Deltares

enabling delta life

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Collaborating on innovative and sustainable solutions for integrated water management

Resilient City Toolbox for Urban Resilience Planning

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in cooperation with

Reinder Brolsma and Helena Hulsman

11 August, 2020

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Deltares in brief

- We are working on **smart innovations** in the field of water and subsurface
- We are **the knowledge partner** of the Dutch government.
- We make our knowledge applicable **worldwide**
- We are a **strategic partner** and **trusted advisor** internationally.
- We provide **specialist consultancy** internationally.

Number of employees

University / Ph.D.
39 nationalities

Regional offices in Abu Dhabi, Singapore and Indonesia

Net turnover

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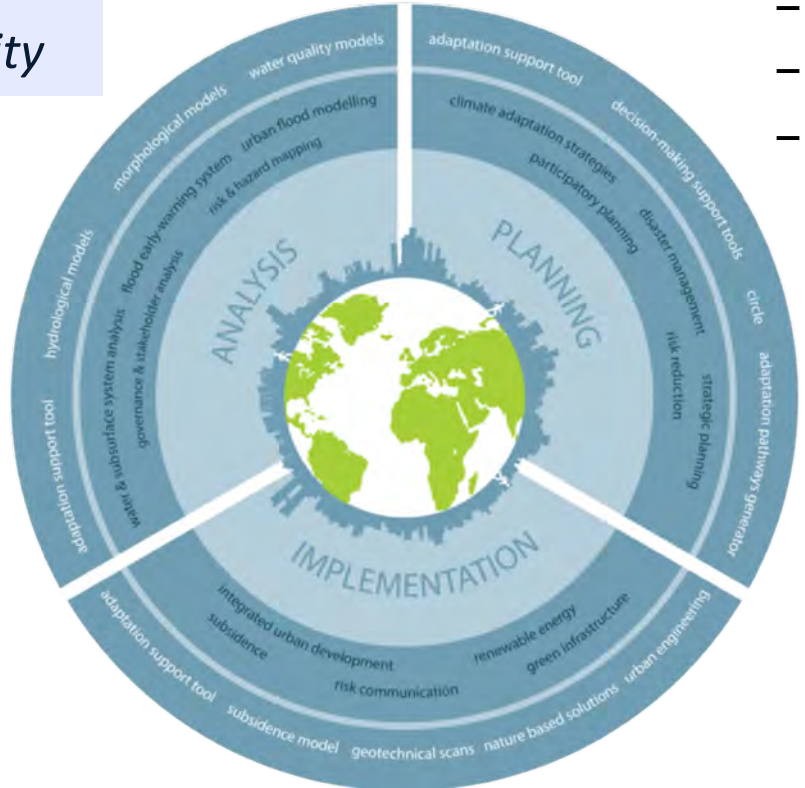
Urban Resilience (from a water perspective)

Urban Resilience

***Resilience**:*
the capability of a society to ***prevent*** *or* ***cope with*** *the impacts of climate change and sea-level rise, including technical, institutional, economic, and cultural ability*



Discussions often focus on

'*too much, too little, too dirty, too compartmentalized and not for everyone*'

That is why we look through **five lenses** at urban resilience:

- **flood risk management**
- **drought**
- **water quality**
- **integrated design and**
- **inclusiveness.**

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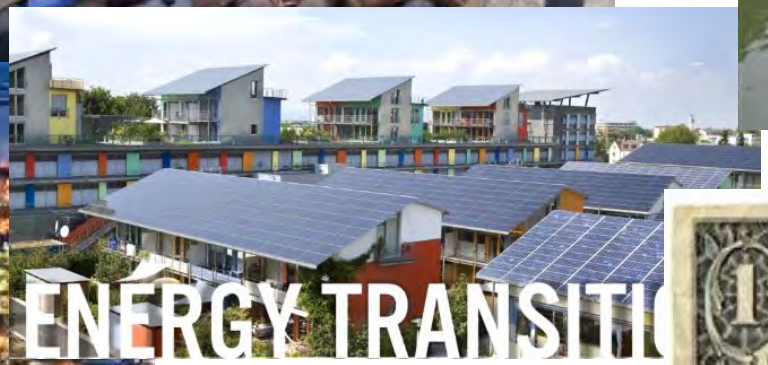
Numerous reasons to strengthen urban resilience….



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…as well as flooding, drought and heat

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Not only threats and challenges,

also many OPPORTUNITIES
to use WATER as a RESOURCE
to improve urban resilience

Water harvesting

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Water surface to live & work on/in/above

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Water and green for biodiversity and food production

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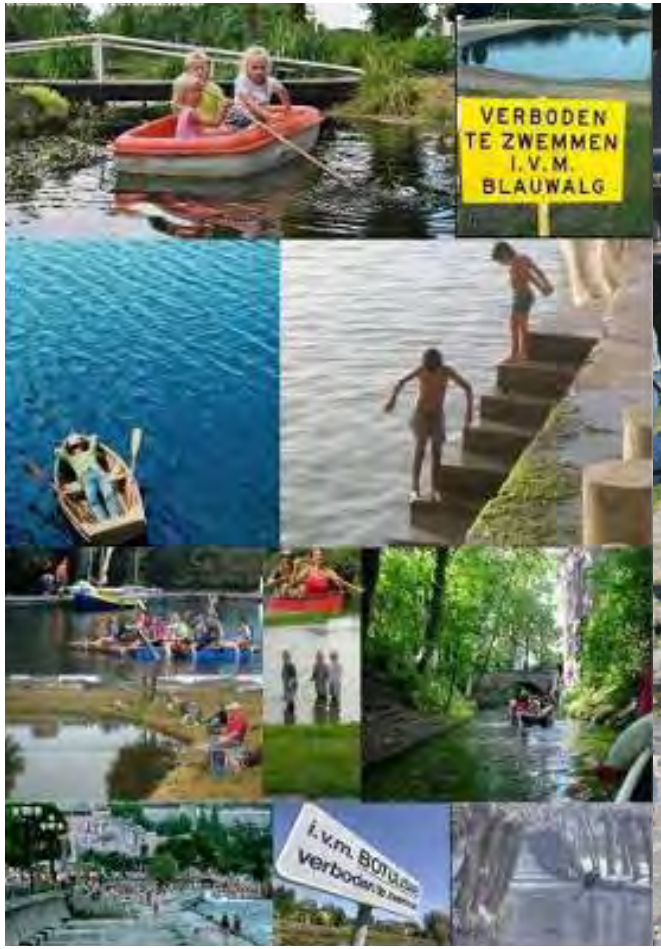
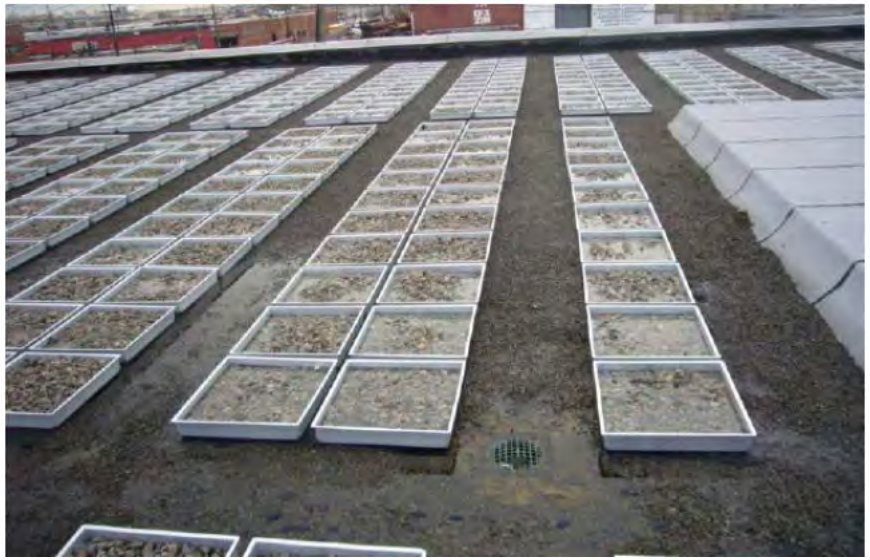
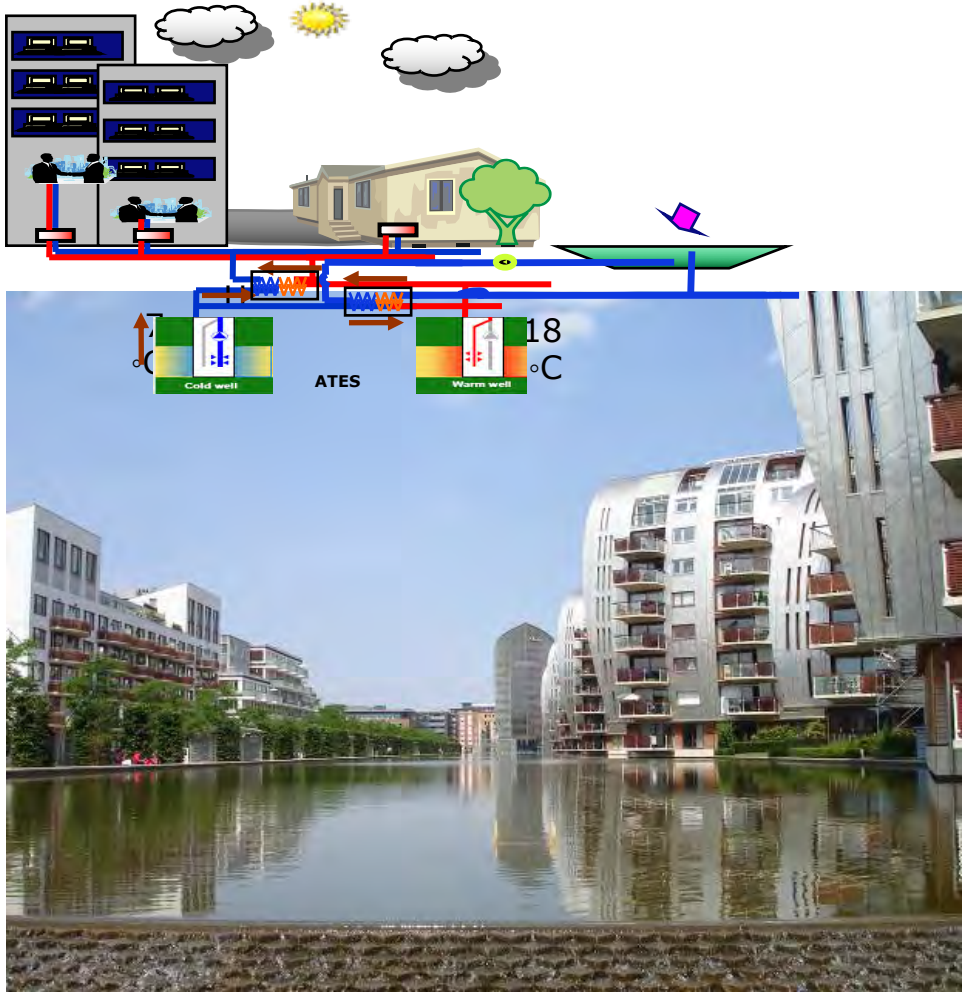
Water and green for recreation and wellbeing



