

Integrated Flood Resilience

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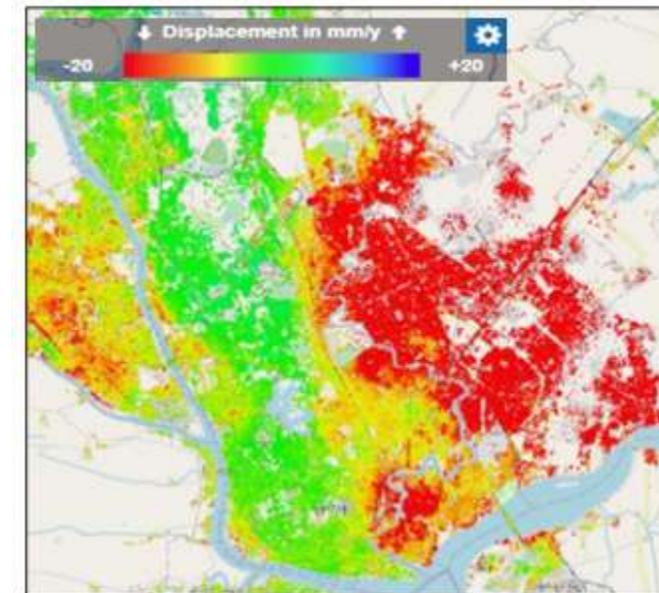
12 April 2022

Nature-based solutions for flood management



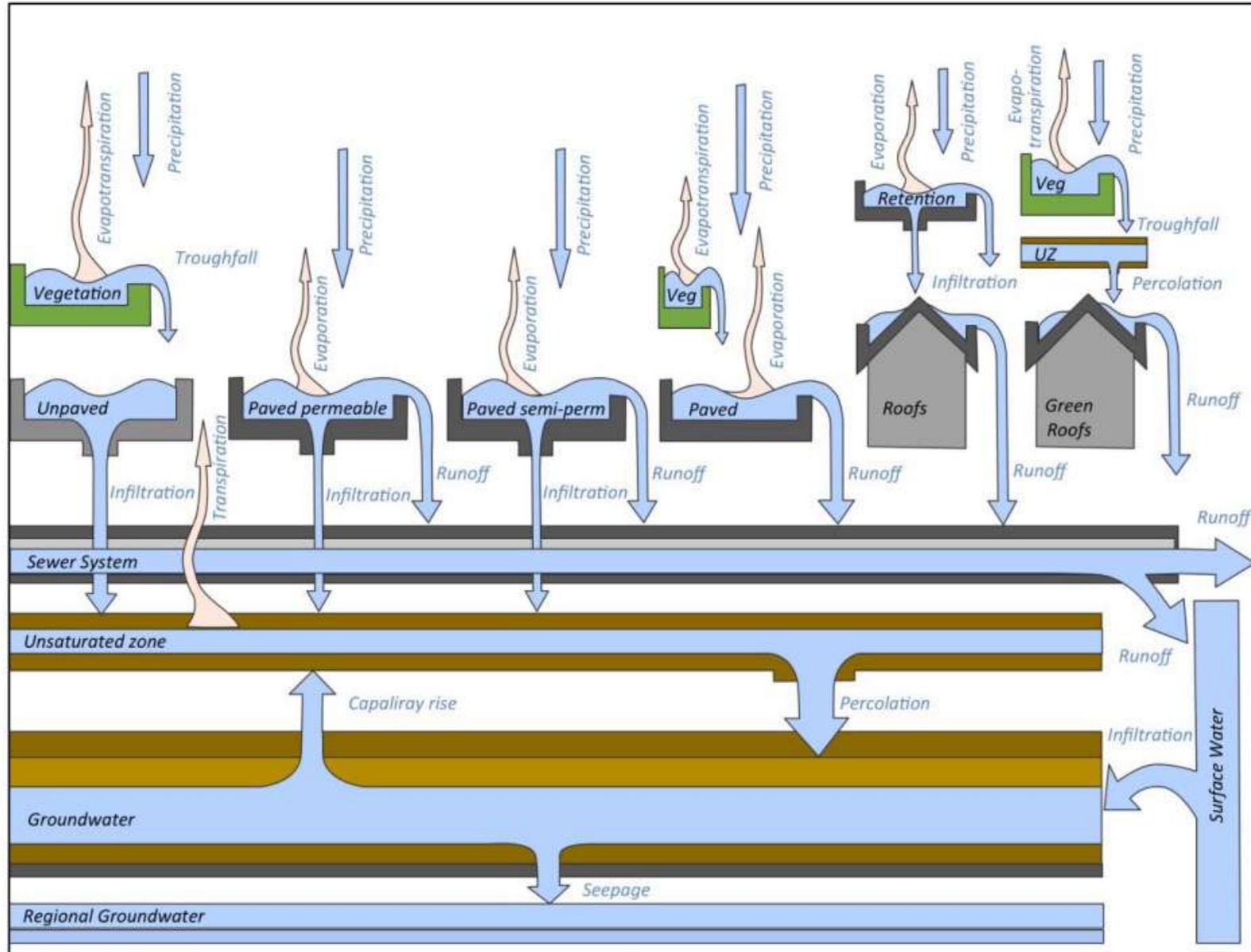
Sense of urgency in urban environments

- Ongoing developments and lack of space in urban areas: less storage / infiltration and more surface run-off;
- Accelerated sealevel rise and storm surges, affecting coastal communities through floods and erosion, but also
- Pollution, droughts, water quality issues, heat stress, land subsidence, etc.
- **Paradigm shift: from civil engineering to more nature-based solutions**
 - A more sustainable and resilient environment
 - Cost-effective solutions with added value for multiple beneficiaries
- > **dealing with uncertainty and need for adaptation**
- **Need for an improved system understanding**



