

Deltares



Training 1: Introduction
Adaptation to Climate Change
How to strengthen Urban Resilience
by Ecosystem-based Adaptation?

Frans van de Ven

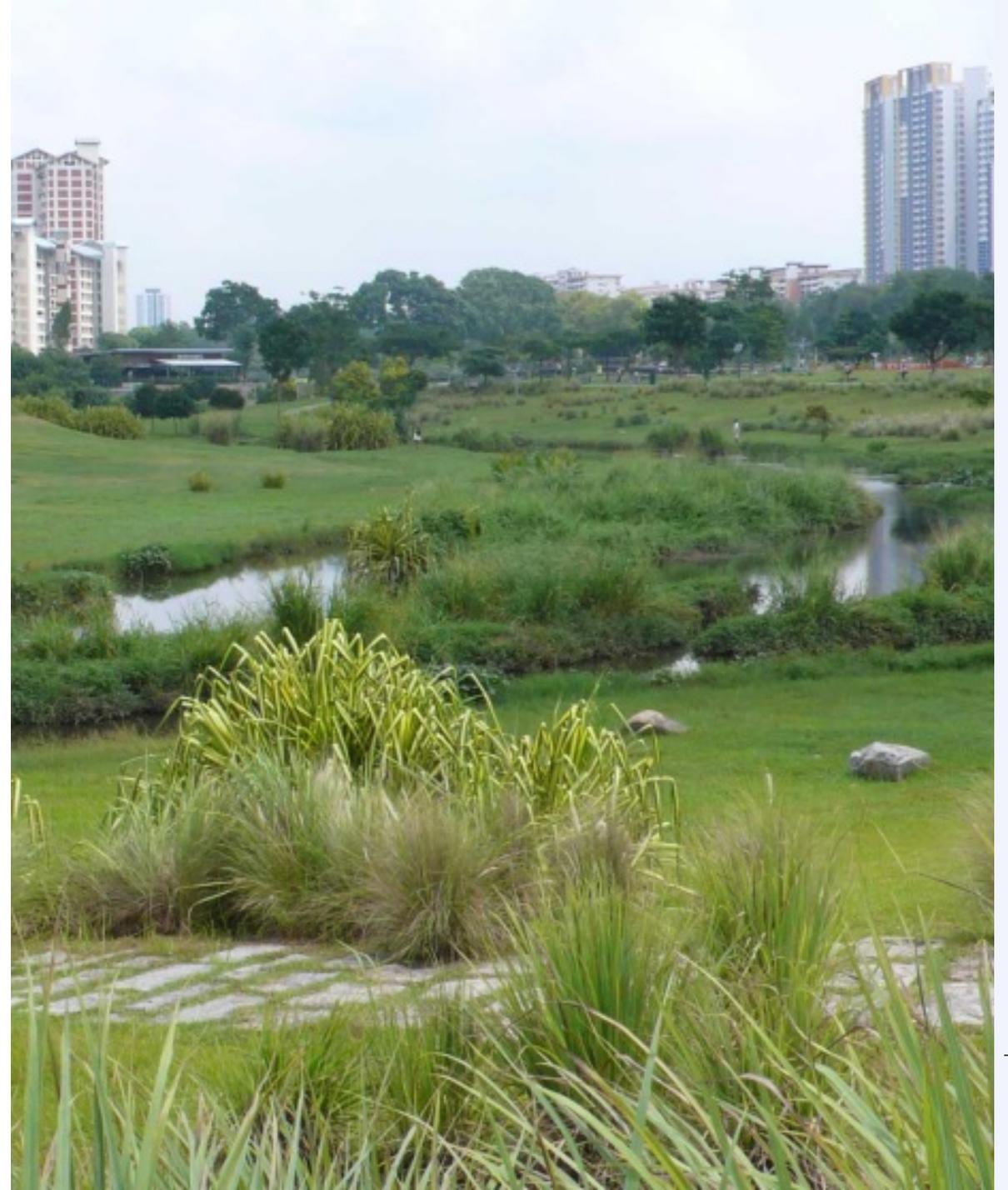
Reinder Brolsma

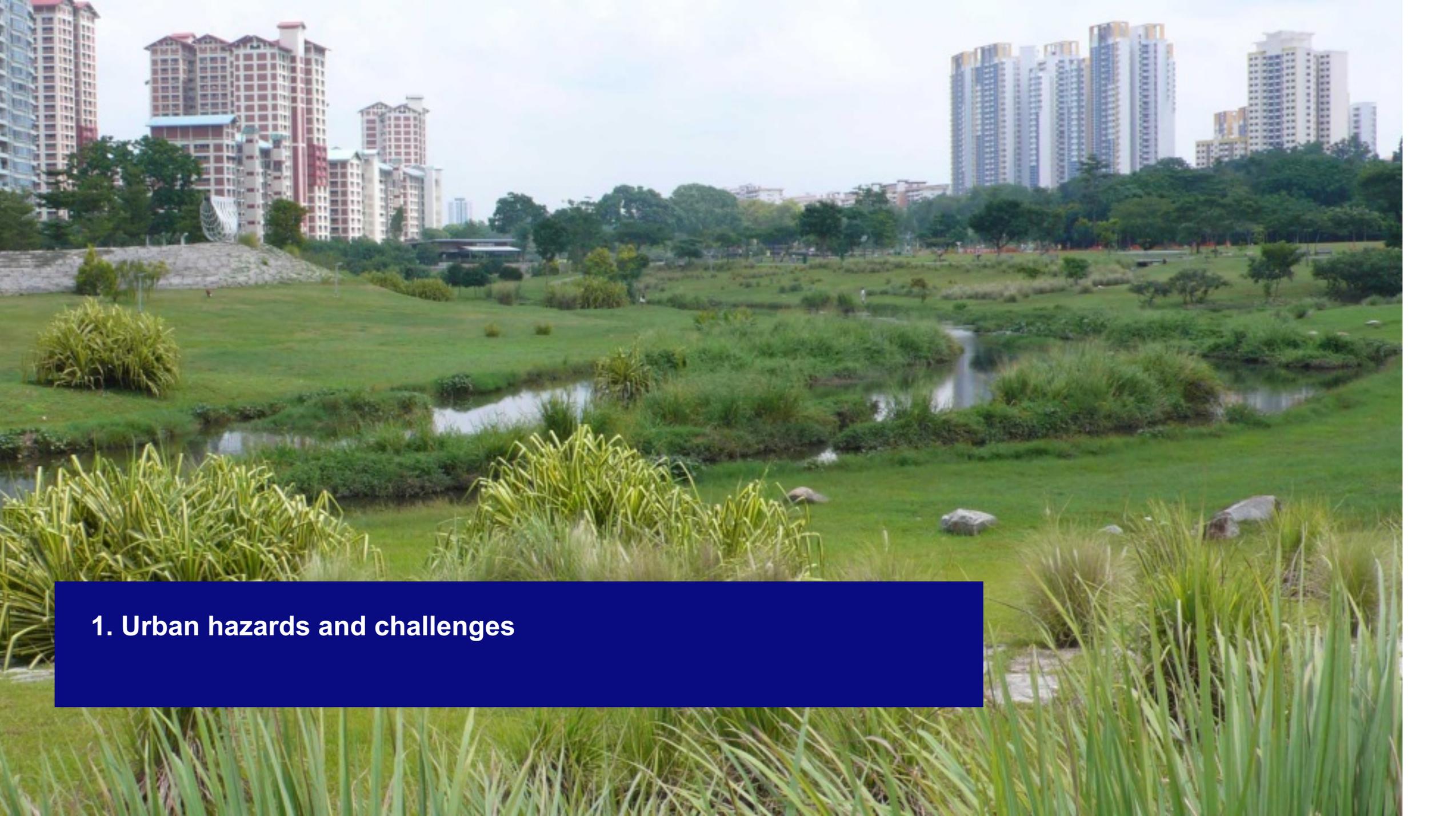
Helena Hulsman

21 October 2020

Adaptation to climate change

1. Urban hazards and challenges
2. Urban resilience
3. Climate resilience
4. Adaptation planning
5. Planning support tools
6. Training assignments





1. Urban hazards and challenges

1. Urban hazards and challenges

- Which hazards?
- Challenges to what?
- Definitions of hazard, exposure, sensitivity, vulnerability?
- What is retrofitting?