Water for cooling and heating





Resilience planning – a tiered approach

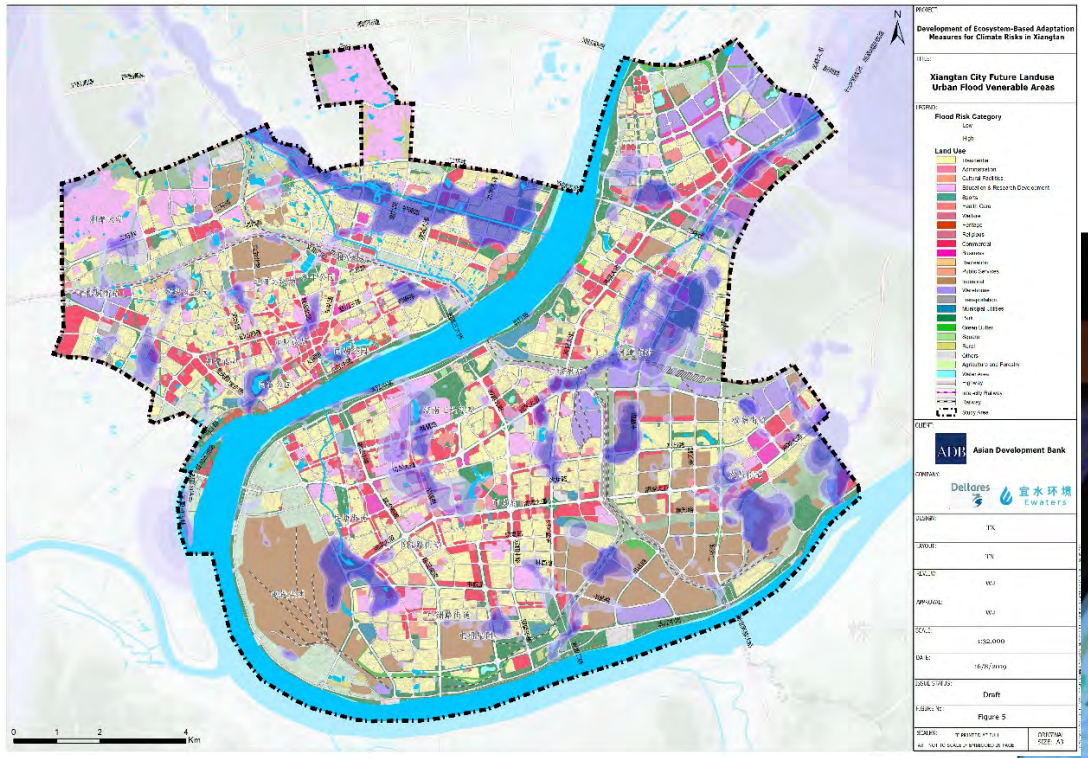
Three steps:

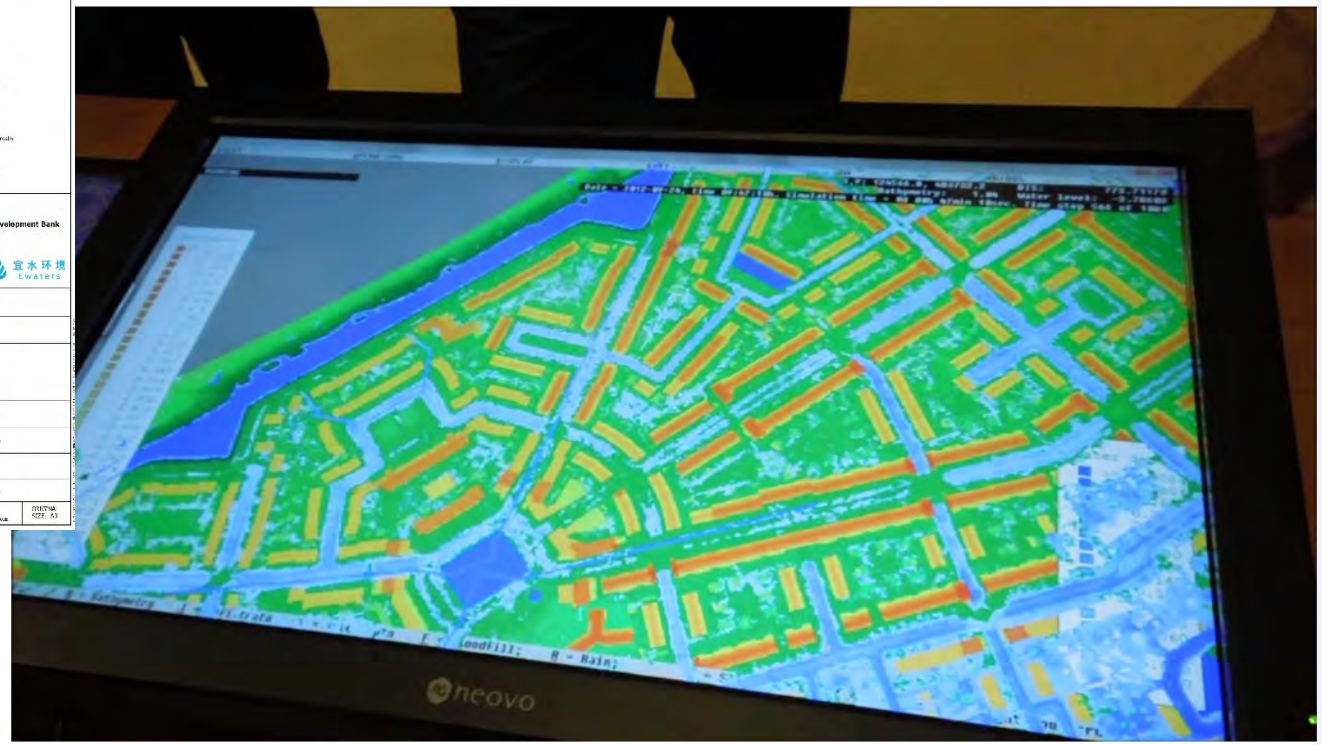
1: Vulnerability scan (“stress test”)

2: Strategy to reduce vulnerability and set targets

3: Select set of adaptation measures

Step 1, including: Flood hazard assessment





Hydraulic modelling, showing the flood-prone areas

Step 1, including: Governance analysis

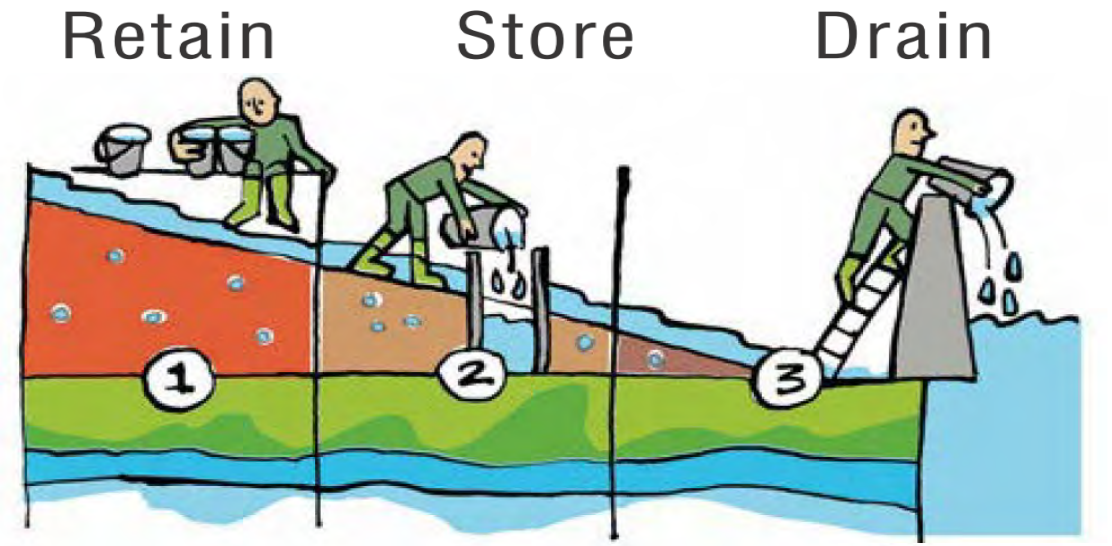
e.g. SWOT analysis of the governance-chain

using the PRIMO-chain approach

Adviesunit Resultaatgericht Beleid, Ministerie van Verkeer en Waterstaat. (1997). Resultaatgericht Beleid. Advies bij Beleidsontwikkeling, Communicatie en Samenwerking . Den Haag: Drukkerij Deltadruk.

Step 2, including: Retain – Store - Drain strategy

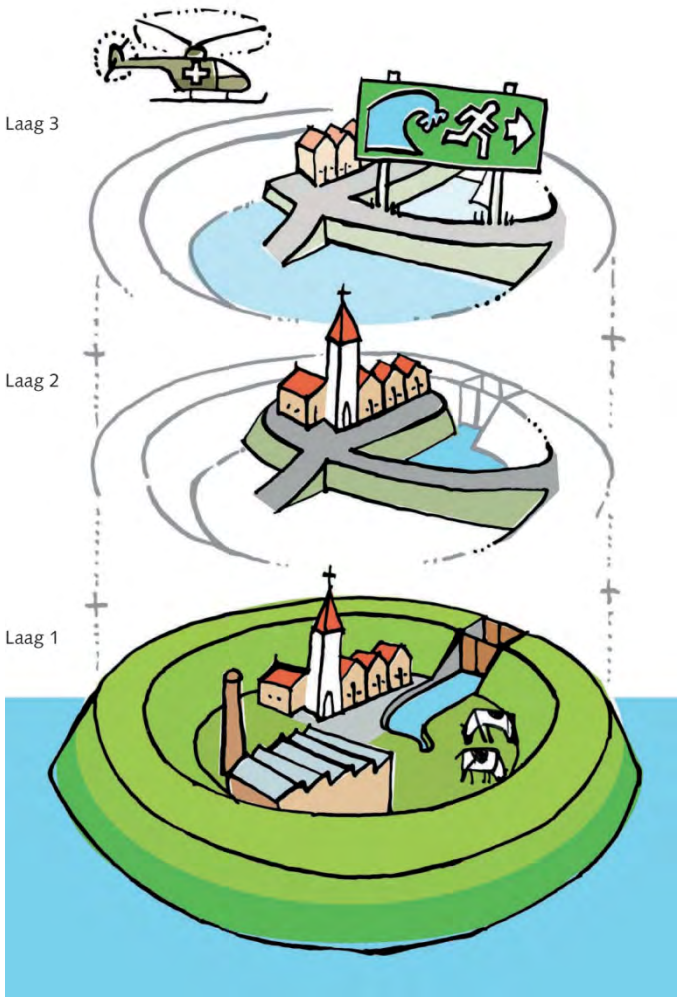
Retain and Detain and Store at the source to avoid overloading the drainage capacity



De Urbanisten

http://www.chinadaily.com.cn/opinion/2017-09/26/content_32491069.htm

Step 2, including: Multi-level protection strategy



Level 3:
Flood warning and emergency plans

Level 2:
Flood robust spatial planning

Level 1:
Flood protection for coastal and fluvial flooding

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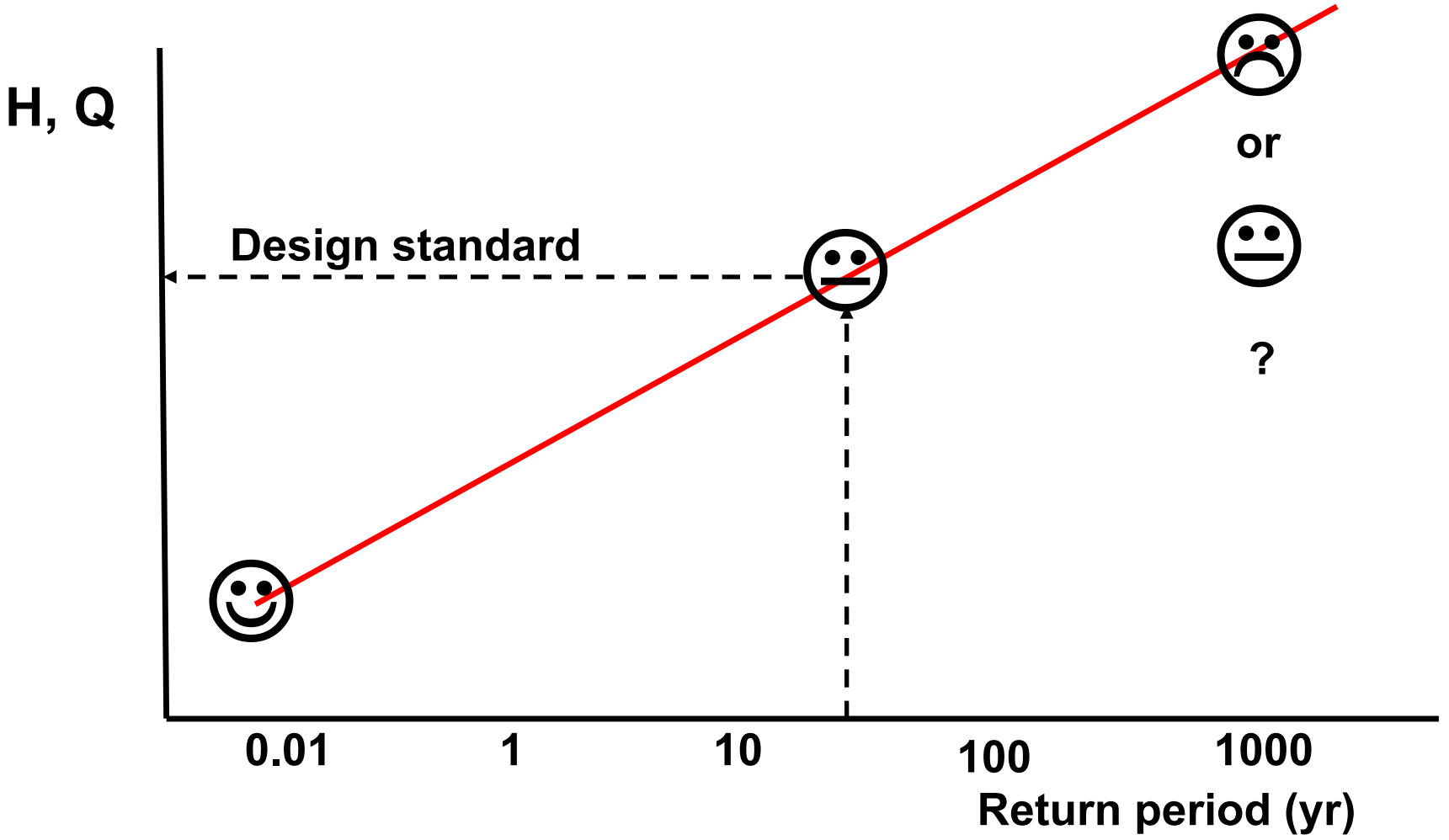
Step 2, including: Three point approach for resilience