Conceptual model of the sponge

Dynamic Water Balance Model



Need for an improved system understanding

Integrated Flood Resilience Strategy for Yangon City



Deltares **adpc**

EPS **AABEL**

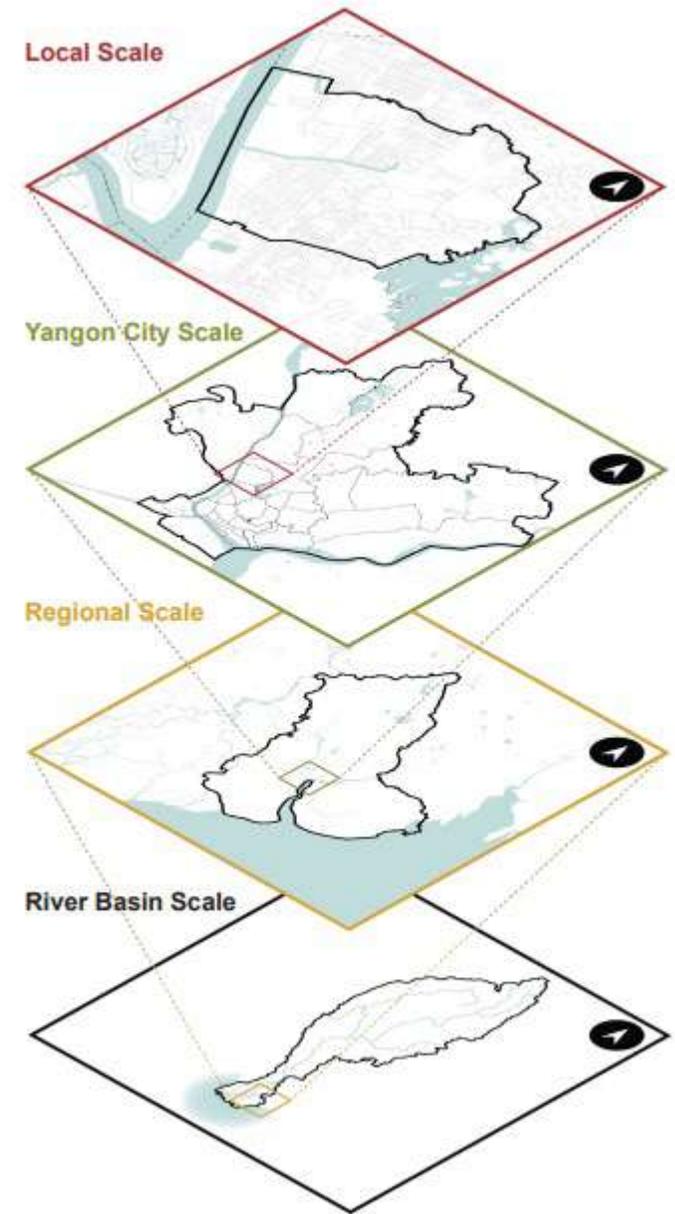
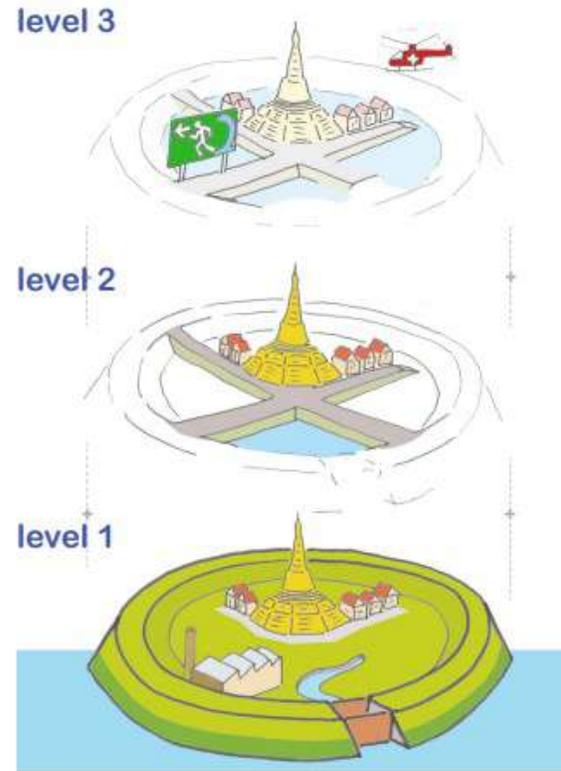
IFRS for Yangon City

The World Bank IFRS project was part of a larger initiative towards a multi-annual flood resilience investment program for Yangon City (2020 – 2040), which should result in the implementation of an Integrated Flood Resilience Strategy (IFRS).