Definitions: climate hazards, sensitivity, vulnerability

Hazard:

The potential occurrence of a natural or human-induced physical event or trend or physical impact that may cause loss of life, injury, or other health impacts, as well as damage and loss to property, infrastructure, livelihoods, service provision, ecosystems and environmental resources. (IPCC, 2014: Annex II: Glossary)

Sensitivity:

The degree to which a system is affected, either adversely or beneficially, by climate variability or change. The effect may be direct or indirect (IPCC 2007, 881)

Vulnerability:

The degree to which a system is susceptible to, and unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate change and variation to which a system is exposed, its sensitivity and its adaptive capacity (IPCC 2007, 883)

The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements including sensitivity or susceptibility to harm and lack of capacity to cope and adapt. (IPCC, 2014: Annex II: Glossary)

Hazards for our urban environment

- Climate change: more severe extremes
 - Flooding
 - Drought
 - Heat
- Socio-economic changes in society



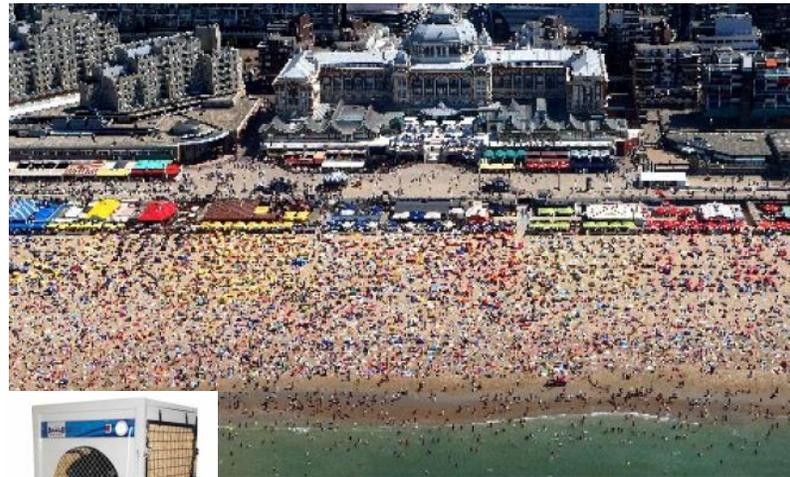
Flooding (coastal, fluvial, pluvial, groundwater)



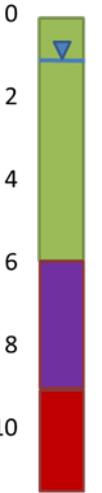
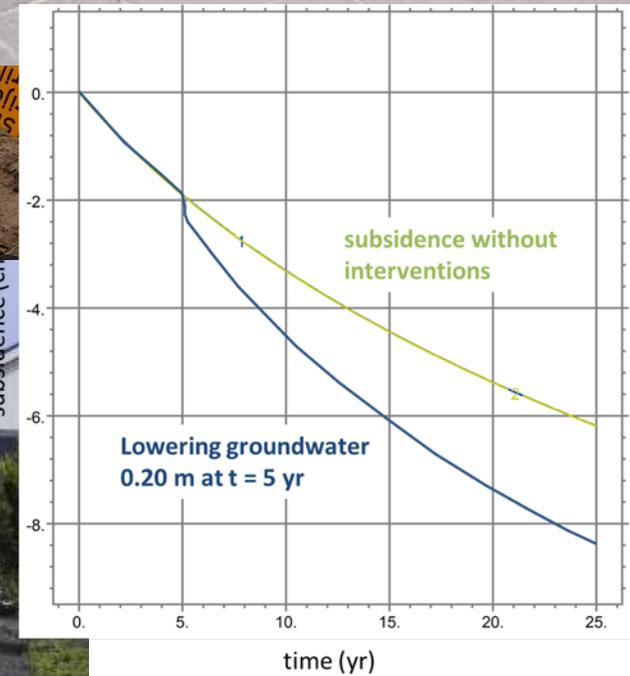
Drought



Heat stress



Land subsidence



B001

Society is changing!