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Step 2: 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***





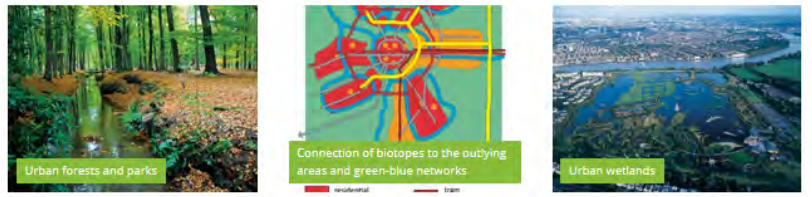


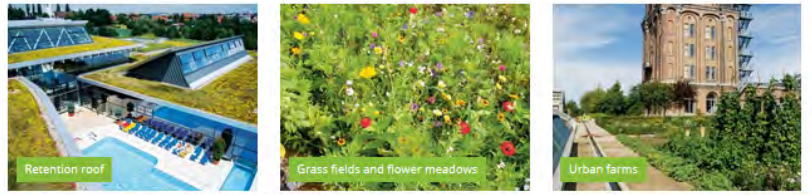

Step 3 Adaptation planning

Selecting the best set of adaptation measures

Selection and planning process

- EbA, Blue-green solutions, Nature-Based Solutions, Green infrastructure, grey solutions, SuDS,
- Many options => hard to make choices





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Step 3 Adaptation planning

Collaborative planning / co-design of solutions

- **Many different fields of expertise** required, e.g. urban planners, drainage experts, road engineers, landscape designers, project developers, housing experts, economists, etc.
- **Stakeholders** to be involved (residents, businesses) to get support for the plan by all stakeholders and political decision makers
- **Location specific solutions** are developed, using local knowledge and preferences
- Discussions are focusing on **opportunities, benefits and co-benefits** of specific interventions
- **Benefits are maximized** while risks are minimized

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Planning support tools

Required:

- Should facilitate and structure discussions
- Fit the structure planning & design process

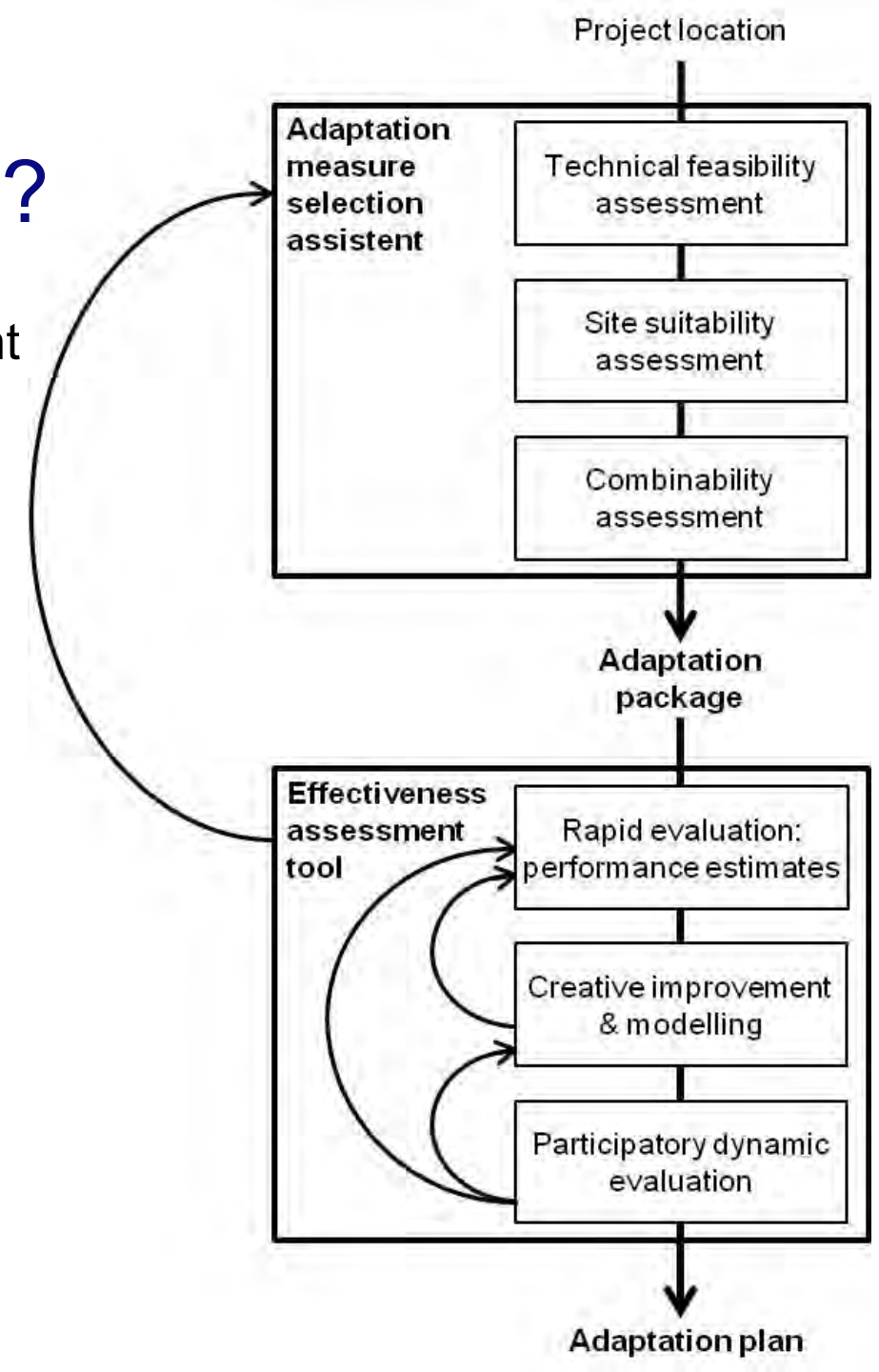
What is the Resilient City Toolbox meant for?

- **Support dialogue** with all stakeholders (experts, local representatives, constructors, financers, etc.) **about options and alternatives**; which adaptation measures can be implemented, where, and how?
- Provide **first estimate of hydrological effectiveness and costs** of a proposed adaptation measures for extreme rainfall, drought, heat and water quality, so that these aspects become an explicit part of the planning process.
- Results are shown on a **map**, which then becomes **input for a detailed design** by landscape architects and urban planners.

How is the Toolbox built up?

- An adaptation measures selection assistant
  - technical feasibility
  - site suitability
  - combinability assessment

- An effectiveness assessment tool



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Indicators of effectiveness of measures

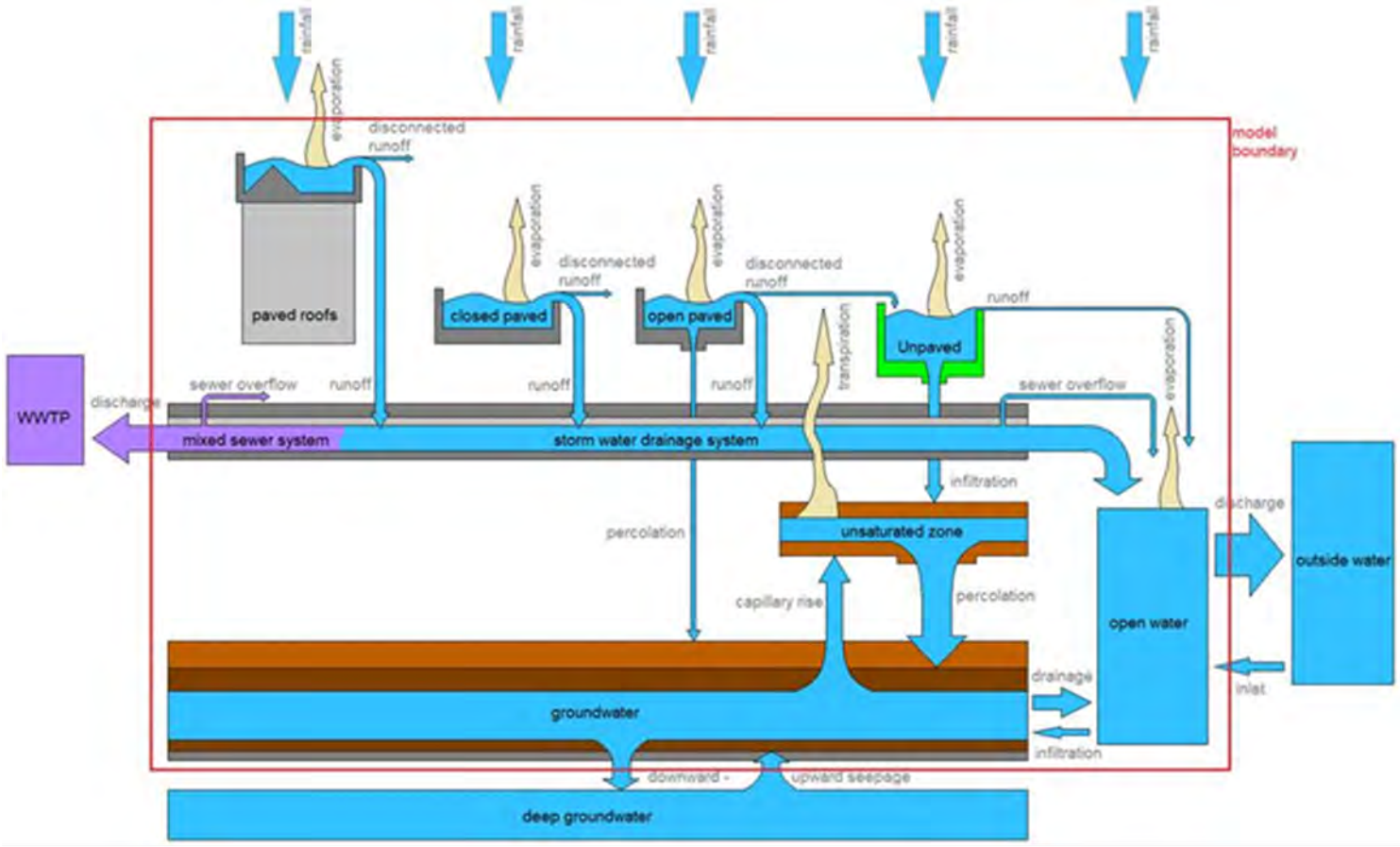
Adaptation goal	Key performance
Pluvial flooding	Storage capacity [m^3] Return time factor [-]
Drought reduction	Groundwater recharge (infiltration) [m/y]
Heat stress reduction	Evapotranspiration [mm/y] Cool spots [-]
Water quality improvement	Pathogen reduction Nutrient reduction Adsorbed pollutants reduction
Cost	Construction cost Maintenance cost

Effectiveness calculations with urban water balance model

Effects of the adaptation measures determined by means of a **multi-reservoir water balance rainfall-runoff model**

based on (ideally) long (30 years or more) time series of meteorological data, using hourly time steps.