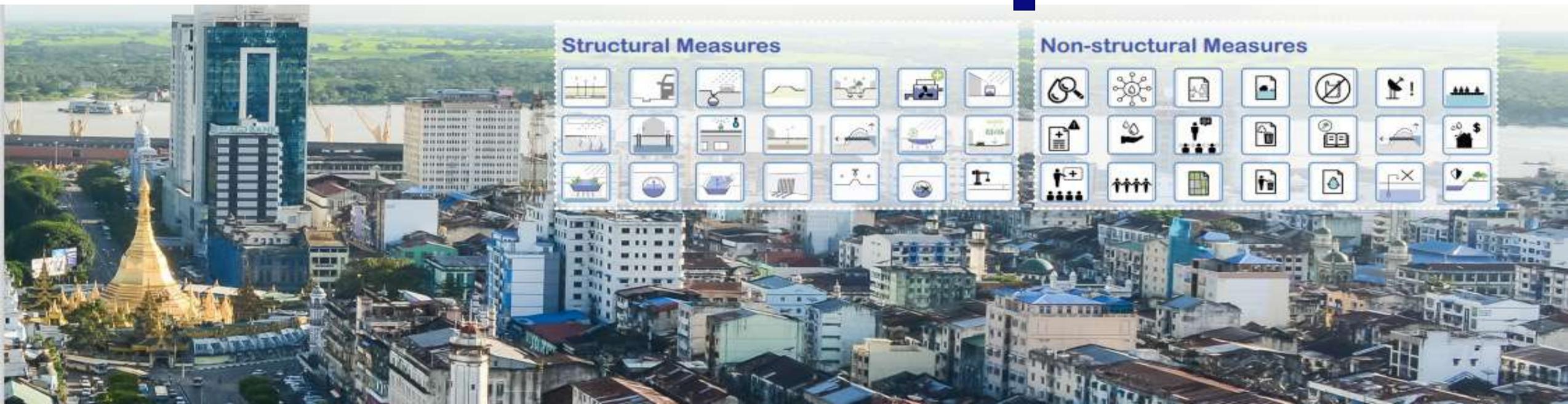
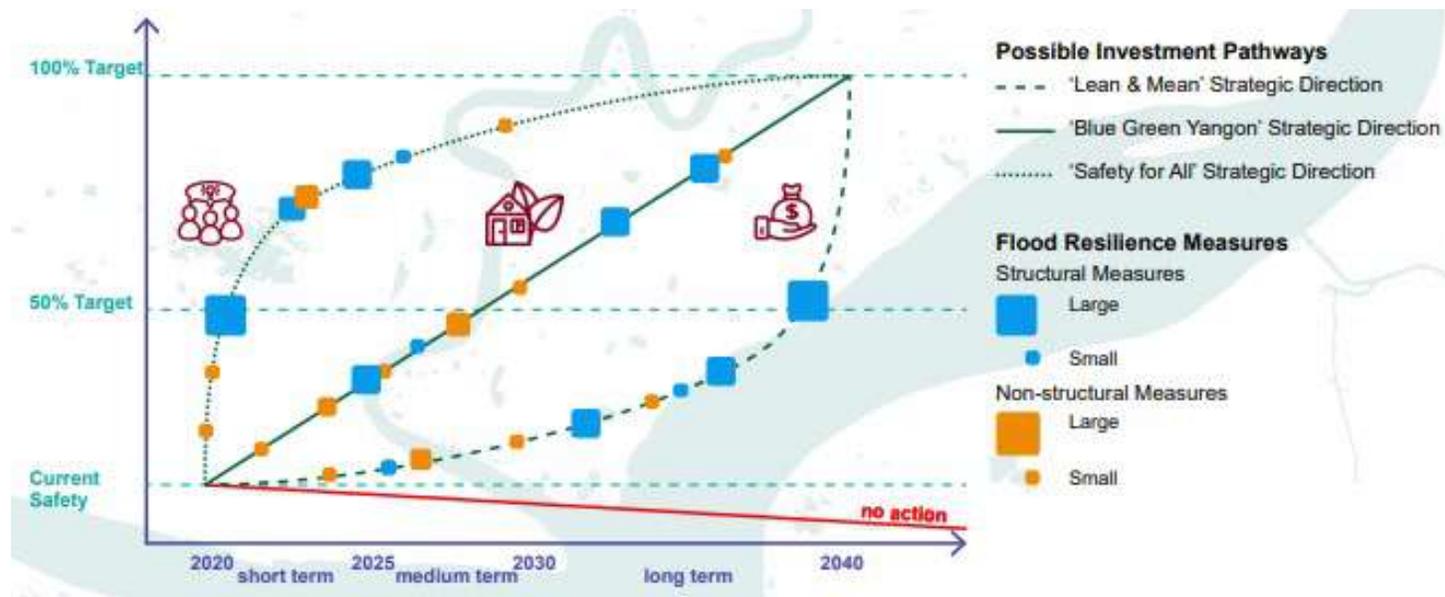
Resilience strategies for flood risk management not only aim to **resist** floods risks, but also to **relieve** and **recover** from their impacts as well as **adapt** themselves to next floods.

IFRS for Yangon City

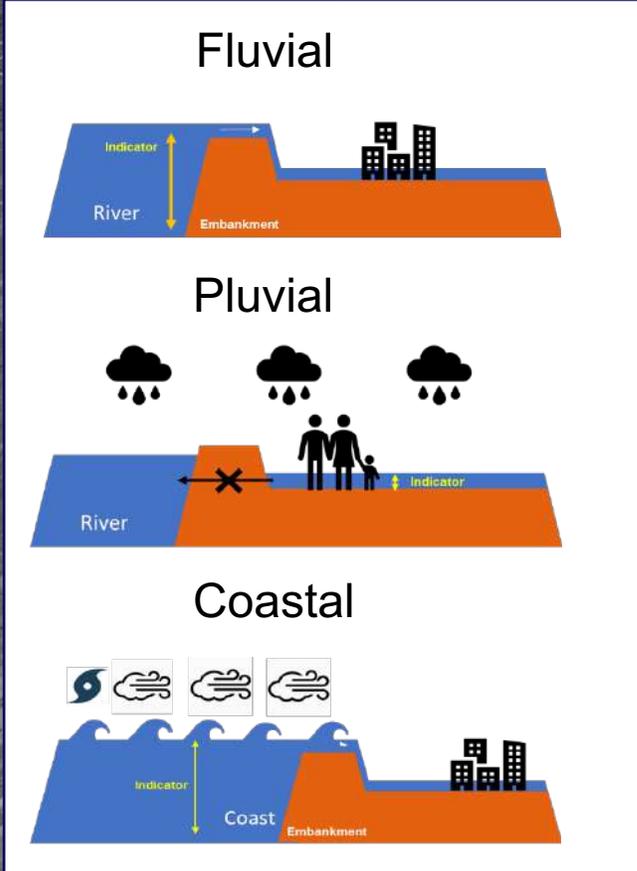


“A Flood Resilient Yangon City has appropriate standards of flood protection..... and the ability to relieve and recover from flooding, in a way that minimizes social and economic disruption to an acceptable level..... so that all people have equal opportunities for a prosperous future in a safe, healthy and attractive living environment.”

IFRS for Yangon City



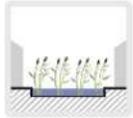
Reconstruction of tropical cyclone Nargis (2008)



Resilient City Toolbox (RCT)

