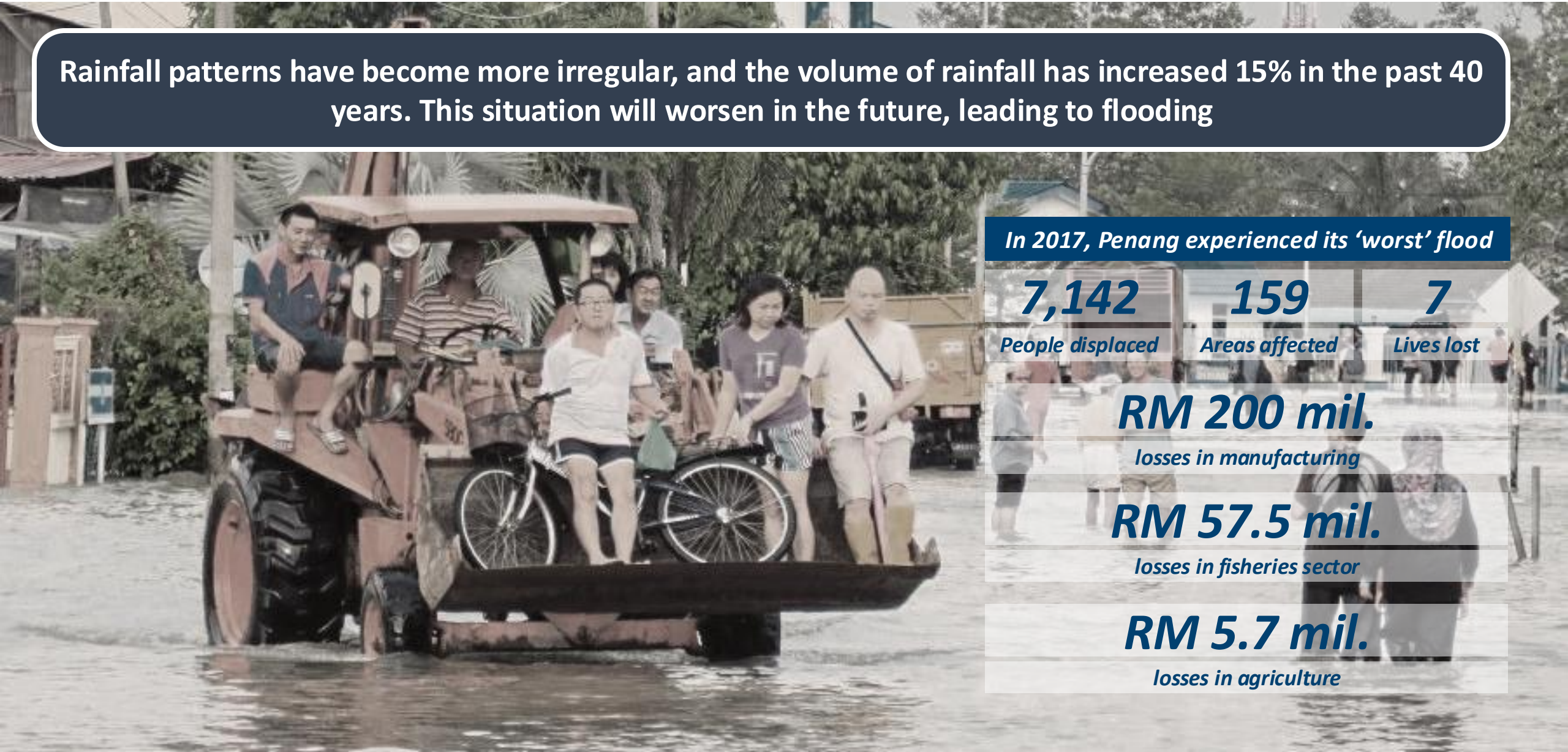


An increase of almost 30°C

Source: Images produced by Think City with Perfect Prime IR0006 Thermal Imager Camera.

MAIN CLIMATE IMPACTS

Rainfall patterns have become more irregular, and the volume of rainfall has increased 15% in the past 40 years. This situation will worsen in the future, leading to flooding



In 2017, Penang experienced its ‘worst’ flood

7,142	159	7
People displaced	Areas affected	Lives lost

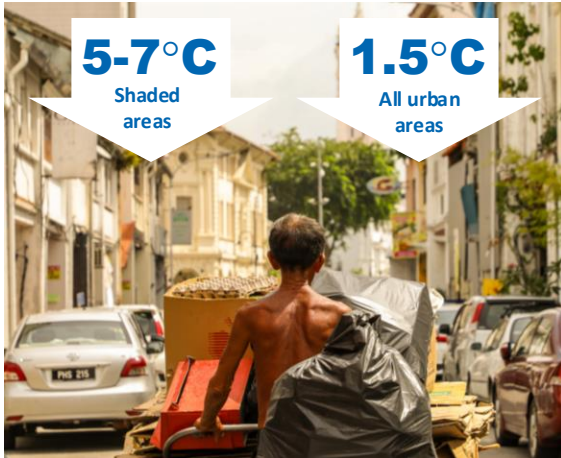
RM 200 mil.
losses in manufacturing

RM 57.5 mil.
losses in fisheries sector

RM 5.7 mil.
losses in agriculture

THE PROGRAM

GOAL 1



Reduce temperatures and UHI effect by strategically planting trees and introducing green spaces in the city