- **Hydrological boundary conditions** of the water balance model are based on local conditions



Same model to assess target ‘sponge capacity’

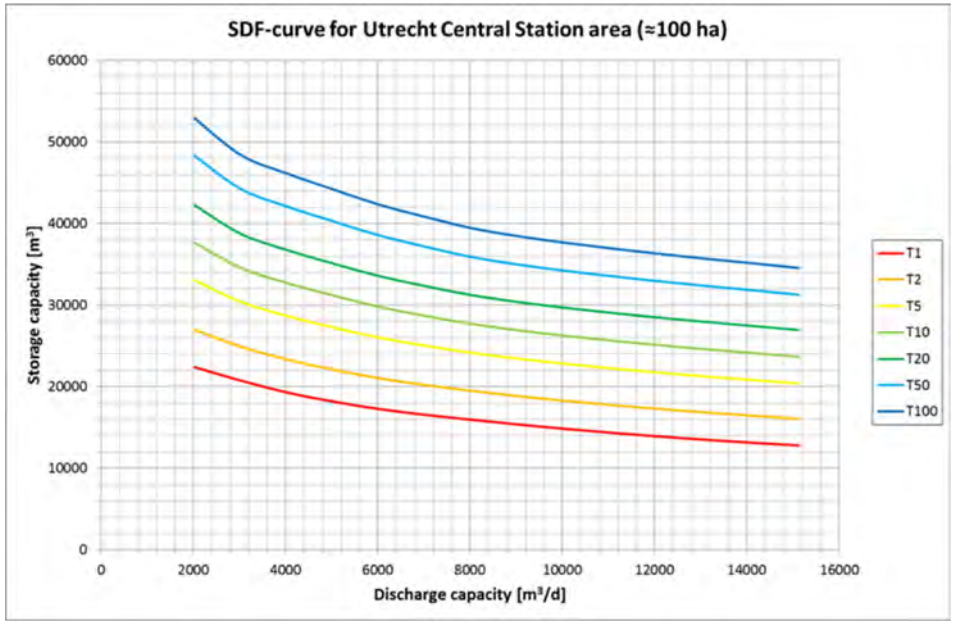
Input:
- land use data
- soil property data
- long series rainfall data
- long series evaporation data
- climate change assumptions

Urban Water Balance Model

Output:
- discharge capacity
- long series of stored volumes

extreme value statistics

Storage – Discharge – Frequency (SDF) curves



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Using the Climate Resilient City Toolbox online

Available on: https://crctool.org

- **Web-based**; no software installation required; project data stored on own PC
- **Customize** Toolbox for local conditions (climate, costs, applicability criteria,…)
- **Explore** alternatives and **co-create** plans
- **Export** the map and corresponding effectiveness results

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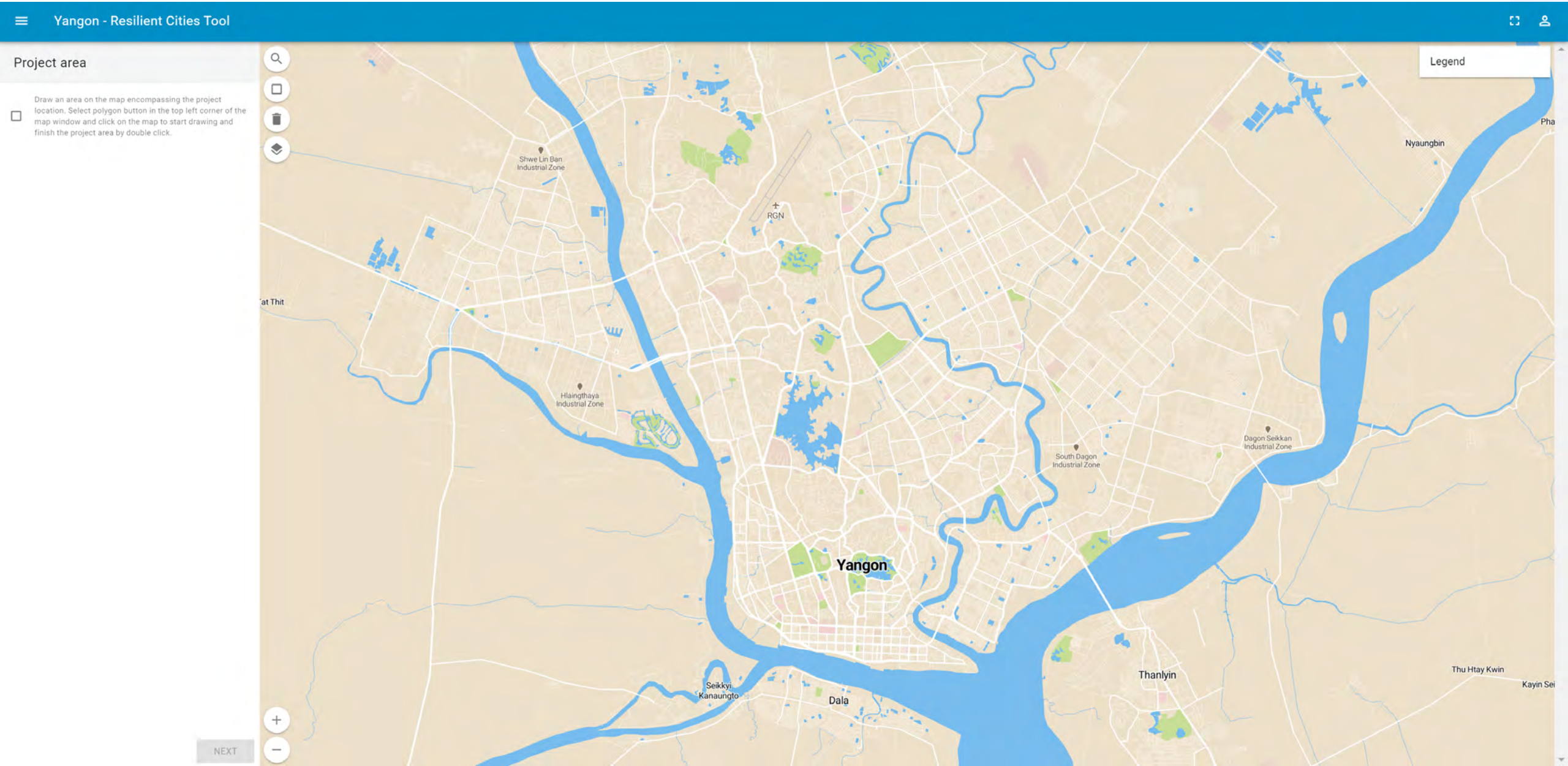
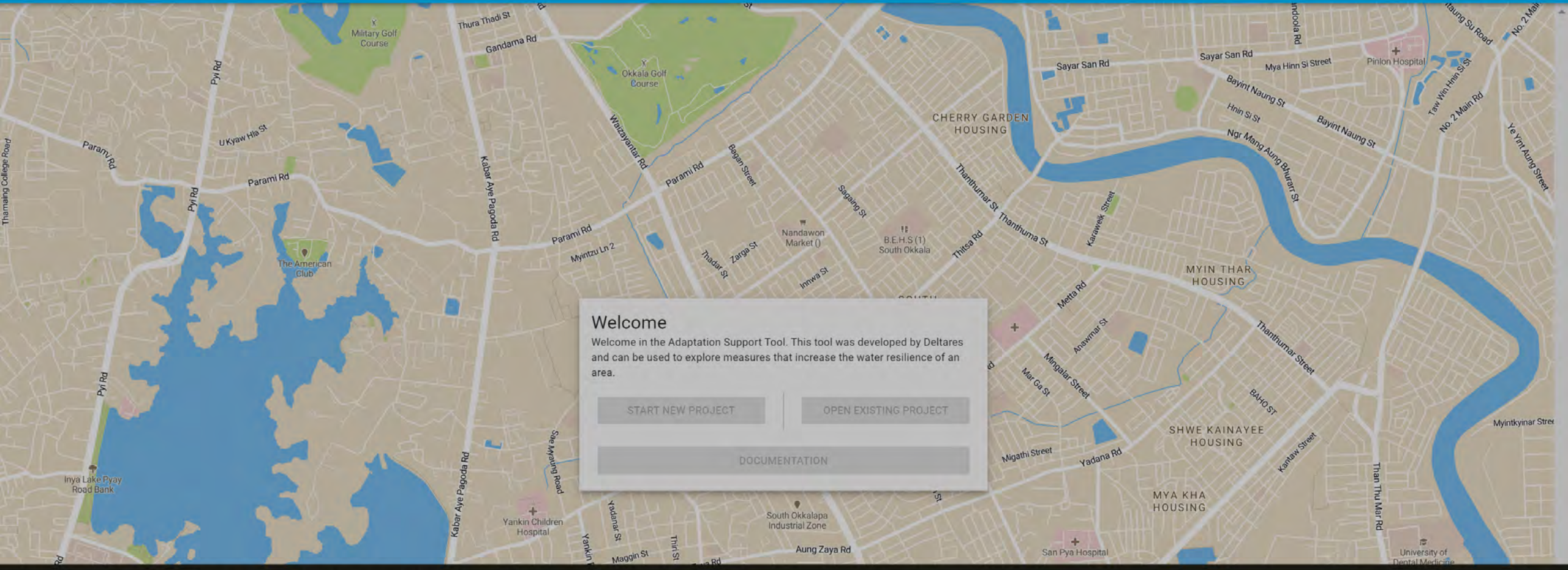
Resilient City Toolbox ; screen-shots





Welcome

Welcome in the Adaptation Support Tool. This tool was developed by Deltares and can be used to explore measures that increase the water resilience of an area.

START NEW PROJECT | OPEN EXISTING PROJECT

DOCUMENTATION

Toolbox Klimaatbestendige Stad (Climate Resilient City Toolbox) website User Agreement

You can print and file this legal agreement on the user terms and conditions of this Toolbox Klimaatbestendige Stad (Climate Resilient City Toolbox) website (hereinafter "User Agreement"), e.g. prior to accepting these terms and conditions.

Please read this User Agreement carefully.

This is a legal agreement between you, acting on behalf of a legal entity, and Stichting Deltares (hereinafter "Deltares"). The use of this Toolbox Klimaatbestendige Stad (Climate Resilient City Toolbox) website and of the resulting outcomes of its use (e.g. a data-file) is subject to the conditions of this User Agreement as set out below. The website and the resulting outcomes of its use are hereinafter jointly referenced to as "Website".

By marking the "I Agree"-checkbox:

1. You expressly declare being authorized to act on behalf of the legal entity (hereinafter "User") you represent for the purposes of accepting this User Agreement;
2. User expressly accepts this User Agreement and accepts to be legally bound by the terms and conditions contained therein.