← back

CHOOSE



Urban wetland

Pluvial flooding

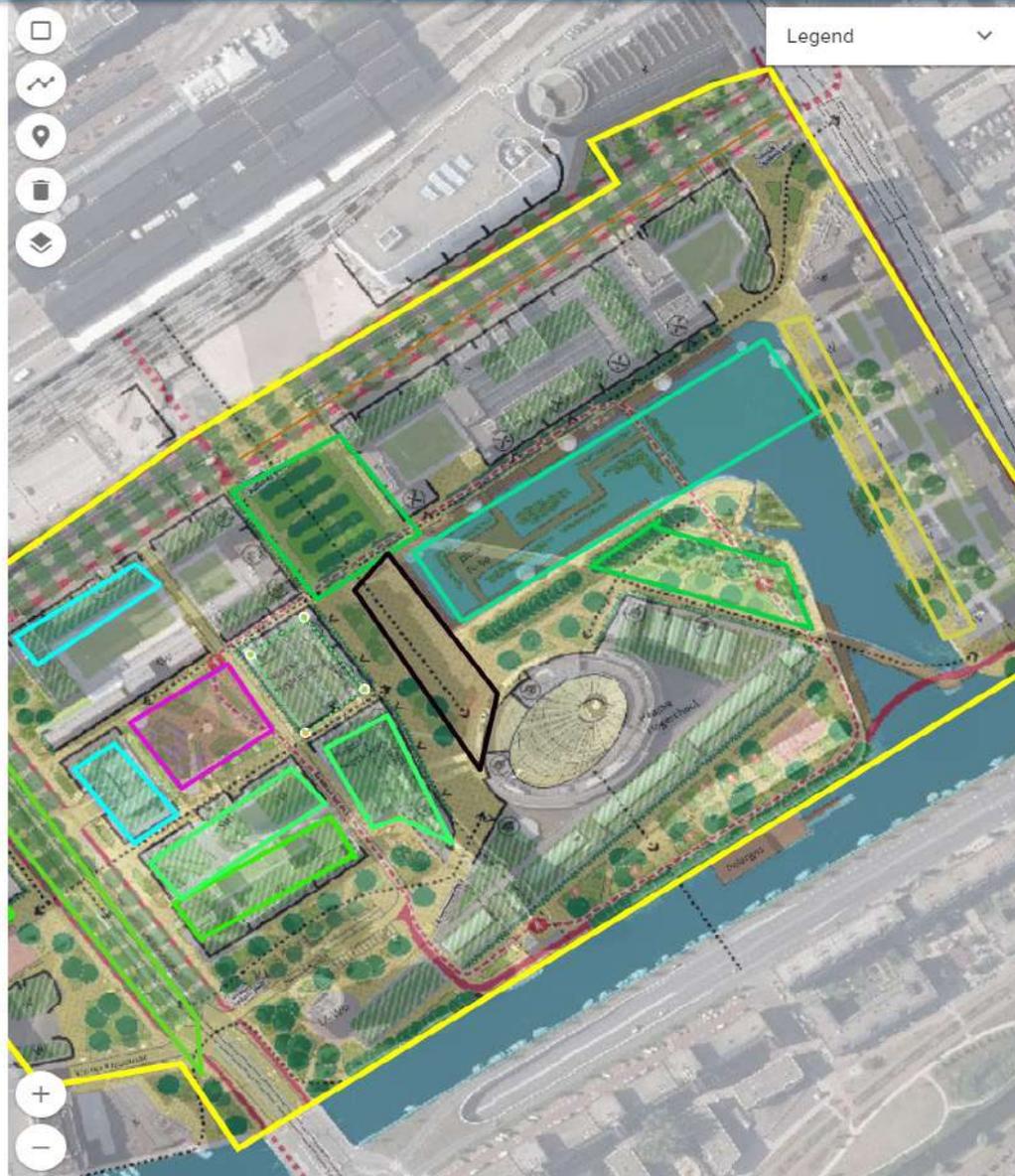
Heatstress

Drought

Wetlands are water-rich natural areas that occur chiefly along rivers and in deltas. By their very nature, wetlands are overflow areas for rivers and as such are natural rainwater buffers. However, the urban expansions and the correspondingly lower groundwater levels put pressure on wetlands and wet nature around the world. In some cities, London for example, wetlands serve a function by developing greater biodiversity and natural and pleasant recreation areas for city dwellers.



[For more information click here](#)



Legend

Results

Climate

Storage capacity:

Return time factor:

Groundwater recharge:

Evapotranspiration:

Heat reduction:

Cool areas:

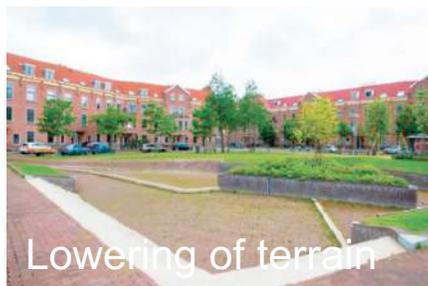
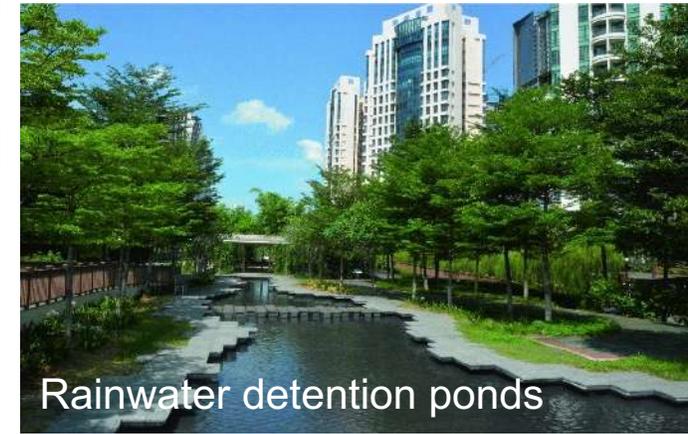
Cost

Construction:

Maintenance:

Nature-based Solutions

- Nature-based Solutions, making optimal use of ecosystem functions and services
- Multiple smaller Nature-based Solutions can **collectively contribute** to meeting flood resilience objectives!
- The solutions can provide **additional benefits** by improving air quality, water quality, living quality and human health.