GOAL 2



Reduce and if possible eliminate the number of flooding events

GOAL 3



Strengthen social resilience, vulnerable communities, women and girls empowered

GOAL 4

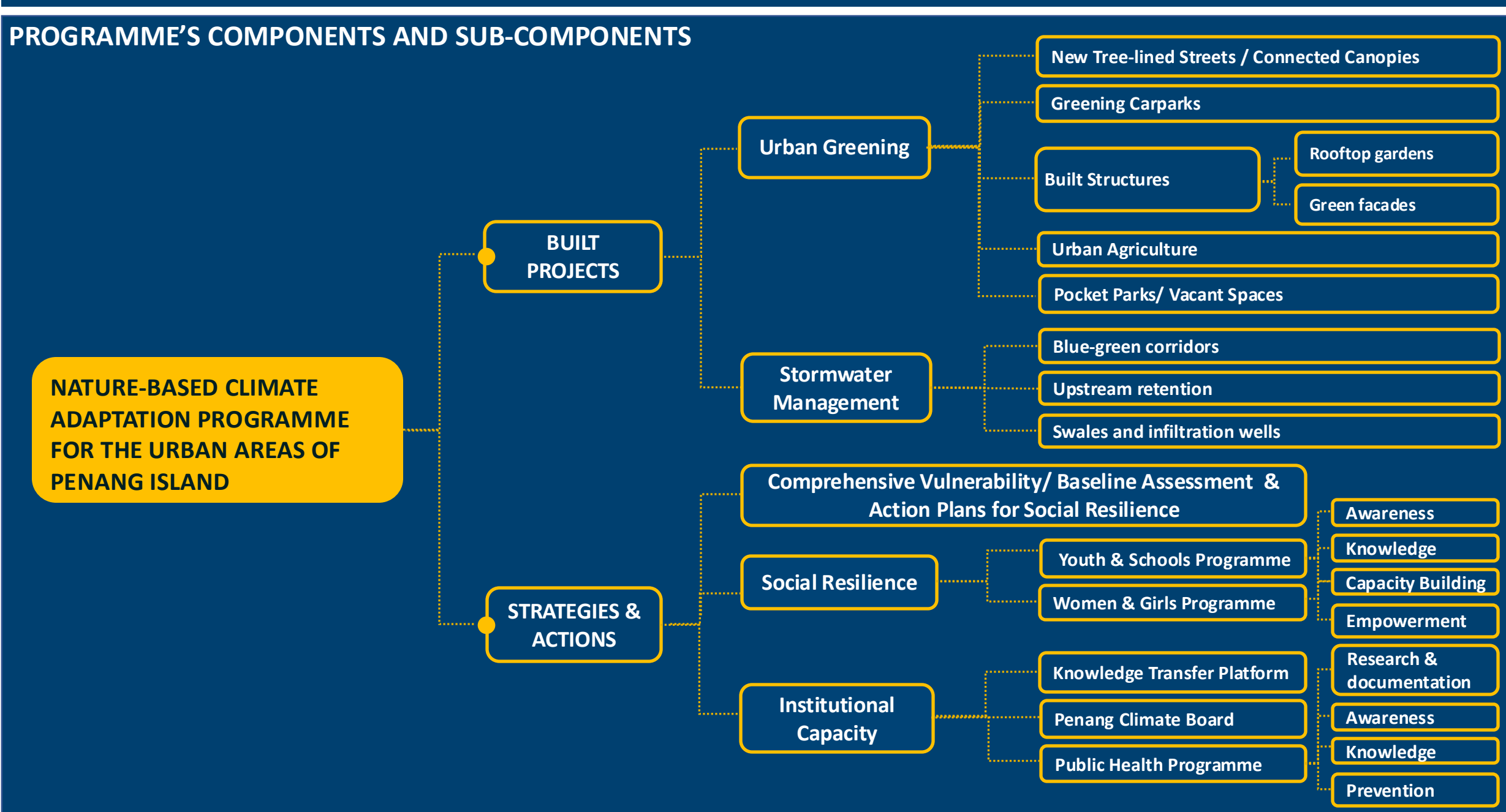


Institutional capacity in public health reinforced

Knowledge management platform created for municipal adaptation

Climate-resilient urban tree species study developed

PROGRAMME’S COMPONENTS AND SUB-COMPONENTS





Reduction of 1.5°C in temperatures in urban areas and 5-7°C in shaded areas 6-8 years after completion

Improved government knowledge and capacity to reduce and manage climate impacts

Reduced GDP losses due to flooding

Reduced impact on public health/ improved understanding of heat-related diseases

Improved community readiness

Reduced vulnerability asymmetries in the community

The framework for urban adaptation and the assessment of impact of the programme will be shared with other Malaysian and Southeast Asian cities

1. The Penang Climate Adaptation Program

EXHIBITION, OCTOBER 2020



COMMUNITY OUTREACH, JUNE - AUGUST 2020



International recognition

The Penang Nature-Based Climate Adaptation Programme won the Climathon Global Cities Award 2020, having been shortlisted among five city programmes from a pool of more than 100 cities.