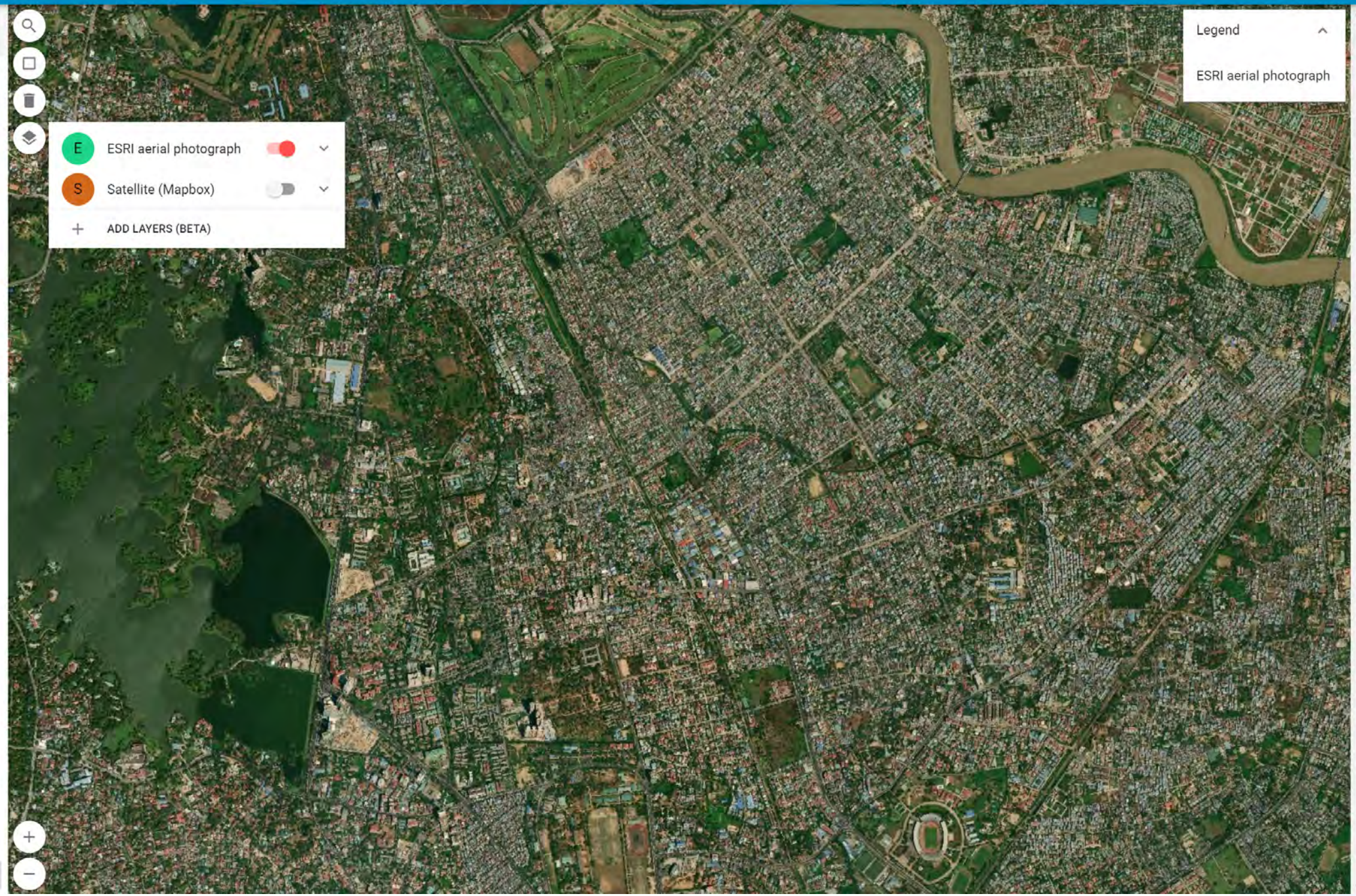
If you are not authorized to act on behalf of User to agree upon this User Agreement, please do not mark the "I agree" checkbox and exit this Website. Furthermore do not mark the "I Accept" checkbox and end the visit to this Website if User does not agree with the User Agreement.

I AGREE

Project area

Draw an area on the map encompassing the project location. Select polygon button in the top left corner of the map window and click on the map to start drawing and finish the project area by double click.

NEXT



PROJECT AREA | PROJECT TARGET

Area size: **953557m²** CHANGE AREA

Scenario Name

Choose Scenario

Default test

Climate Resilience Capacity

- [x] Heatstress
- [ ] Drought
- [x] Pluvial flood
- [ ] Water safety

Multi-functional landuse

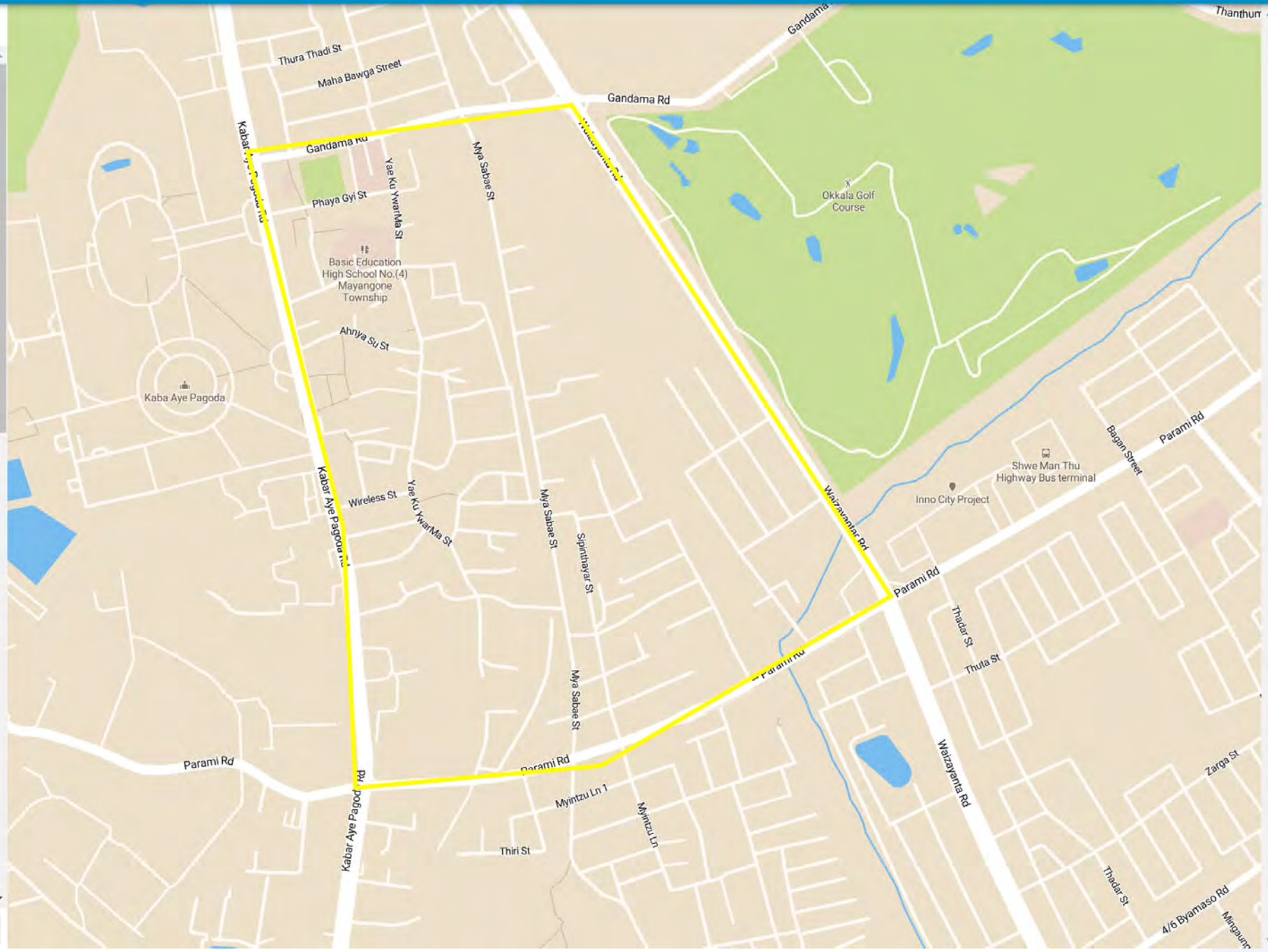
- ( ) Not important
- (•) Important
- ( ) Very important

Scale level

- [ ] City
- [x] Neighbourhood
- [ ] Street
- [ ] Building

Existing space types

NEXT



1 Select a measure — 2 Draw an area

search

Adding trees to streetscape
51.6

LEARN MORE CHOOSE

Bioswale (with drainage)
41.6

LEARN MORE CHOOSE

Gravel layers
25.3

LEARN MORE CHOOSE

Hollow roads
61.6

LEARN MORE CHOOSE

Water square
61.6

LEARN MORE CHOOSE

Urban forest
53.2

LEARN MORE CHOOSE

Green roofs
52.7

LEARN MORE CHOOSE

Green roofs with drainage delay
52.7

LEARN MORE CHOOSE

Cooling with water elements - ponds
51.6

LEARN MORE CHOOSE

Creating shadow
50.8

LEARN MORE CHOOSE

Infiltration fields and strips with surface storage
48.3

LEARN MORE CHOOSE

Small quays
48.2

LEARN MORE CHOOSE

Cool building materials (high albedo)
47.8

LEARN MORE CHOOSE

Permeable pavement (storage)
47.3

LEARN MORE CHOOSE

Remove pavement to plant green
47.3

LEARN MORE CHOOSE

Permeable pavement systems (infiltration)
47.3

LEARN MORE CHOOSE

CANCEL

Results

Climate

Storage capacity:	0 m3
Return time factor:	0 +1
Groundwater recharge:	0 mm/year
Evapotranspiration:	0 mm/year
Heat reduction:	0 C
Cool areas:	0

Cost

Construction:	0 €
Maintenance:	0 €/year

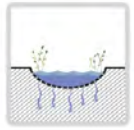
Water quality

Pathogen reduction:	0 %
Nutrient reduction:	0 %
Adsorbing pollutants:	0 %

VIEW AS TABLE

BACK

CHOOSE



Rainwater detention pond (wet pond)

Pluvial flooding | Drought | Heatstress

Buffer ponds temporarily capture precipitation and allow it to drain off slowly. During rainfall, the rainwater is captured in the pond and subsequently drained off to create room for the next precipitation. Buffer ponds can be designed to have a mostly stony or a mostly natural appearance.

For more information click here

Results

Climate

Storage capacity:	0 m3
Return time factor:	0 +1
Groundwater recharge:	0 mm/year
Evapotranspiration:	0 mm/year
Heat reduction:	0 C
Cool areas:	0

Cost

Construction:	0 €
Maintenance:	0 €/year

Water quality

Pathogen reduction:	0 %
Nutrient reduction:	0 %
Adsorbing pollutants:	0 %

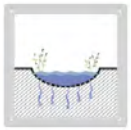
VIEW AS TABLE

Selected measures

Area-1
Rainwater detention pond (wet pond)

Area name
Area-1

Measure
Rainwater detention pond (wet pond)