1900

1970

2005



3. Need to retrofit adaptation measures

Cities are designed for the conditions of the past

- **retrofitting adaptation measures** for new conditions is required
- vulnerability is to be reduced
 - reduce exposure to the Hazards
 - reduce Sensitivity
- **Urban RESILIENCE** is to be strengthened



Urban Resilience – definition

- **Resilience:** The capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation. (IPCC, 2014: Annex II: Glossary)
- **"Urban Resilience** is the capacity of individuals, communities, institutions, businesses, and systems within a **city** to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience." (100RC)
- "Resilience refers to the ability of any urban system to maintain continuity through all shocks and stresses while positively adapting and transforming towards sustainability. Therefore, a resilient city is one that assesses, plans and acts to prepare for and respond to all hazards, either sudden or slow-onset, expected or unexpected. By doing so, cities are better able to protect and enhance people's lives, secure development gains, foster and investible environment and drive positive change." (UNHabitat)
- "Applying a resilience lens leads to better designed projects and policies that address multiple challenges at one time, improving services and saving resources. This is known as the resilience dividend—the net social, economic and physical benefits achieved when designing initiatives and projects in a forward looking, risk aware, inclusive and integrated way."(Rockefeller Foundation)

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

Ayyam V, Palanivel S and Chandrakasan S, 2019, *Coastal Ecosystems of the tropics – adaptive management*. ISBN 978-981-13-8925-2, p 250