Miami, USA

Karthoum, Sudan

Dublin, Ireland

Penang, Malaysia

Salvador, Brazil



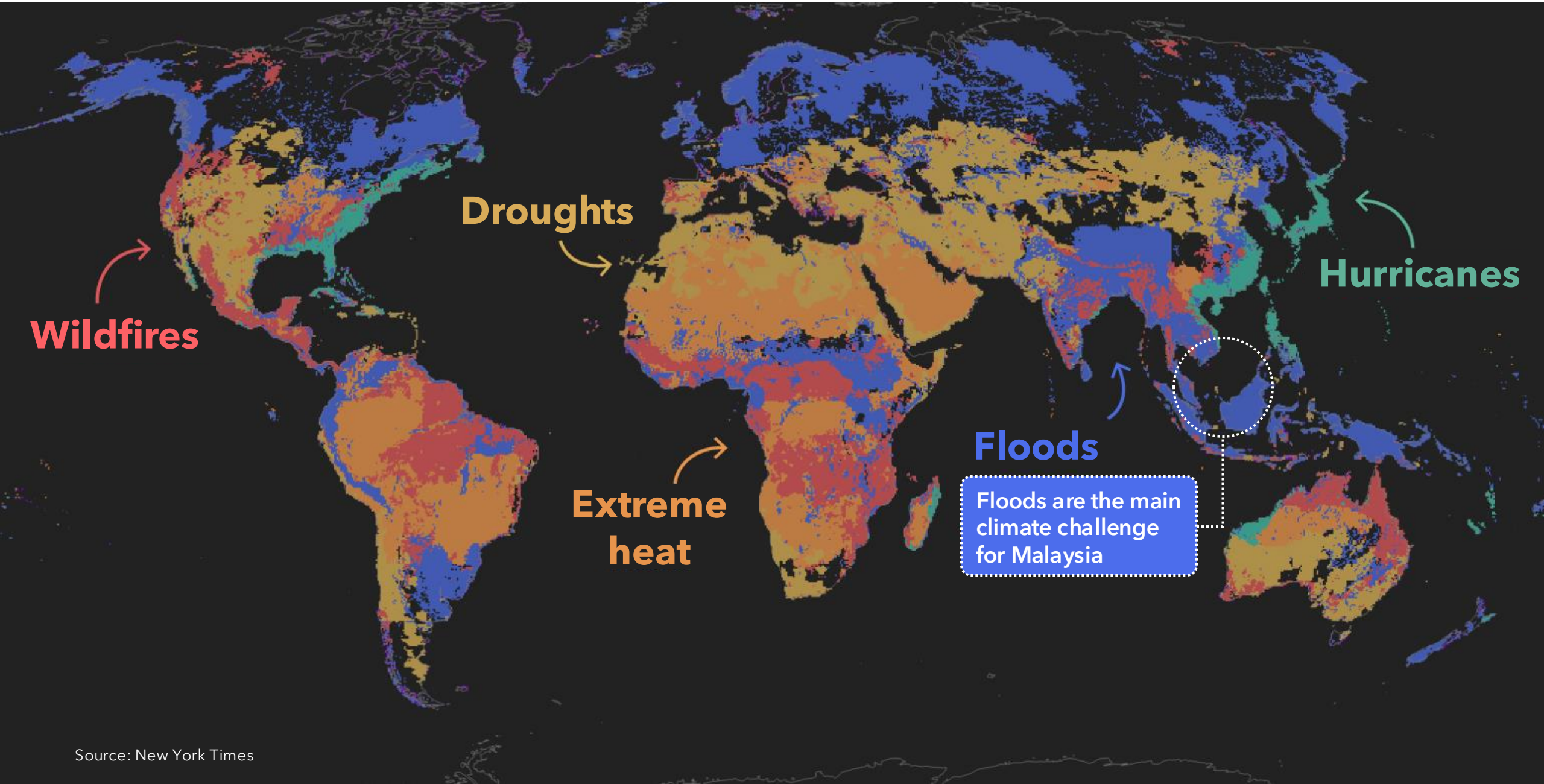
JANUARY 2020



OCTOBER 2021



The programme was endorsed to receive US\$10 million in funding for implementation in 2021. Implementation started in 2022.



CLIMATE-RELATED WATER CHALLENGES

Increase in volume of rainfall (15% since 1980)

Changes in rainfall patterns
(more concentrated rainfall/prolonged droughts)

Sea level rise
Estimated at 4mm/year

COMPOUNDED BY URBANISATION CHALLENGES

THE STRAITS TIMES

Peninsular Malaysia hit by '1-in-100-year' rainfall, govt says amid severe flooding

20 DEC 2021



Adding to the complexity of rescue efforts, Malaysia is seeing a surge in Covid-19 cases.

The Guardian

Malaysia's worst flooding in years leaves 30,000 people displaced

19 DEC 2021



Residents being evacuated from a district on the outskirts of Kuala Lumpur.

MALAYSIA TREND

Massive flash flood hits Shah Alam, with water level rising up to 1.2 metres

27 SEPT 2021



Apart from Section 13, residents around Section 9, Section 10, Section 4, and Section 7 also experienced flash floods near their homes.

The Star

Wet weather affecting greens

14 DEC 2020



Prolonged poor weather and a lack of farmland has caused the prices of vegetables to rise sharply.