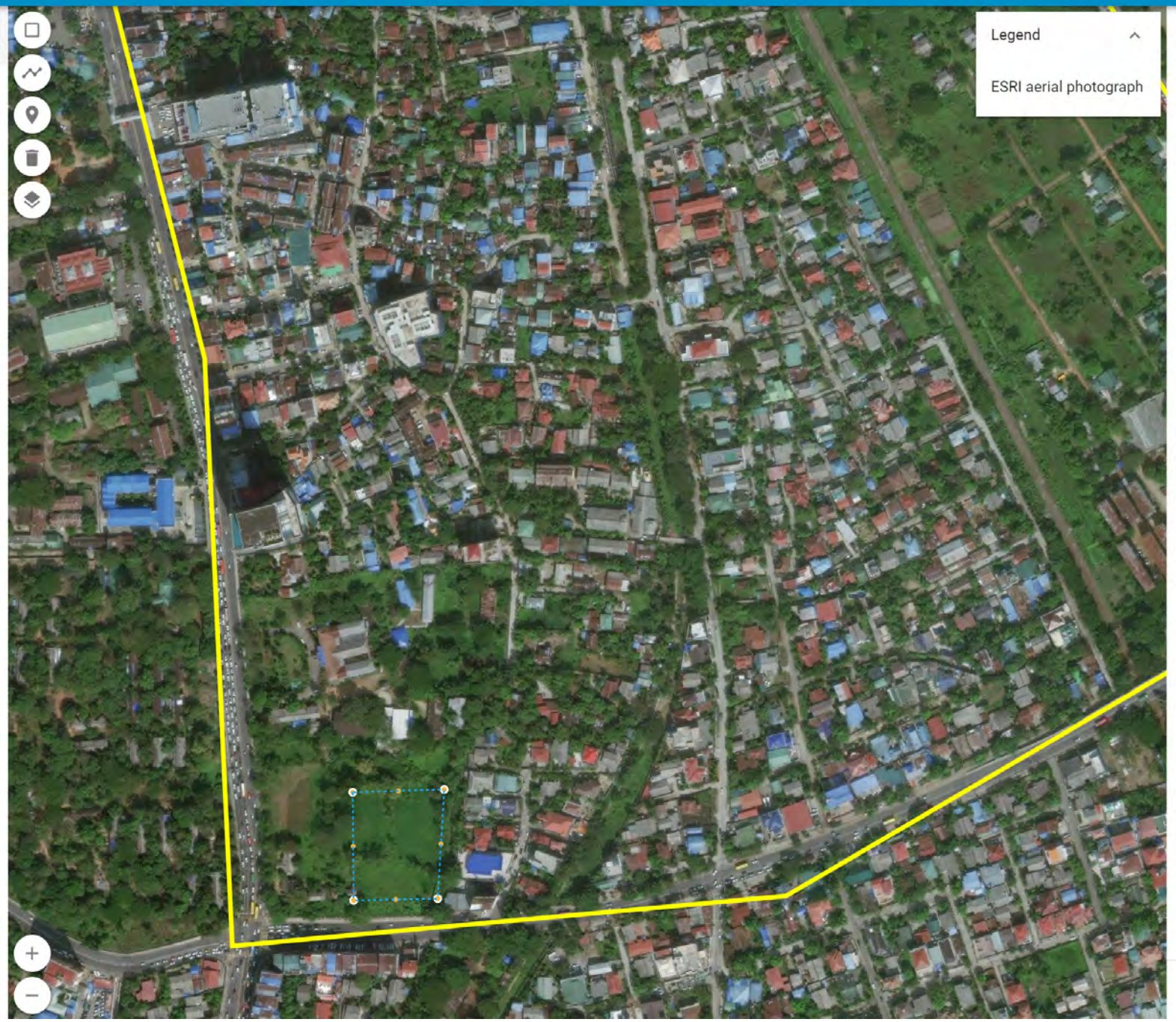


CHANGE MEASURE

Water storage depth (m)
0.3

Inflow area (x)
10

DONE



Results

Climate

Storage capacity:	1948 m3
Measure	*1948 m3*
Return time factor:	68.03 +1
Measure	*68.03 +1*
Groundwater recharge:	13.35 mm/year
Measure	*13.35 mm/year*
Evapotranspiration:	-0.15 mm/year
Measure	*-0.15 mm/year*
Heat reduction:	0.02 C
Measure	*0.02 C*
Cool areas:	0
Measure	*0*

Cost

Construction:	259738 €
Measure	*259738 €*
Maintenance:	1299 €/year
Measure	*1299 €/year*

Water quality

Pathogen reduction:	0.34 %
Measure	*0.34 %*
Nutrient reduction:	0.14 %
Measure	*0.14 %*
Adsorbing pollutants:	0.41 %
Measure	*0.41 %*

VIEW AS TABLE

Selected measures

Area-3
Bioswale (with drainage)

Area name
Area-3

Measure

Bioswale (with drainage)

CHANGE MEASURE

Water storage depth (m) 0.35

Inflow area (x) 10

Width (m) 1

DONE

Results

Climate

Storage capacity:	2033 m3
Measure	*61.77 m3*
Return time factor:	68.11 +1
Measure	*0.08 +1*
Groundwater recharge:	13.7 mm/year
Measure	*0.35 mm/year*
Evapotranspiration:	0.17 mm/year
Measure	*0 mm/year*
Heat reduction:	0.03 C
Measure	*0 C*
Cool areas:	0
Measure	*0*

Cost

Construction:	553008 €
Measure	*13236 €*
Maintenance:	15433 €/year
Measure	*132 €/year*

Water quality

Pathogen reduction:	0.58 %
Measure	*0.02 %*
Nutrient reduction:	0.1 %
Measure	*0.01 %*
Adsorbing pollutants:	0.65 %
Measure	*0.02 %*

VIEW AS TABLE

Applied Measures

- Bioswale (with drainage)
- Green roofs
- Rainwater detention pond (wet pond)

Results

CLIMATE AND COSTS | CO BENEFITS

Measure	Surface	Storage capacity (m3)	Return time factor (+1)	Groundwater recharge (mm/y)	Evapotranspira... (mm/y)	Heat reduction (C)	Cool areas	Construction	Maintenance
Bioswale (with drainage)	176.48	62	0.08	0	0	0	0	13236	132
Green roofs	2333.61	23	0	0	0	0.01	0	280034	14002
Rainwater detention pond (wet pond)	6493.46	1948	68.03	13	0	0.02	0	259738	1299

+ MEASURE

Results

Climate

Storage capacity:	2033 m3
Return time factor:	68.11 +1
Groundwater recharge:	13.7 mm/year
Evapotranspiration:	0.17 mm/year
Heat reduction:	0.03 C
Cool areas:	0
on:	553008 €
ce:	15433 €/year
ity	
reduction:	0.58 %
duction:	0.1 %
pollutants:	0.65 %

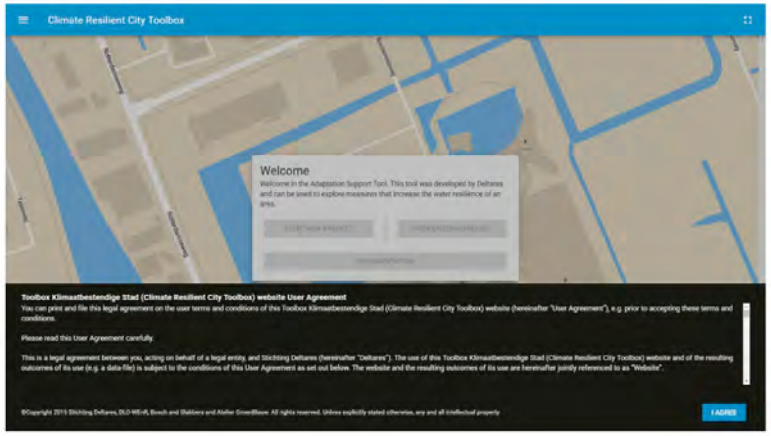
VIEW AS TABLE

BACK

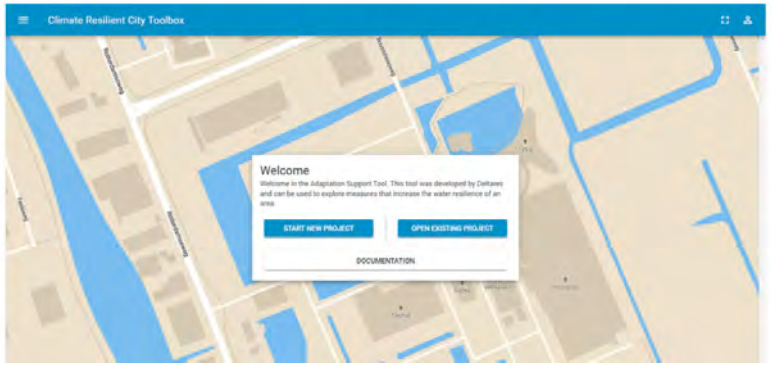
Documentation

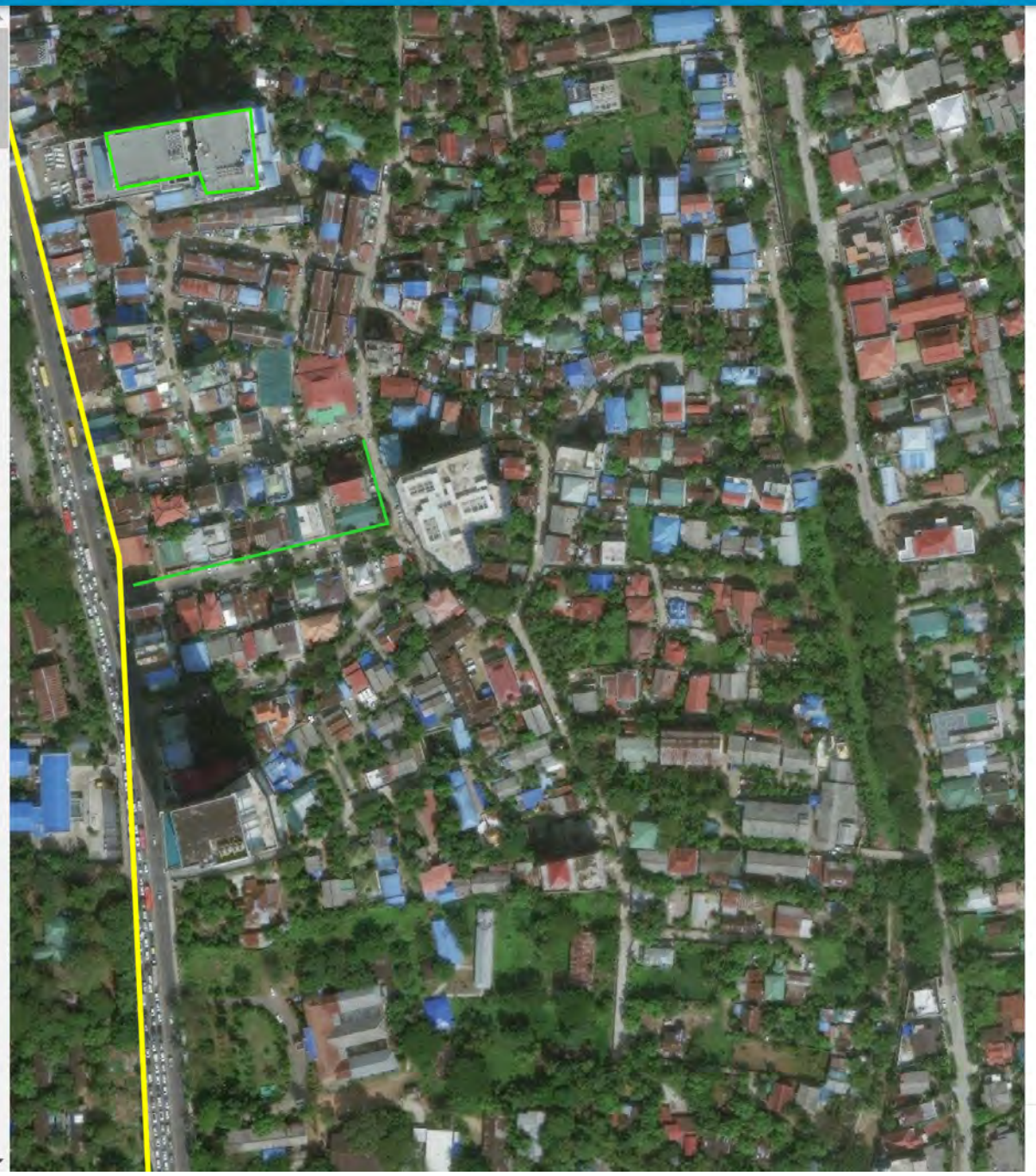
This guide explains the use of the Adaptation Support Tool 2.0 going through the initial setup and configuration step by step. More detailed information on the tool can be found here.

First, read, discuss and accept the disclaimer and copyrights. All participants have to understand and agree that the results of the AST are merely indicative and cannot be used for final design and decision making. After accepting the disclaimer and copyrights you can start using the tool.



To use the AST for the first time, select *Start a new project* or, in case you already have a saved project select *Open existing project*.