Blue-green / nature-based solutions preferred

Grey solutions

Nature-based solutions

less space required

more space needed

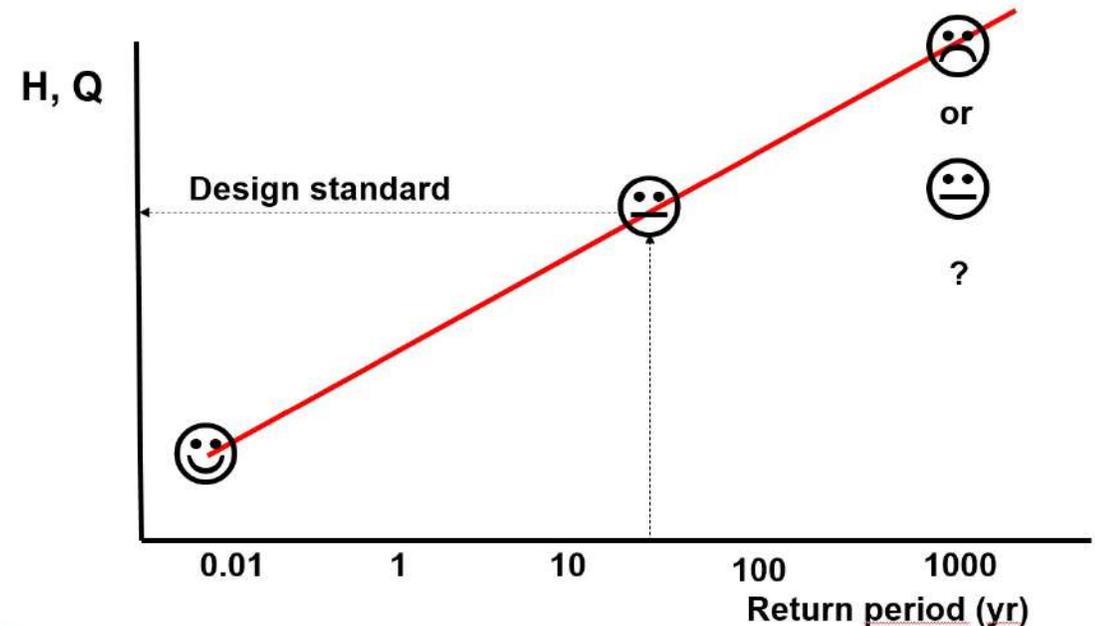
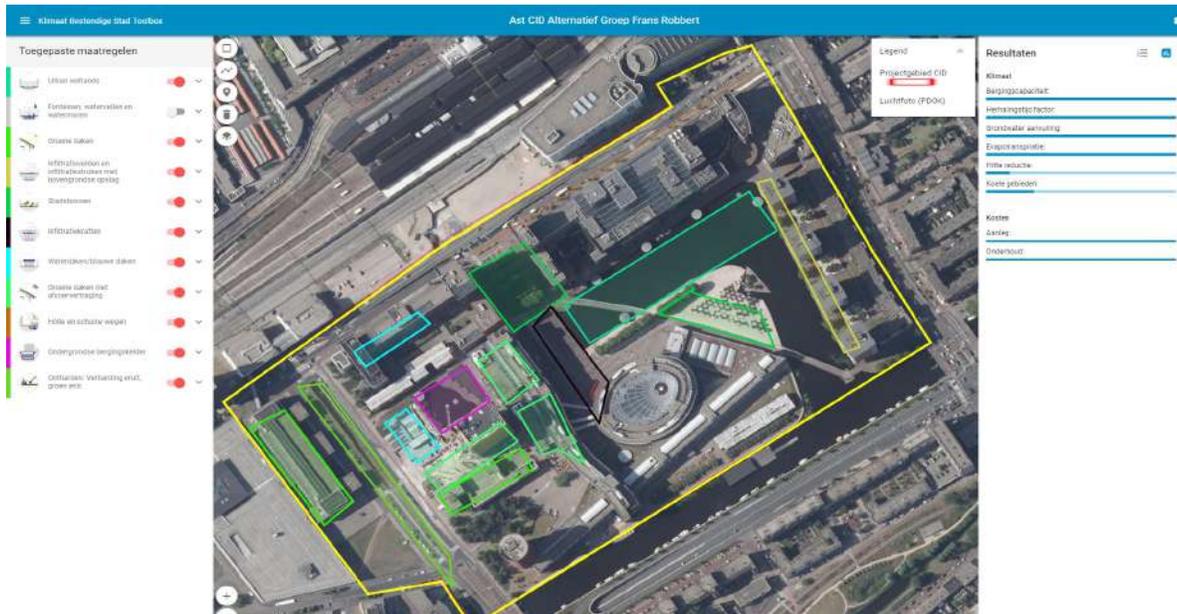
less flexible, extra investment

flexible and cost-effective



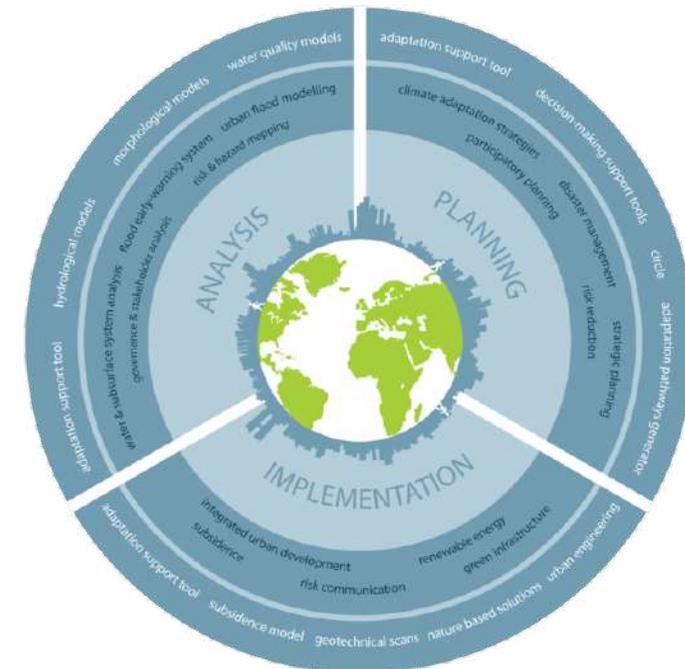
What is the RCT?

- RCT is a tool to support **dialogue** with all stakeholders on which adaptation measures can be implemented, where, and how.
- RCT provides estimates on the effect of a proposed package of measures on resilience against extreme rainfall, drought, and heat stress, and on stormwater quality
- The results of the dialogue become input for a detailed design conducted by landscape architects and urban planners.