Climate change is a threat to development

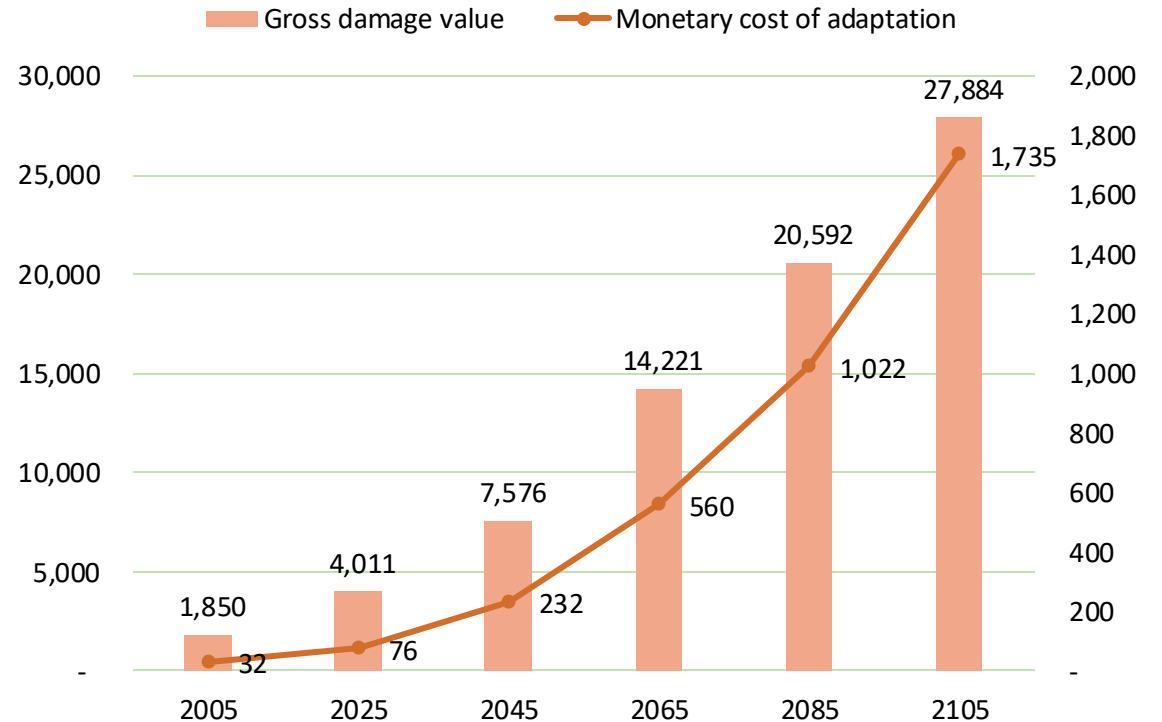
Potential Losses in National GDP
due to Climate Change

-3% GDP decline per year (2040)

Source: Kompas, T., Pham, V. H., & Che, T. N. (2018). The effects of climate change on GDP by country and the global economic gains from complying with the Paris Climate Accord. *Earth's Future*, 6, 1153– 1173.

-6% GDP decline per year (2060)

-12% GDP decline per year (2100)

Climate Change Damage and Adaptation
Cost for Malaysia (RM Million)

Taking adaptation action **NOW** mitigates the rising cost of climate change damage and adaptation implementation **LATER**

“ The volume of rainfall increased 15% in the past 40 years in Malaysia ”

- NAHRIM

Estimates for
Malaysia in 2050

RCP 4.5

Future climate projection shows a decrease in air temperatures and an increase in precipitation

Rainfall increase: **18.1%**

The United in Science (2020) report shows that Malaysia will continue to see an increase in precipitation.



Representative Concentration Pathway (RCP) 4.5 is a scenario of long-term, low to moderate future emissions of greenhouse gases, short-lived species, and land-use-land-cover which stabilizes radiative forcing at 4.5 Watts per meter squared.

Flooding has **multiple causes** which must be addressed simultaneously.
Climate scenarios must be developed for the future, as rainfall volumes will continue to increase.



The December 2021 flood in Shah Alam led to RM 1 billion in damages.
Future events will likely be much worse.

URBANIZATION

Malaysia's rapid urbanisation has led to economic growth and social progress. However, rapid urban development comes with challenges.

MALAYSIA'S URBAN RESILIENCE CHALLENGES

Environmental Resilience



Long-term national growth threatened by increasing vulnerability to **climate change**

Social Resilience



Lack of an integrated approach to lift B40 households out of poverty and address **socio-economic inequality**