2. Urban Resilience

2. Urban Resilience

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

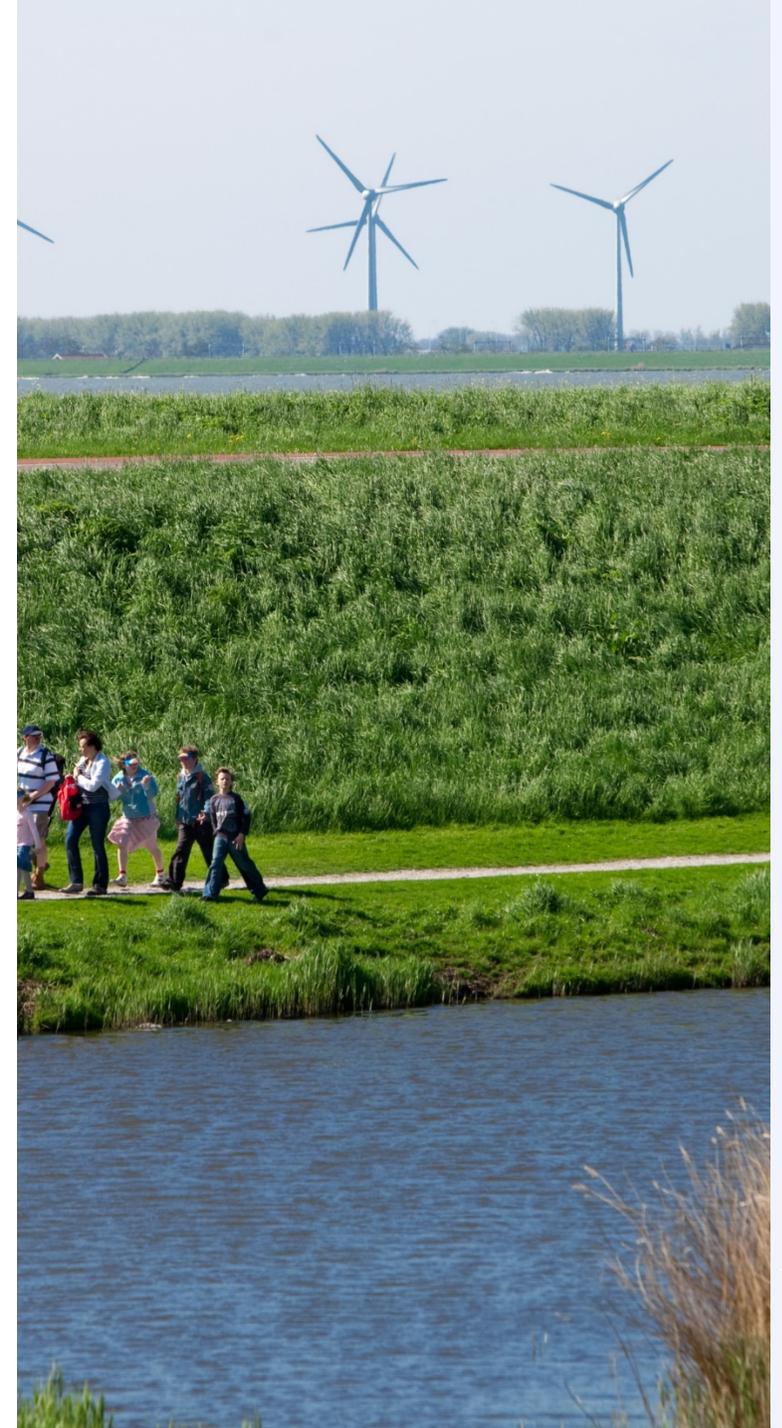




3. Climate resilience

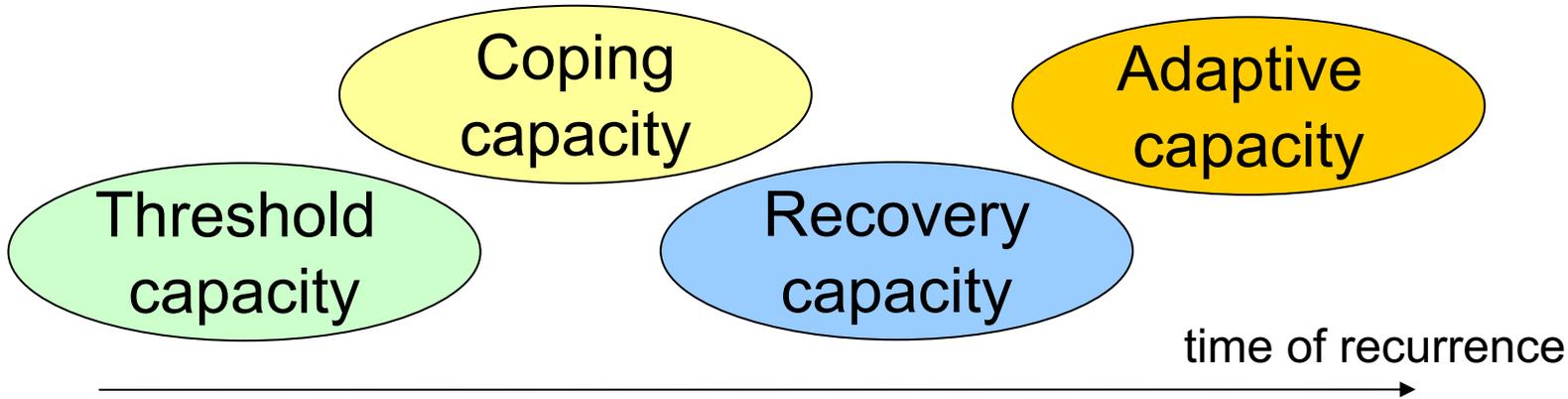
3. Climate resilience

- Climate resilient: four capacities
- Creating urban resilience: triple water



Climate resilience

Capacities to reduce vulnerability:



Climate resilient cities:

Urban areas

(re)developed in such a way, that they are better able to cope with more extreme weather:

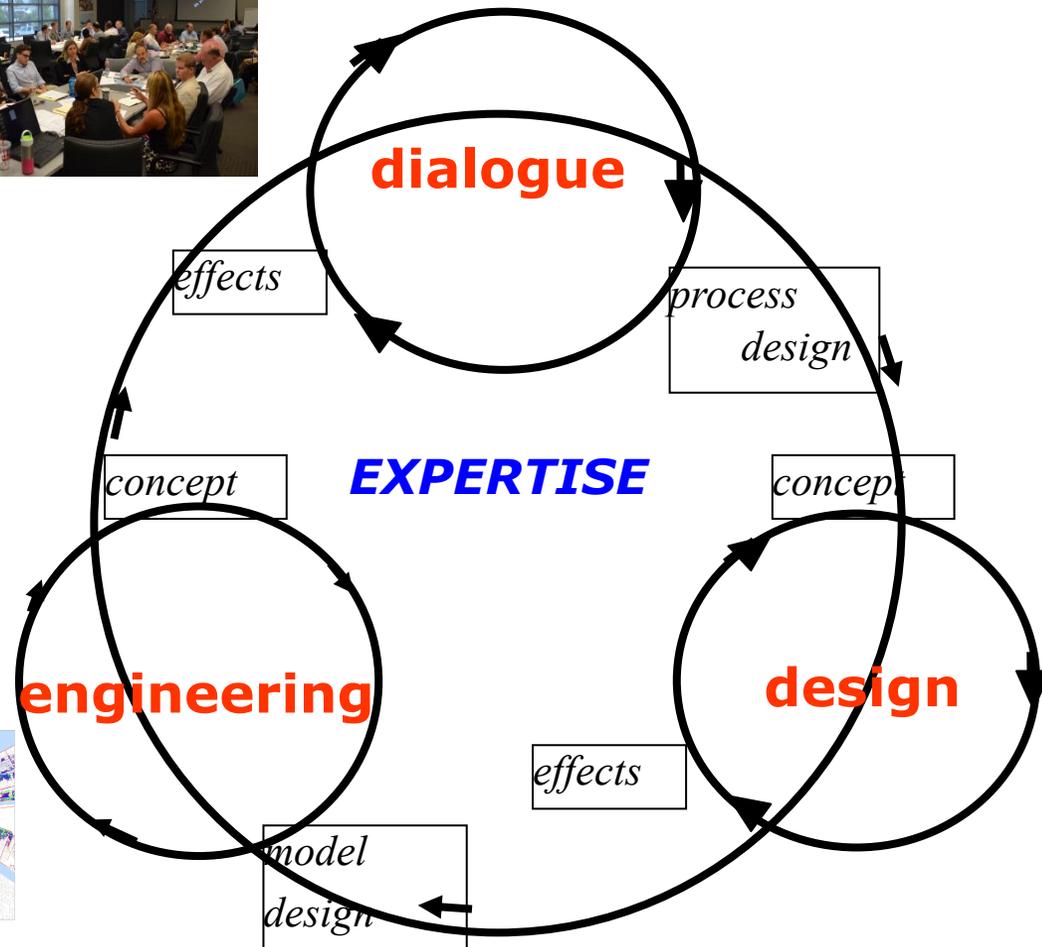
- water surplus or
- shortage of water and
- heat stress
- land subsidence

(and contribute to a better environment for living and working)

* Graaf, R. de, N. van de Giesen and F. van de Ven, 2007, Alternative water management; options to reduce vulnerability for climate change in the Netherlands, Natural Hazards Nov. 2007

Adaptive Capacity – The ability of a system to adjust to change, (including climate change, climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences (adapted after IPCC 2007, 869)

Climate Resilience



Creating urban resilience:

a iterative process of

- dialogue,
 - design and
 - engineering
- (triple water)