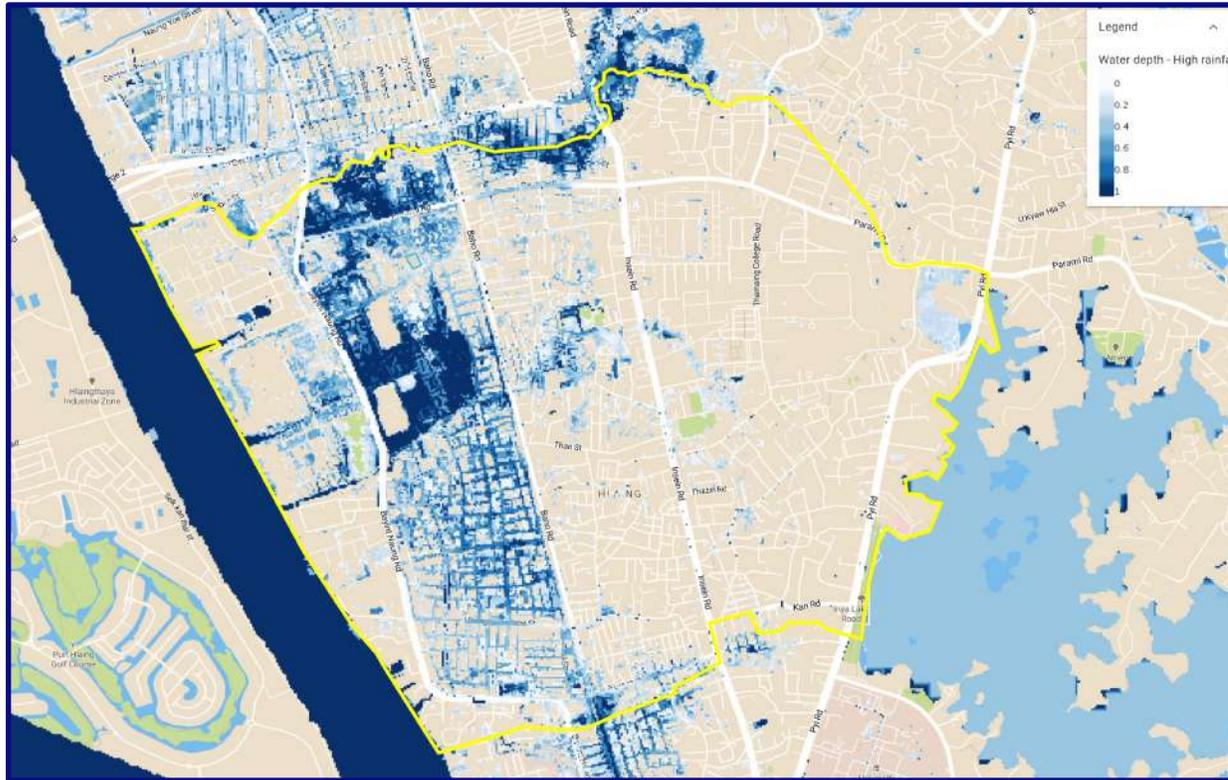


What can the RCT do?

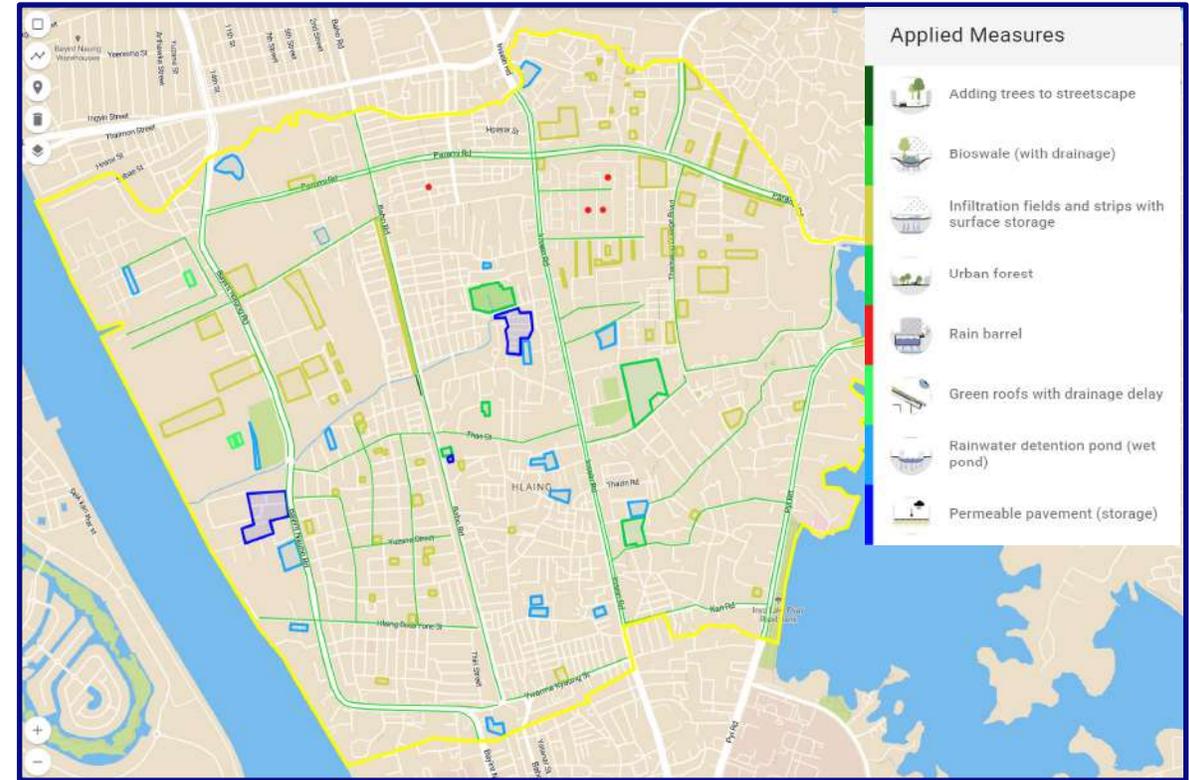
- The RCT can be used during **program formulation** and **conceptual design** to co-create packages of adaptation measures for a more water-robust and climate-resilient urban environment.
- Planners, water managers and other stakeholders (local representatives, experts, constructors, financiers, etc.) are supported by the RCT in **their dialogue about options and alternatives**;
- The RCT provides them with an **overview of different measures** and a **first estimate of hydrological effectiveness and costs**, so that alternative choices can be discussed and evaluated.



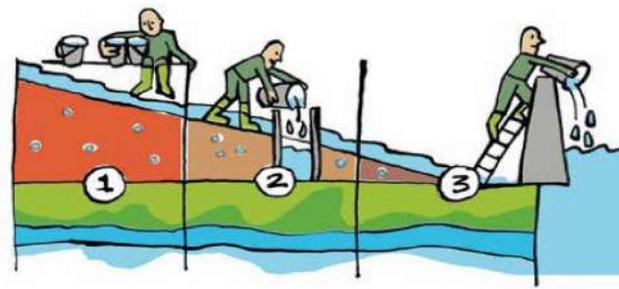
Resilient City Toolbox (Hlaing township)



Flood map (maximum inundation): design rainfall with return period of 10 years (no surge, spring tide and low river discharge).