Results

Climate

Storage capacity:	2033 m3
Return time factor:	68.11 +1
Groundwater recharge:	13.7 mm/year
Evapotranspiration:	0.17 mm/year
Heat reduction:	0.03 C
Cool areas:	0

Cost

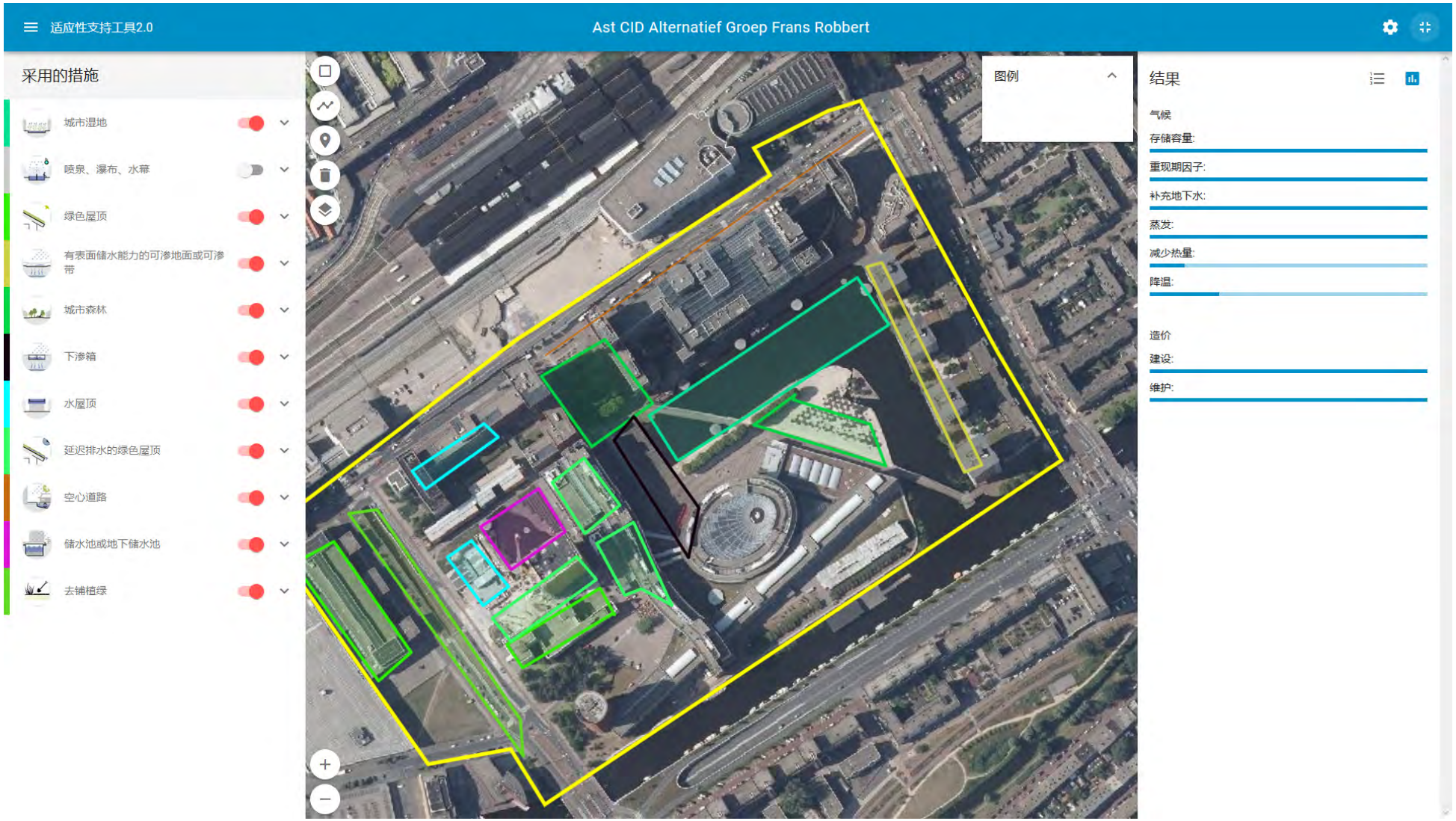
Construction:	553008 €
Maintenance:	15433 €/year

Water quality

Pathogen reduction:	0.58 %
Nutrient reduction:	0.1 %
Adsorbing pollutants:	0.65 %

VIEW AS TABLE

Resilient City Toolbox application examples



Utrecht Center – Fair area

- Stakeholders involved: Municipality + Fair
- Ambition: Most green, climate resilient and healthy
  urban area in Europe
- RCT used with stakeholders to
  - collaboratively explore potential adaptation measures
- Funding: City of Utrecht, Jaarbeurs Fair, EU

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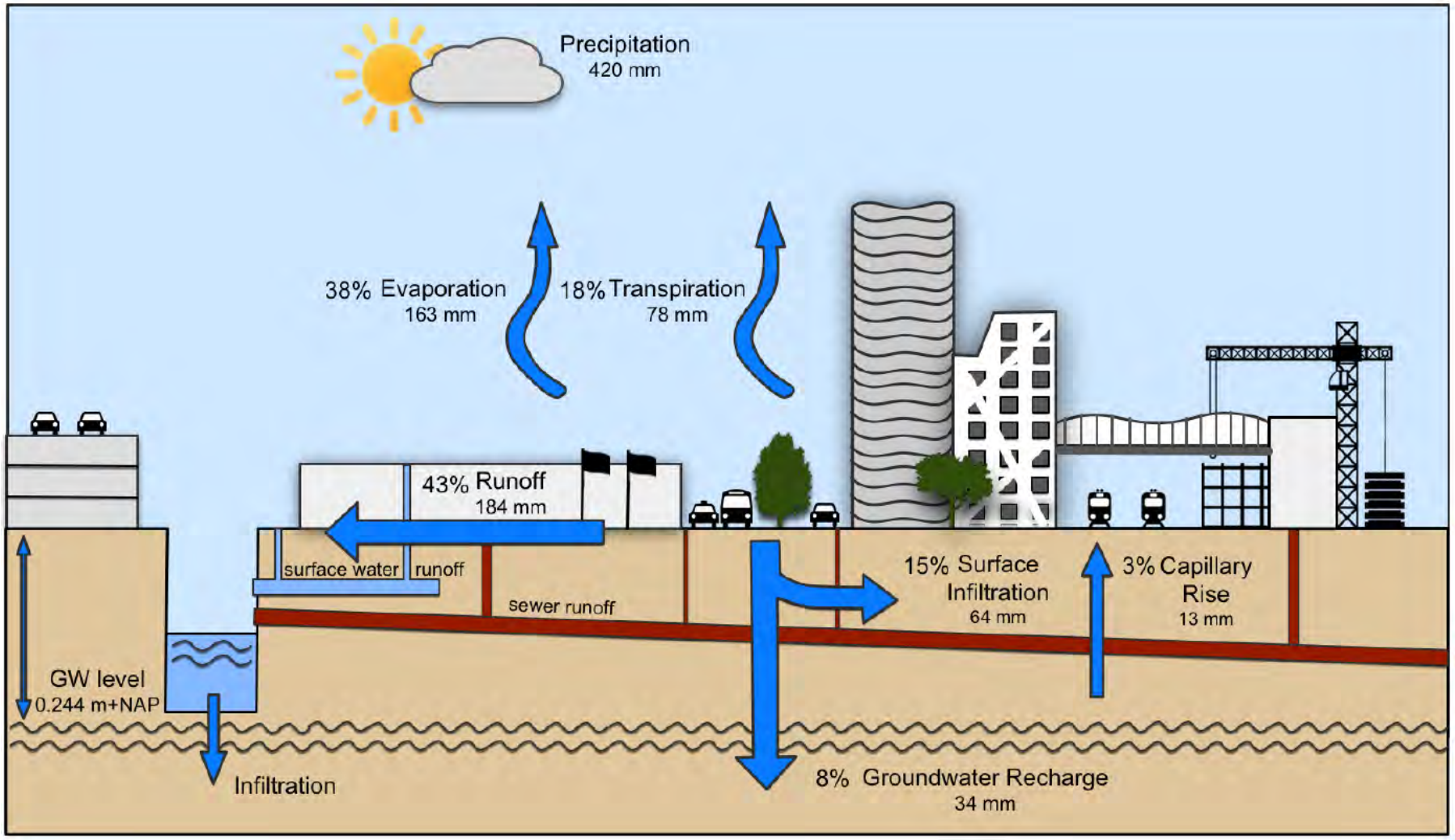
Utrecht Center – Need to change water flow to increase resilience



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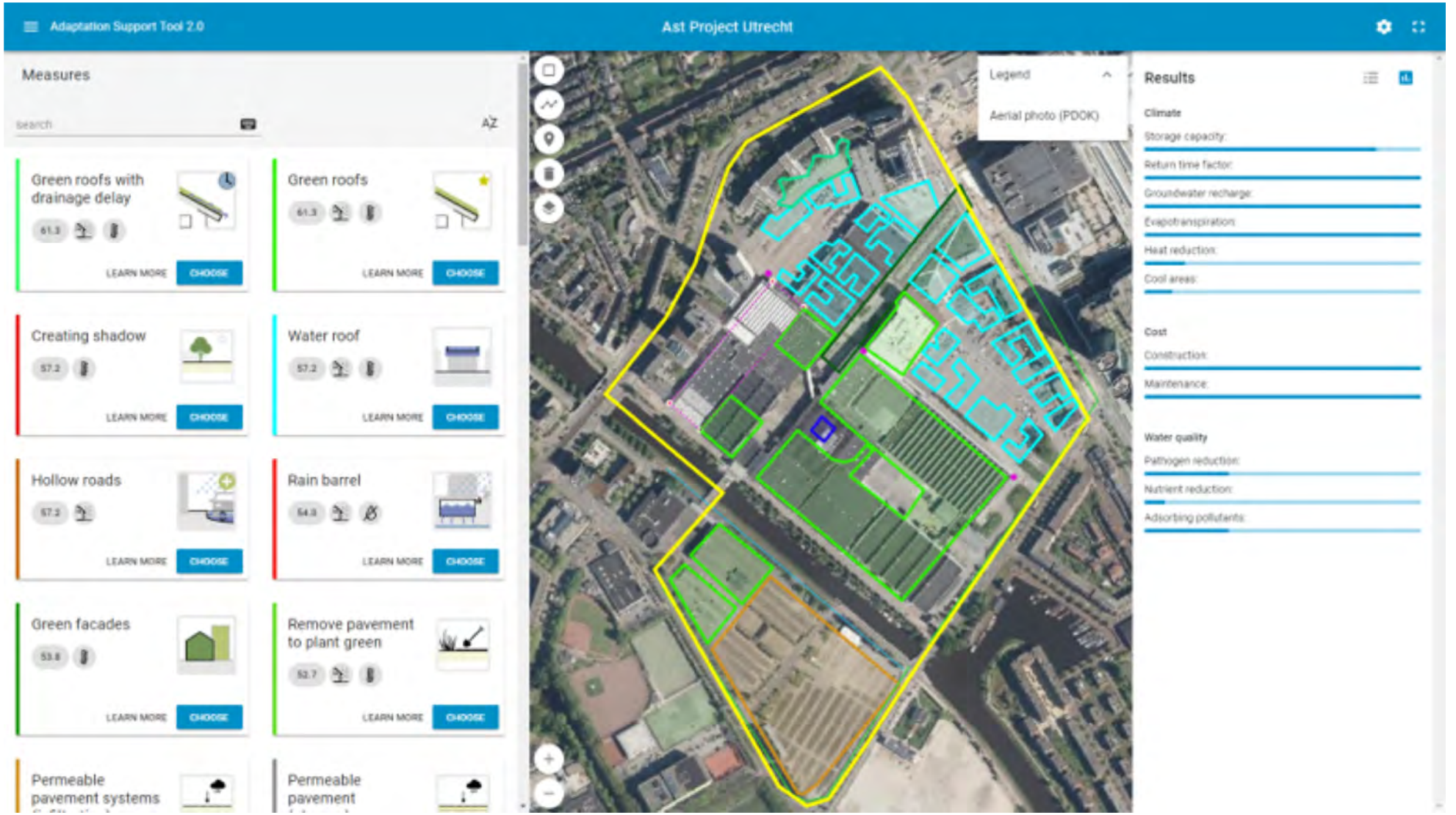
Utrecht Center – fair area



Utrecht Center – RCT to implementation 2018

Source: http://cu2030.nl

Source: www.stefanoboeriarchitetti.net

Van de Ven, F.H.M., P. Bosch, R.J. Brolsma, J.J. Kok, E.S. van der Meulen, F.E. Schasfoort, C.L. ten Velden, A.J.J. Vergroesen (2016) Green, comfortable, attractive and climate resilient Utrecht Centre-West area : Smart Sustainable Districts – deep dive Utrecht opportunity 3. Deltares/TNO report 1220357, http://publications.deltares.nl/1220357_000.pdf