Economic Resilience



Missed opportunities to catalyse **local economic development**

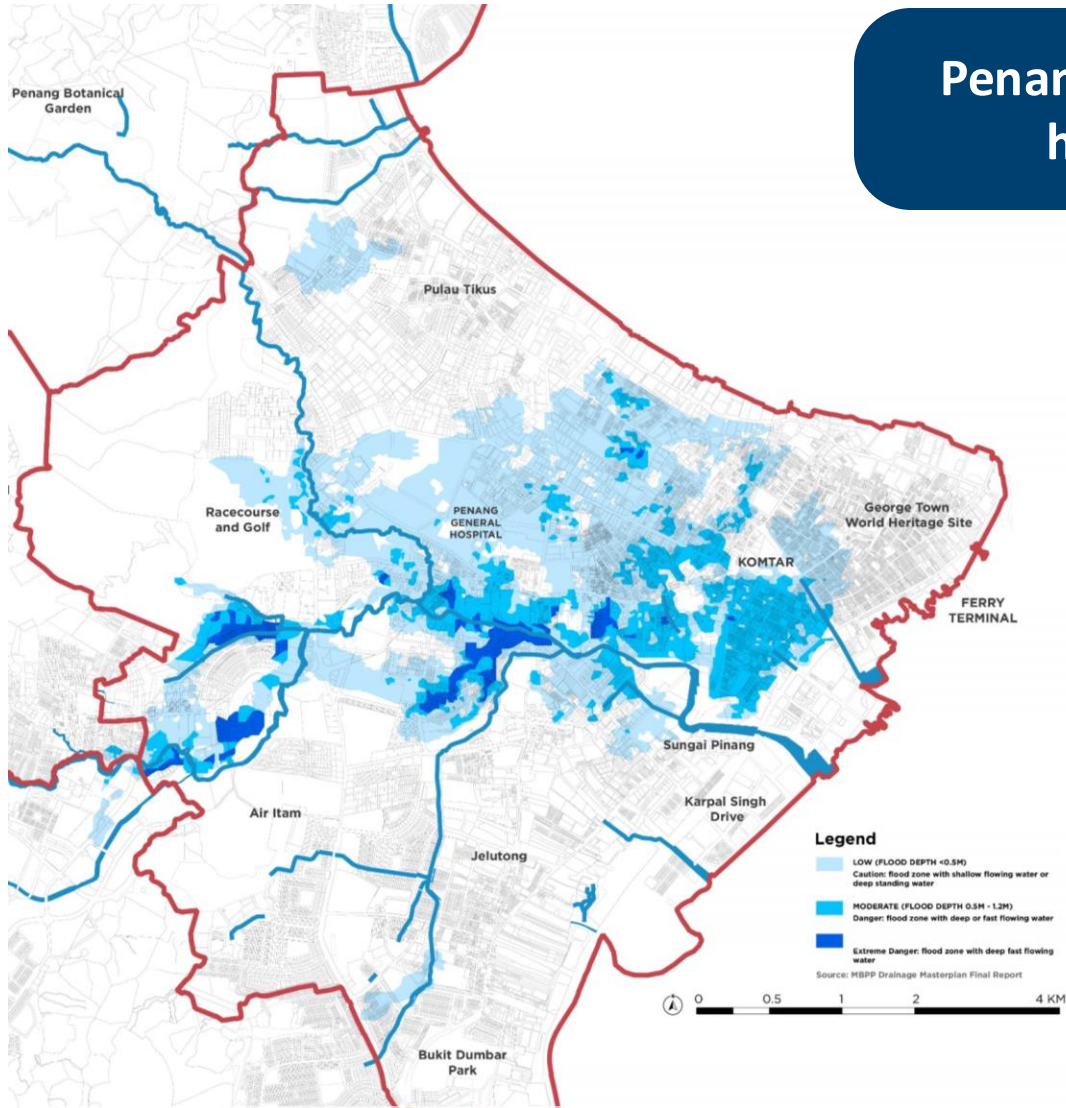
Sustainable Development



Challenges in achieving sustainable urban development due to data, financial, and knowledge **capacity gaps**

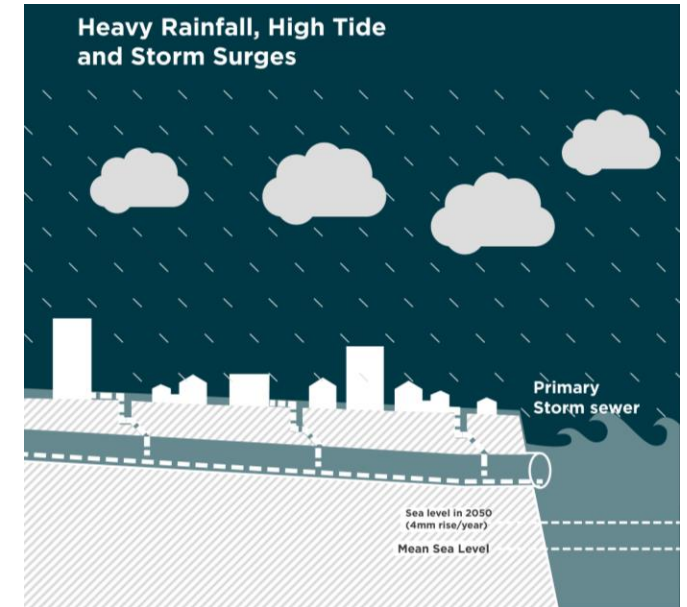
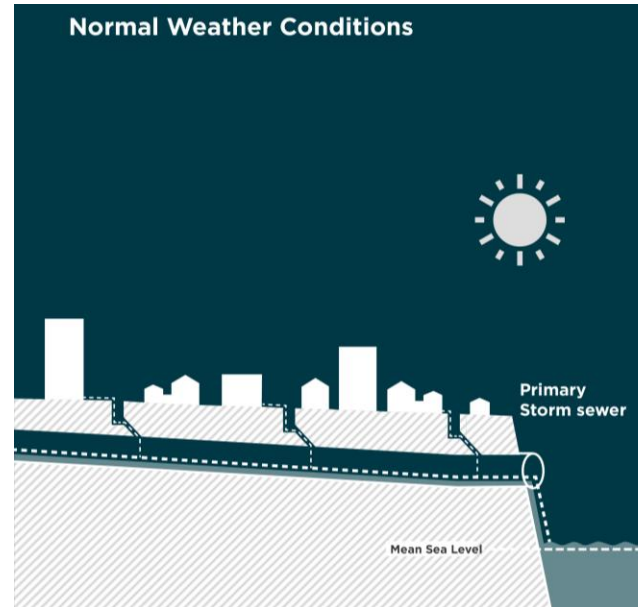
CHANGES IN RAINFALL PATTERNS LEADING TO FLOODING

Penang is vulnerable to flooding due to increased urbanization and hard materials, leading to poorly managed stormwater runoff.