Opportunity map for possible implementation of local structural measures towards a Blue-Green Hlaing Township



- 1: Retain
- 2: Store
- 3: Drain

Hlaing RCT

Yangon - Resilient Cities Tool

Applied Measures

- Bioswale (with drainage)
- Infiltration fields and strips with surface storage
- Rain barrel
- Rainwater detention pond (wet pond)
- Lowering of terrace

Legend

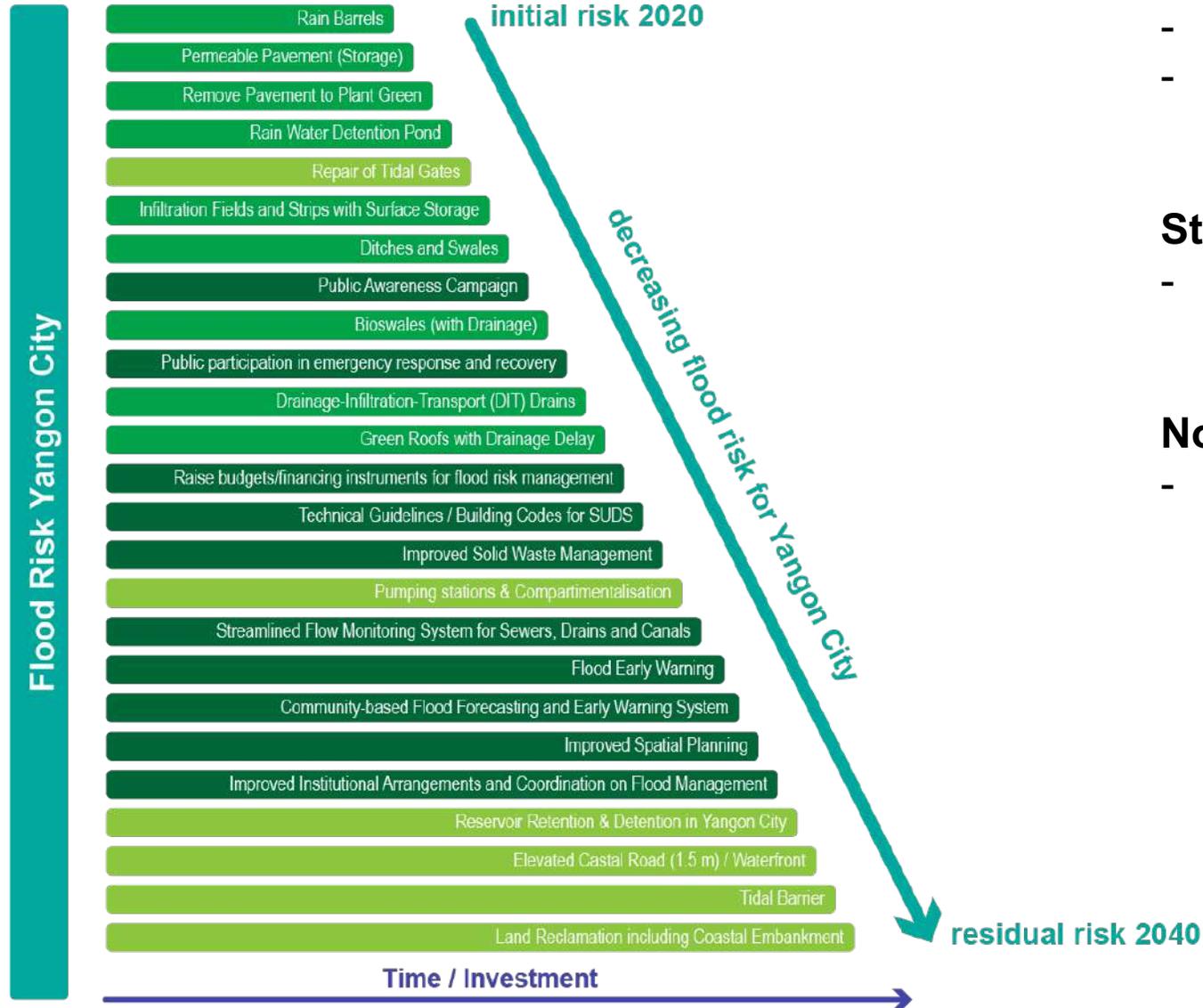
Results

Climate	
Storage capacity:	273676 m ³
Return time factor:	146 -
Groundwater recharge:	39.01 mm/year
Evapotranspiration:	-0.82 mm/year
Heat reduction:	0.09 °C
Cool areas:	0 number
Cost	
Construction:	20648744 €
Maintenance:	184658 €/year
Water quality	
Pathogen reduction:	2.86 %
Nutrient reduction:	2.51 %
Adsorbing pollutants:	2.88 %

VIEW AS TABLE

The screenshot displays the 'Yangon - Resilient Cities Tool' interface. The main map shows an aerial view of the Hlaing RCT area, outlined in yellow. Various green and blue shapes on the map represent the applied measures. The left sidebar lists five measures, all of which are turned on (indicated by red toggle switches). The right sidebar shows the results for these measures, categorized into Climate, Cost, and Water quality. The Climate section includes metrics like storage capacity, return time factor, groundwater recharge, evapotranspiration, heat reduction, and cool areas. The Cost section shows construction and maintenance costs. The Water quality section shows pathogen, nutrient, and adsorbing pollutant reductions. A 'VIEW AS TABLE' button is located at the bottom right of the results panel.

Program of Measures



Structural Measures (Nature-based Solutions) at local scale (Townships):

- Focus on pluvial flood hazards
- Maximum 10-20% problem solving capacity

Structural Measures at City Scale:

- Focus on Coastal (and Fluvial) Flood Hazards

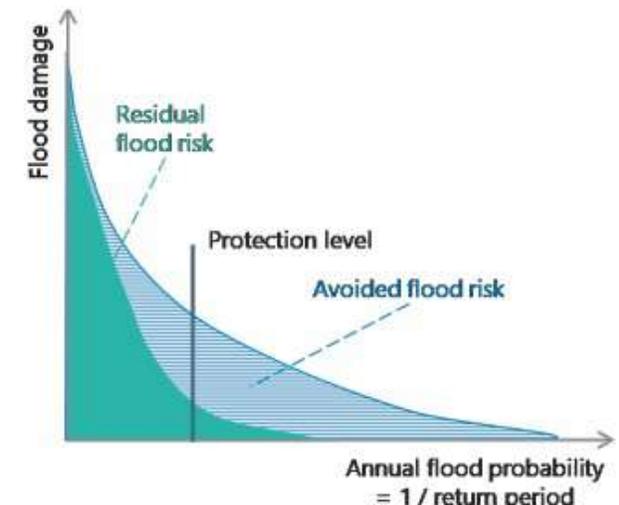
Non-structural Measures:

- Support structural measures

Structural Measures at City Scale

Structural Measures at Local Scale

Non-structural Measures



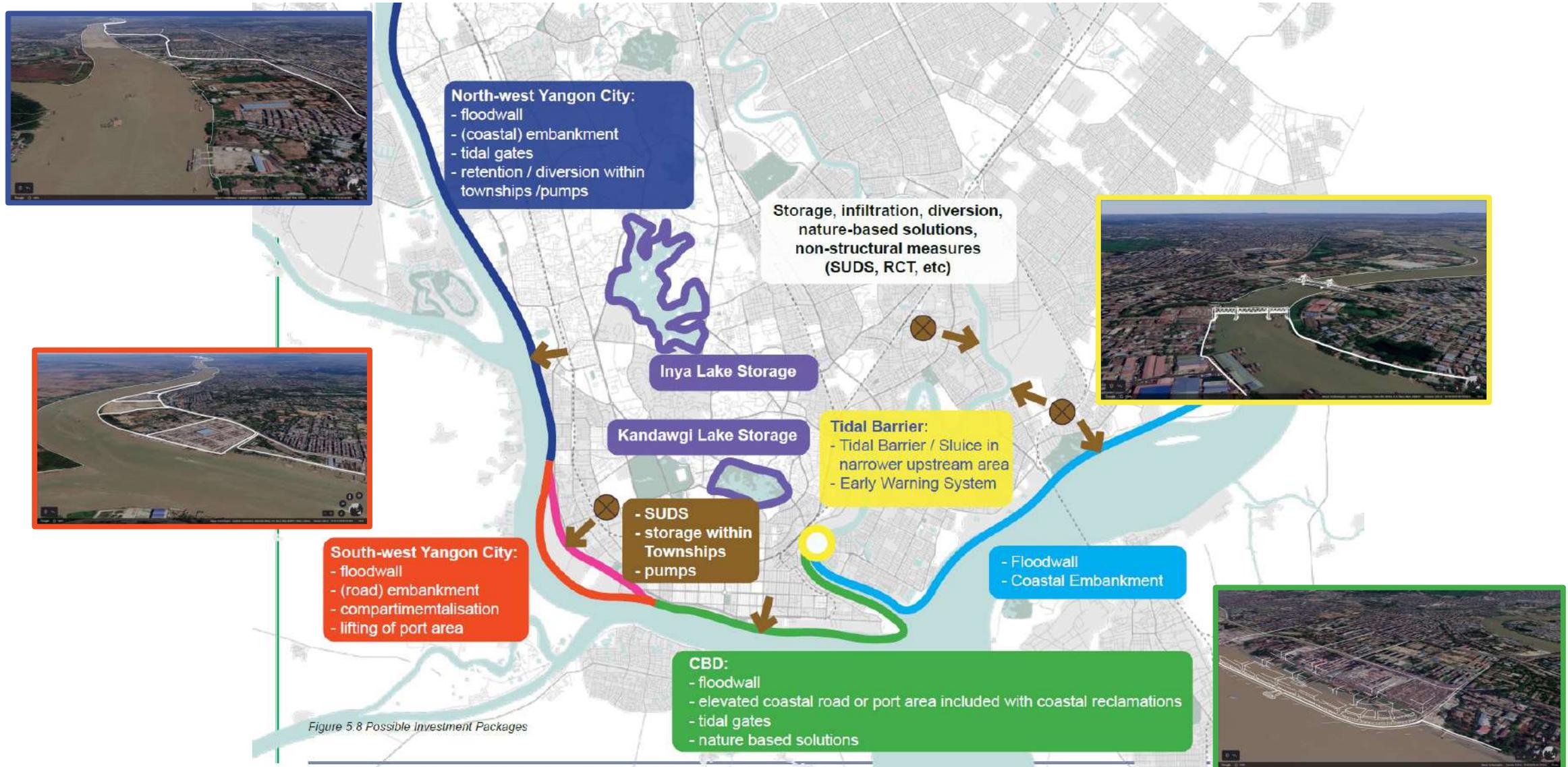
Guiding principles for IFRS

- **Create** Acceptable Level of Flood Safety;
- **Maximize** Flood Resilience;
- **Align** with Urban Planning;
- **Synergize** with Planned Developments;
- **Adopt** Location-specific Approach;
- **Start** both Big and Small;
- **Prioritize** No or Low-regret Measures;
- **Optimize** Planning Horizon.

Maximize co-benefits for people, economy, environment and/or cultural heritage!



Program of Measures



Key take-aways

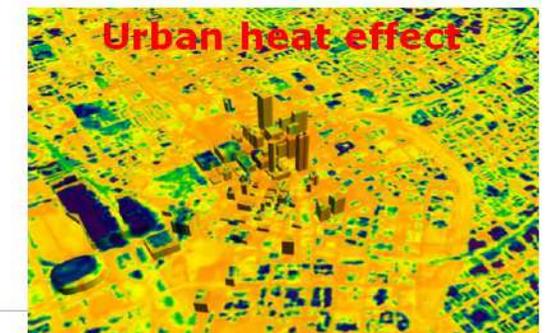
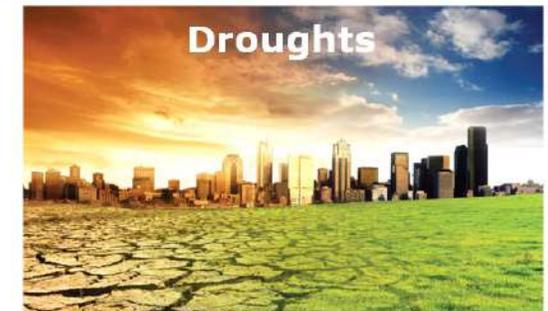
- Data and urban system understanding is essential
- Blue-green where possible, grey where needed!
- Consider the uncertainties
- Plan for the future and be adaptive

and

Realize that floods disproportionately affect vulnerable communities through **direct impact, increasing morbidity and economic impacts.**

www.deltares.nl

[climate resilient city toolbox \(kbstoolbox.nl\)](http://climate.resilient.city.toolbox(kbstoolbox.nl))



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***Thank
you for
your
attention!***