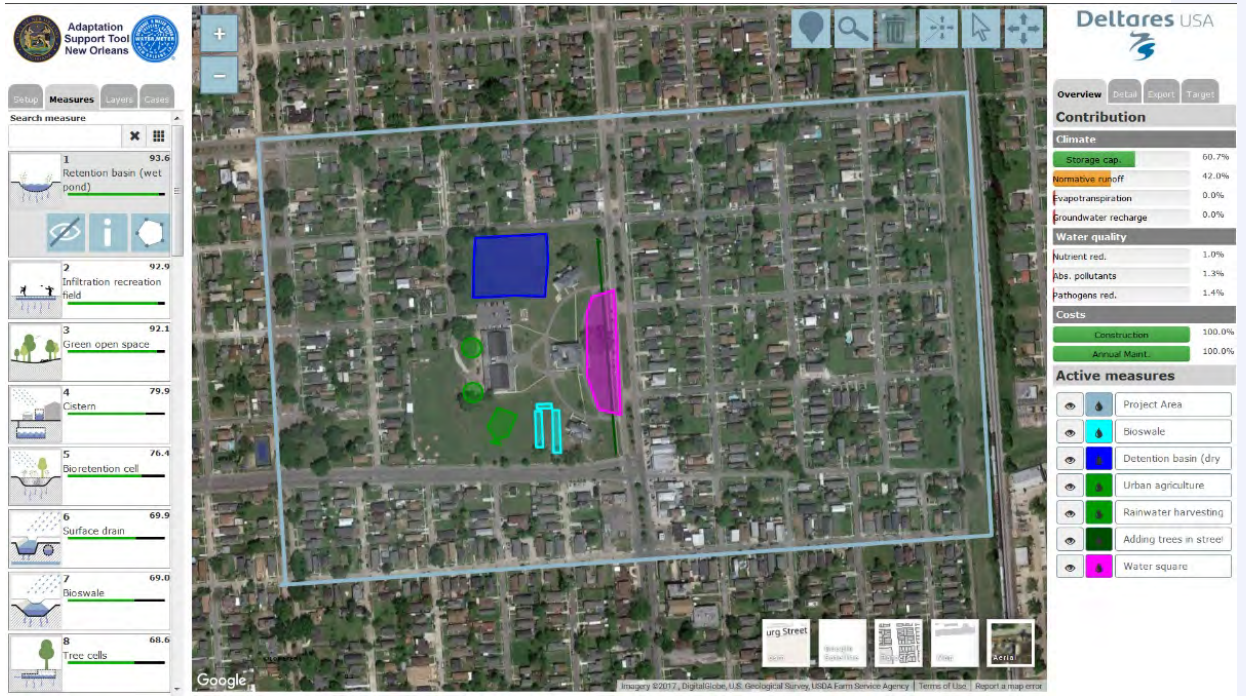
New Orleans CRC Toolbox

Client:

- NO Sewerage
- NO Redevelopment Authority

Objective

- Use toolbox to plan and communicate Green Infrastructure to increase flood resilience

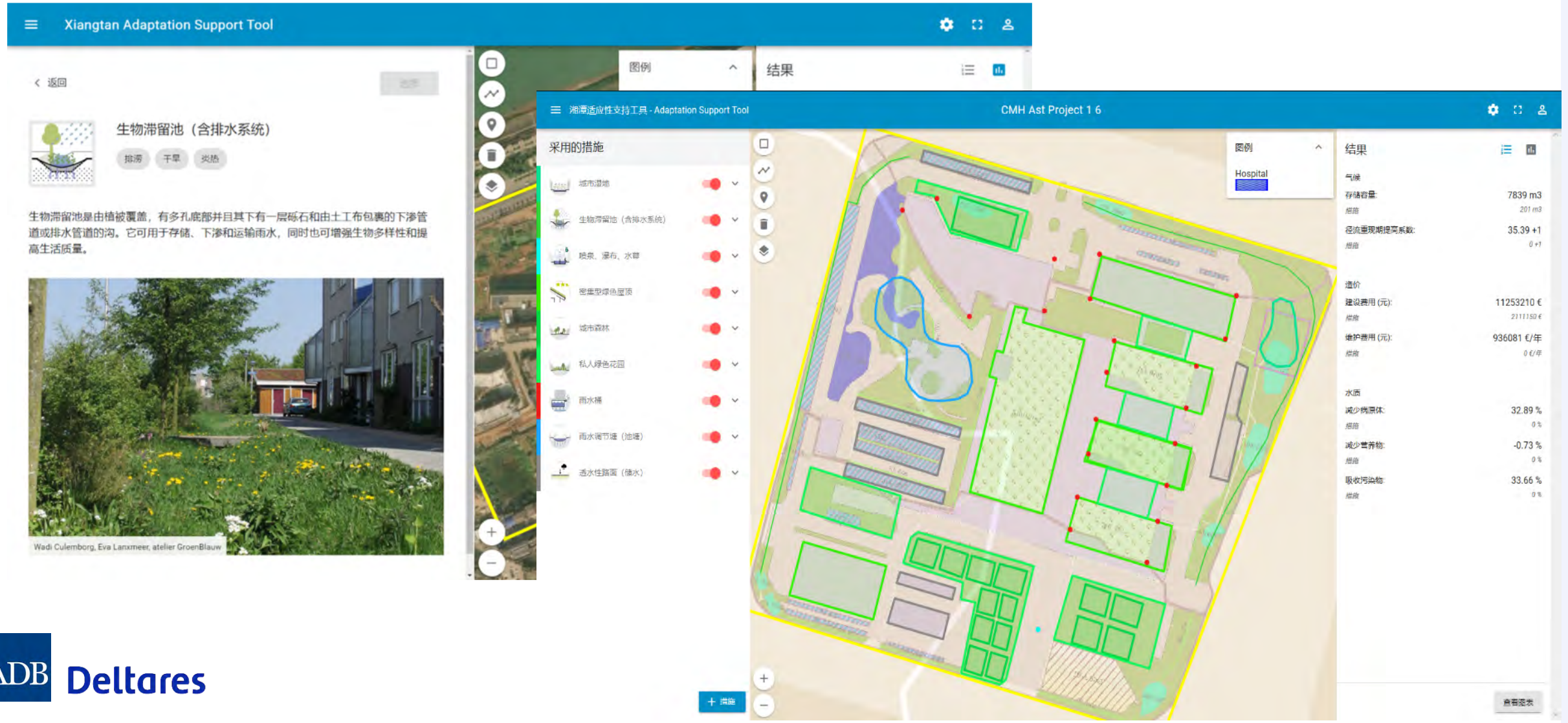


What was needed:

- Customization of the tool for application in and by the city of New Orleans and training to the workshop facilitators.

Collaborative planning workshop

Resilient City Toolbox for Xiangtan



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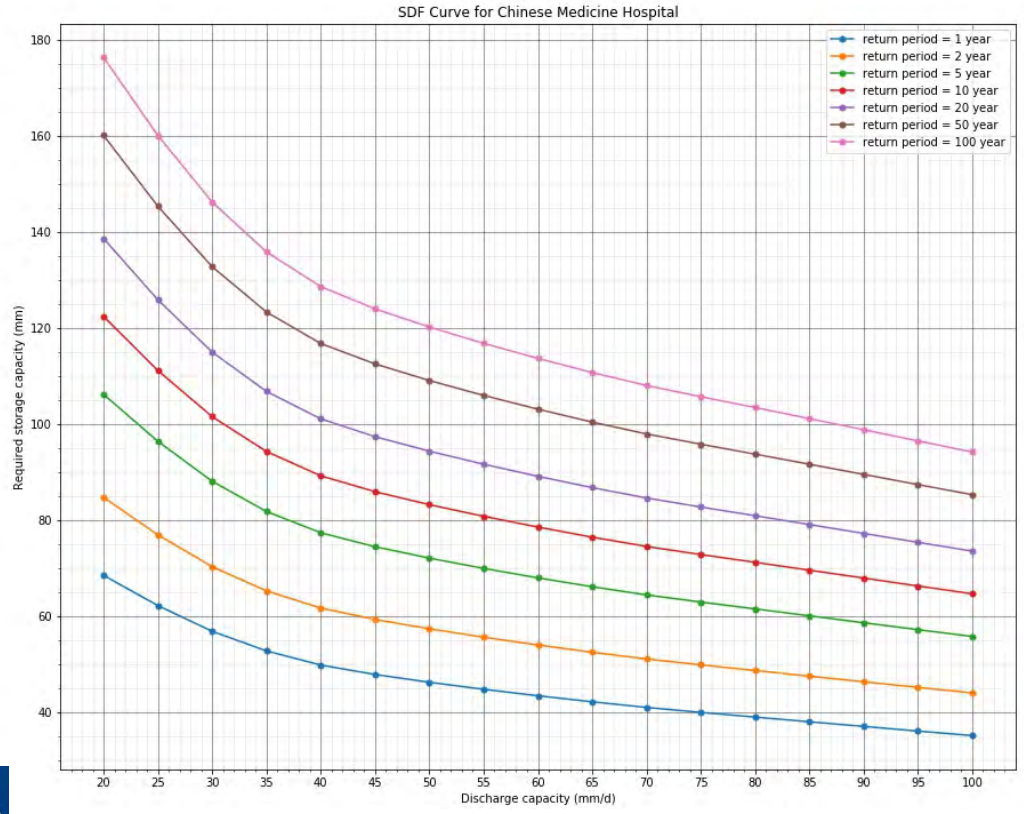
Resilient City Toolbox for Xiangtan

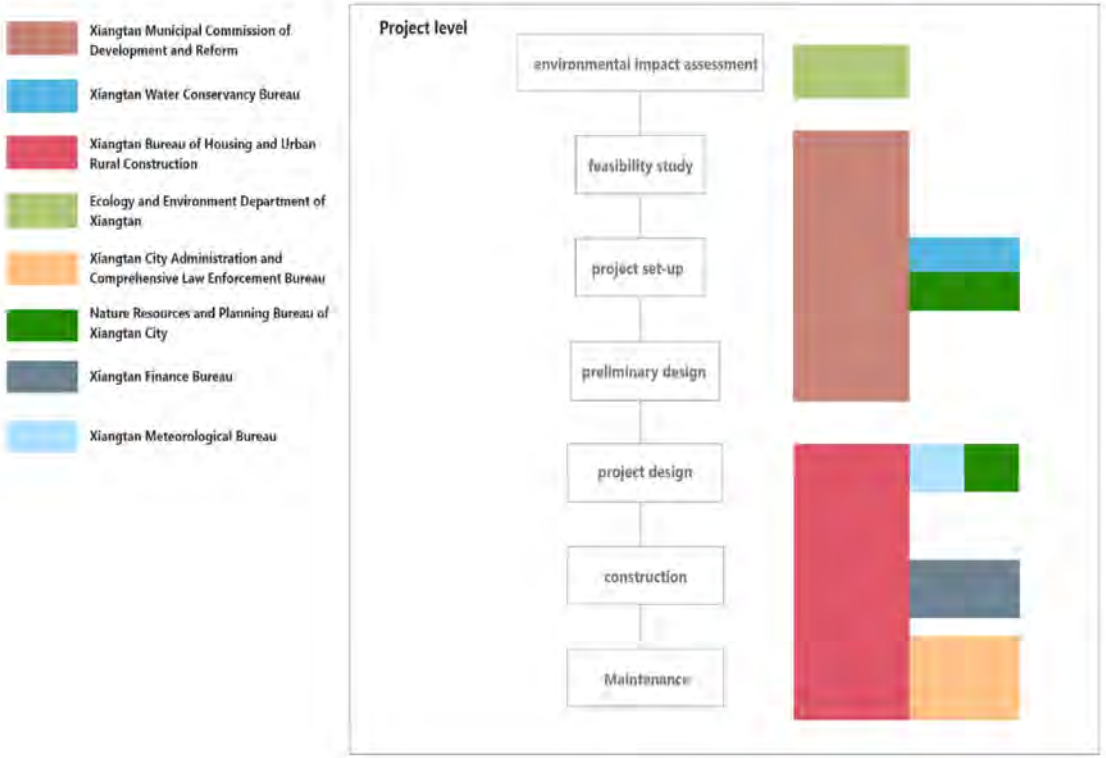
Collaborative planning

Results based on:

Required sponge capacity assessment



Stakeholder analysis



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Background information

- https://**publicwiki.deltares.nl/**display/AST/KBS+Toolbox+and+Adaptation+Support+Tool+Home
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Questions?

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