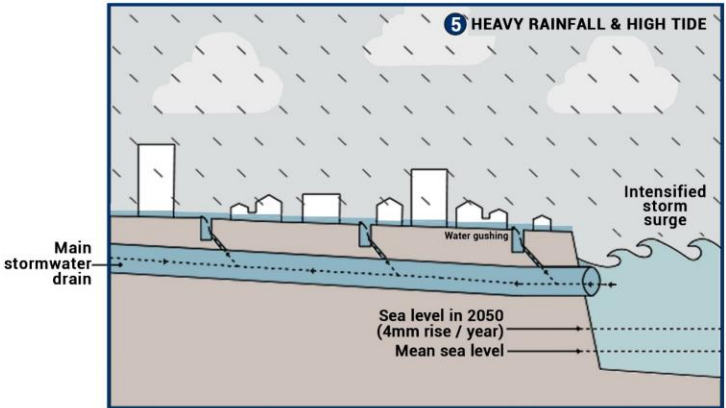
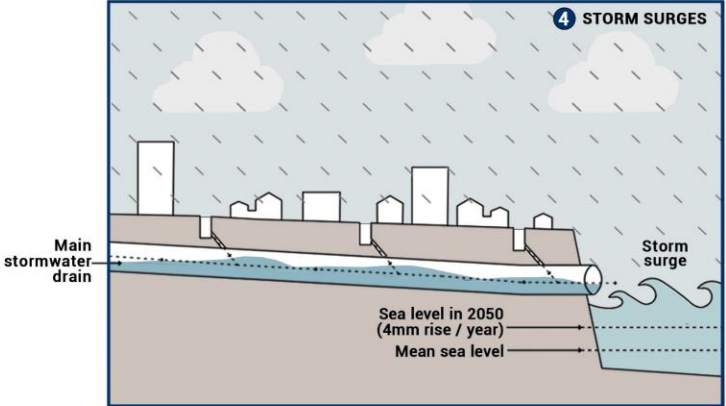
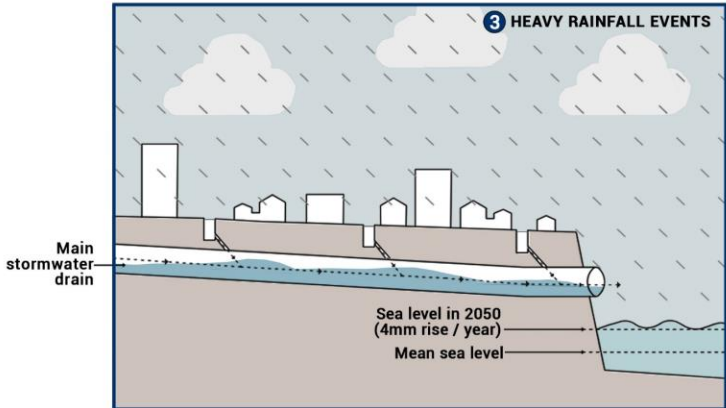
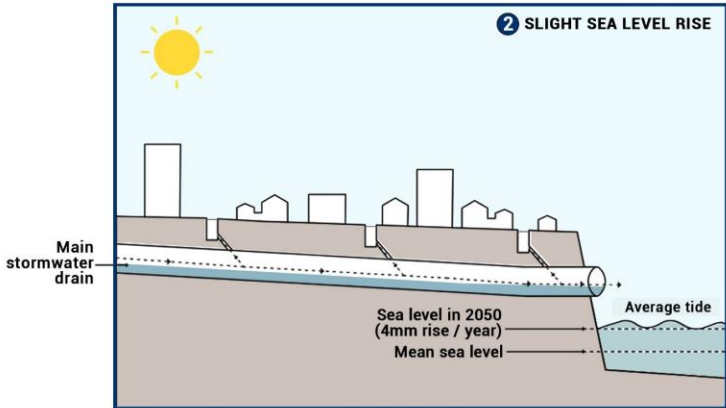
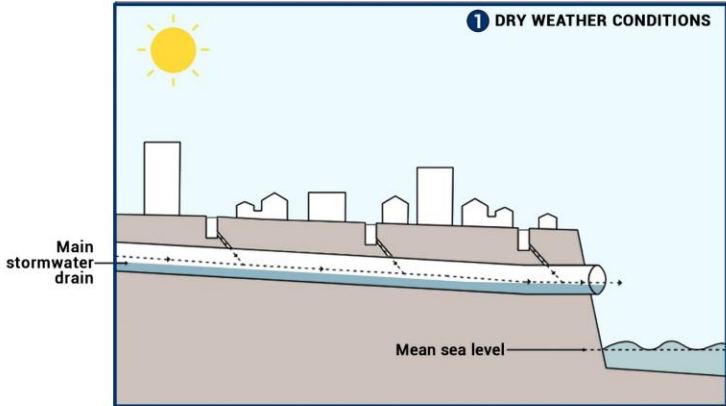


Flood Hazard Map of 50 years ARI

Source: RBM (2018) Flood Mitigation Report for Penang Island



Coastal cities become vulnerable to flooding from drainage infrastructure if a combination of high tide, storm surge and heavy rainfall occurs



Nature-based solutions (NBS) are actions for addressing societal challenges that are inspired by processes and functions of nature. By developing and implementing solutions that are supported by nature, resilience is achieved while producing societal, environmental, and economic benefits.

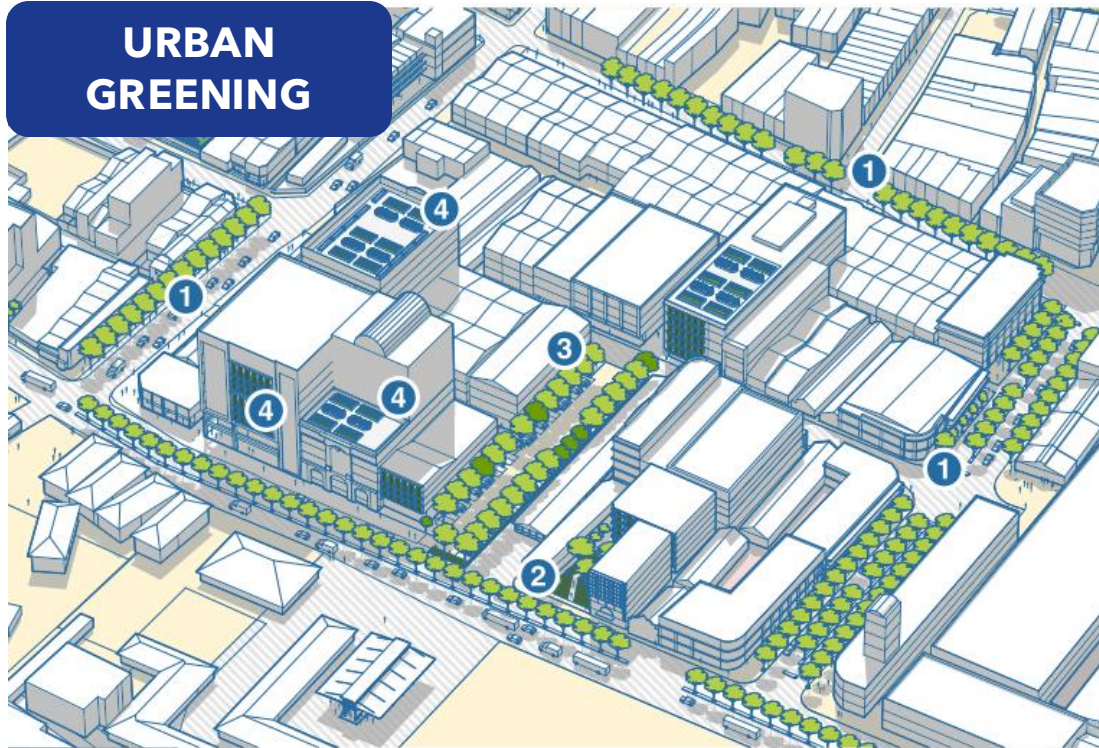
nature-basedsolutions.com



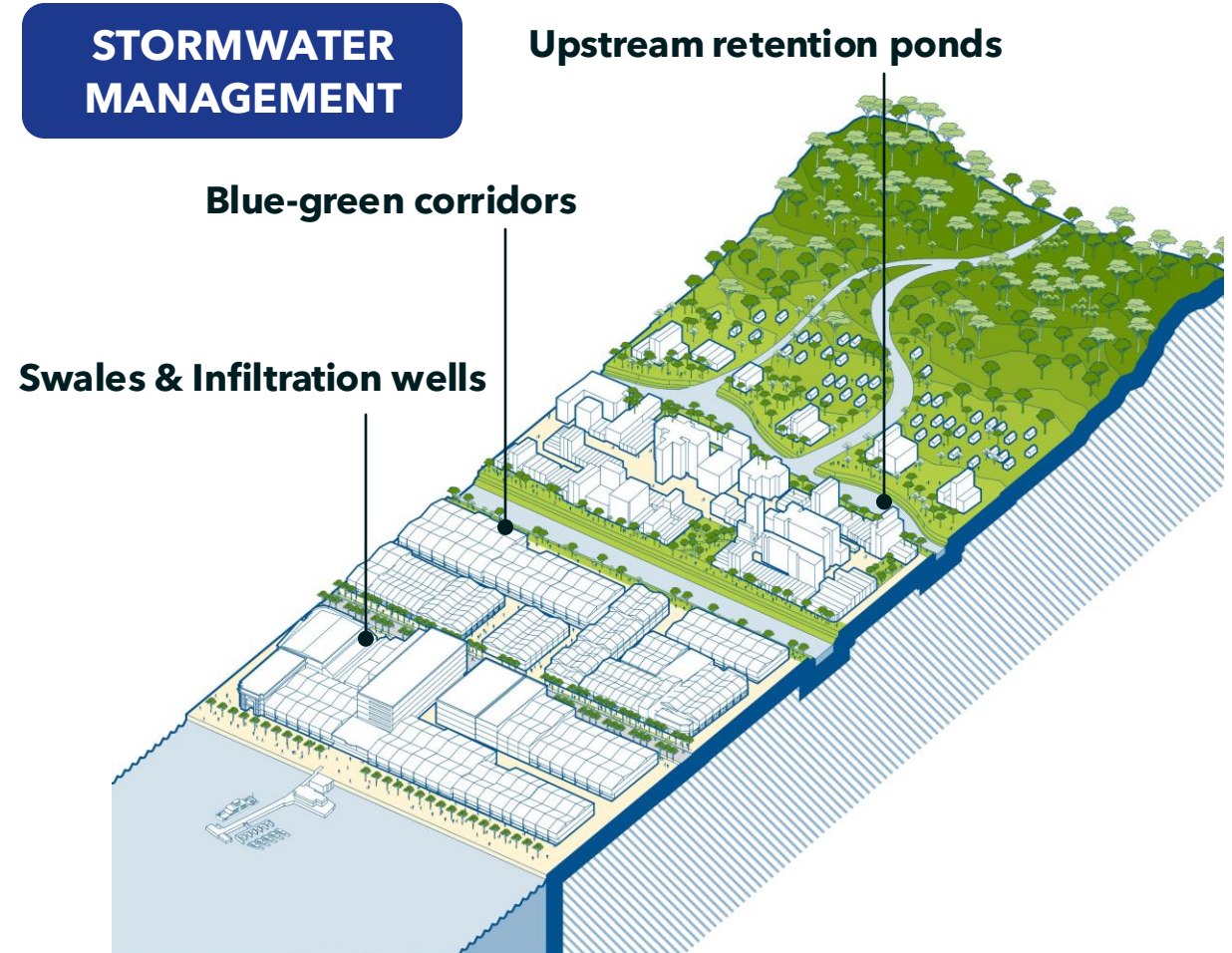
Surface cooling can be achieved through increased wind speed, coverage with surface water and shading. The first and last of these, of course can be provided by suitably placed vegetation. (Guide to Urban Cooling Strategies, 2017, p.11)



A NBS approach such as the [Sponge cities](#) can effectively reduce and help eliminate flooding



- 1 Tree-lined streets
- 2 Pocket parks
- 3 Greening carparks
- 4 Built Structures
 - Rooftop gardens
 - Green facades
- 5 Urban agriculture



SPONGE CITIES - CHINA

There is essential knowledge globally on how to develop the Sponge Cities Approach; one of such institutes is the **Sponge Cities Center in Zhuhai, China**, focused on sponge cities design.

Sponge Cities Center in Zhuhai

List of project locations:



Xing Yuan New Town
(Hanzhong, Shaanxi)

China Mobile LID
(Luoyang, Henan)

Envision - Nanjing Intelligence
Lake Campus
(Nanjing, Jiangsu)

Sponge City in Zhenjiang
(Zhenjiang, Jiangsu)

Huaqiao Waterfront Wetland Water
Treatment Park (Kunshan, Jiangsu)

Ningbo Central Park
(Ningbo, Zhejiang)

River Restoration
(Guangzhou, Guangdong)

Wetland Restoration
(Kunming, Yunnan)

Zhuhai Sponge City
(Zhuhai, Guangdong)

Longmu Bay Resort LID
(Hainan)



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China

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Soaking it up

To prevent floods, China is building “sponge cities”



Reuters



1. RESILIENCE

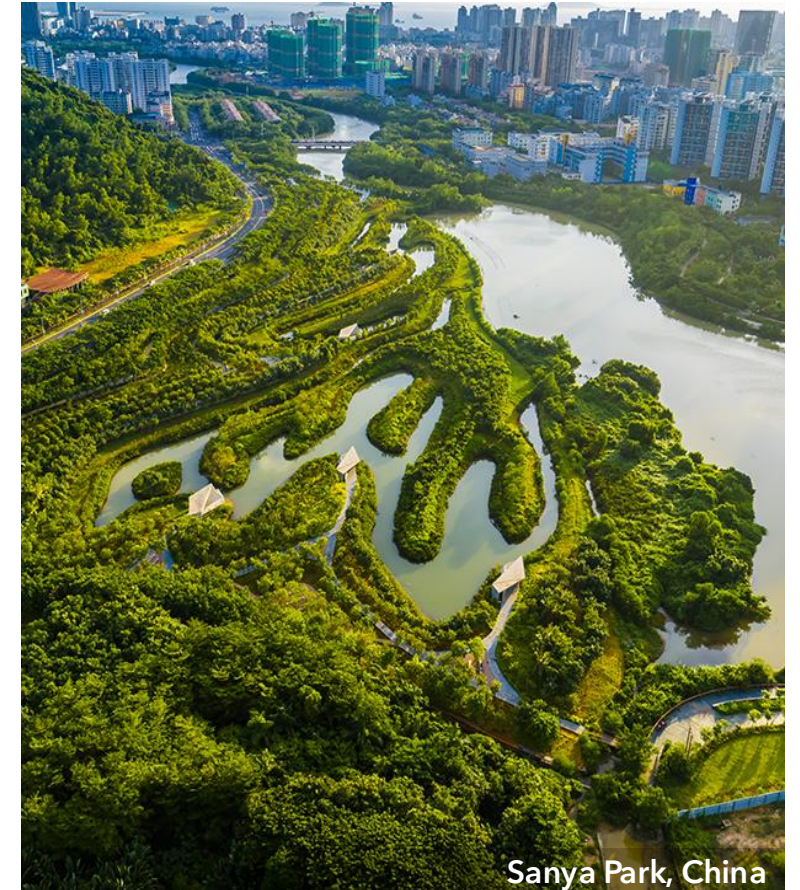
Resilience to extreme rainfall in terms of a) physical adaptation, b) government capacity and c) community preparedness, using nature-based solutions to improve the community's quality of life.



Meishe River Greenway, China



Ningbo Ecological Corridor, China

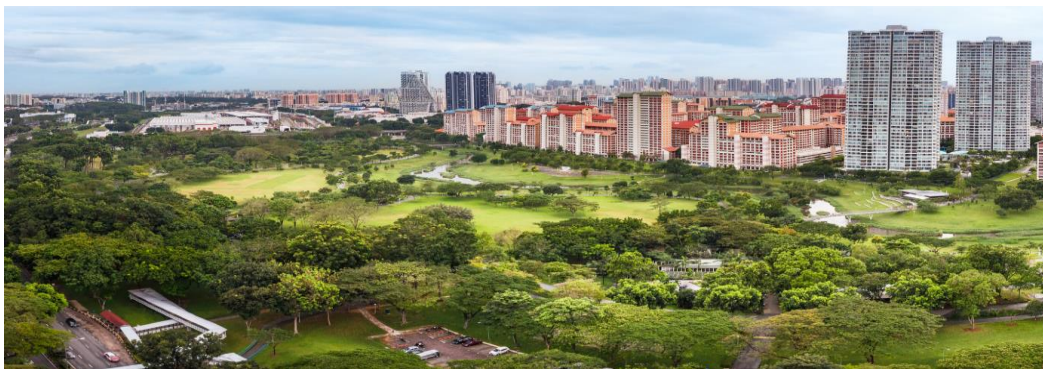


Sanya Park, China

2. ECONOMIC BENEFITS

a) Reducing flood losses; b) Obtaining funding for project implementation; c) Adopting nature-based climate adaptation solutions can also create associated economic uplifts, as shown in [Singapore](#), and [Colombia](#)

Bishan-Ang Mo Kio Park - Singapore



Naturalization of a concrete storm drain through the park into the river with lush vegetated banks.

- **RM 327 million** in *SDG socio-economic benefits a year*
- **RM 180 million** in *capital savings*
- **4 million** *visitors a year*
- **~3.6 times** *increase in socio-economic value*

Medellín Green Corridors - Colombia



Establishment of 36 green and blue corridors in the city to support biodiversity and societal well-being.

- **RM 65.2 million** *invested*
- **RM 544 million** in *estimated benefits between 2020 to 2030*
- **160,787kg** of *CO2 reduction a year*
- **678** *heart-related deaths averted*
- **75** *locals with disadvantaged backgrounds hired as gardeners*



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