4. Adaptation planning – a tiered approach

4. Adaptation planning – a tiered approach

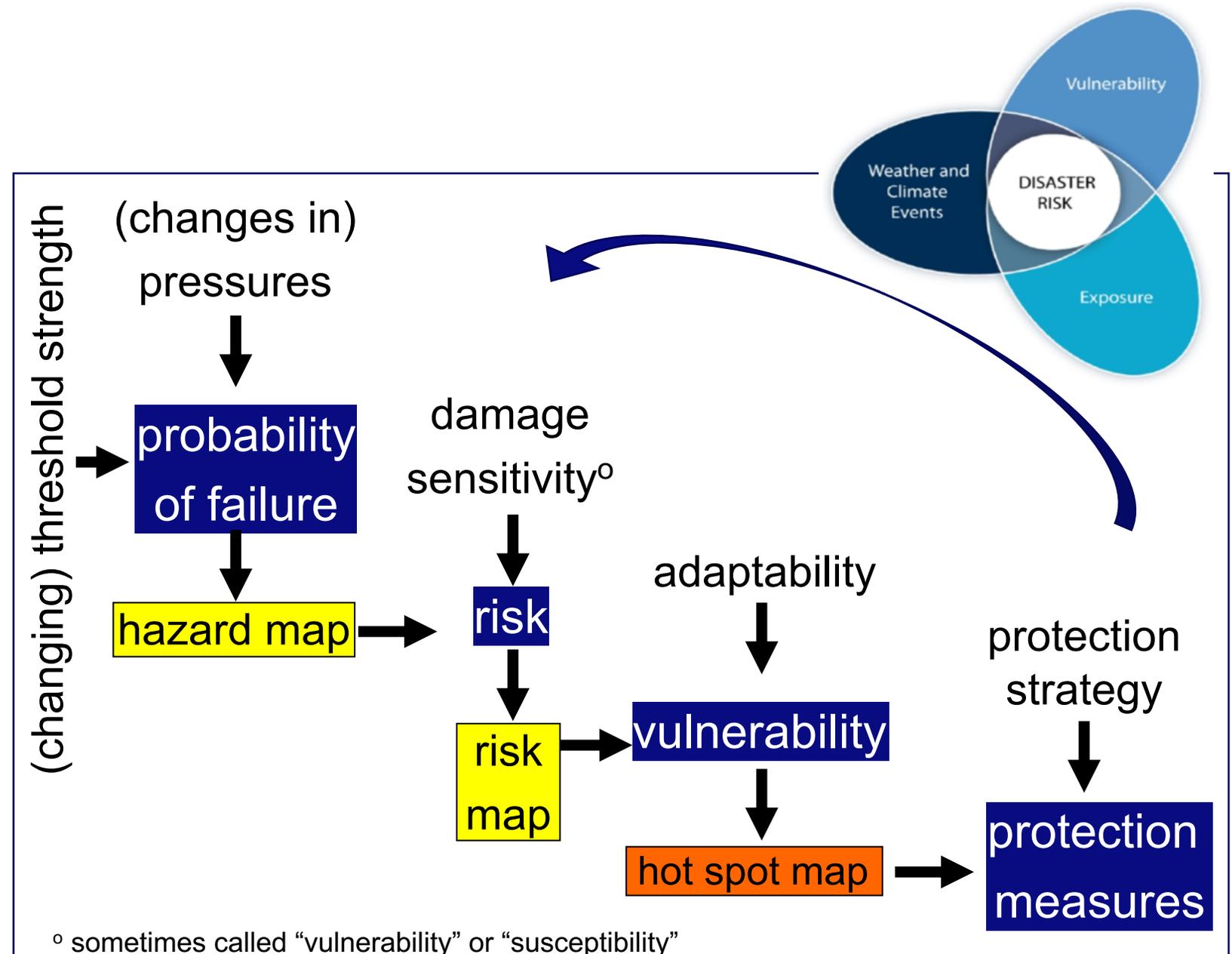
Three steps:

1. **Vulnerability (& opportunities) scan**
(stress testing)
2. Strategy to reduce vulnerability and set adaptation targets
3. Select set of adaptation measures



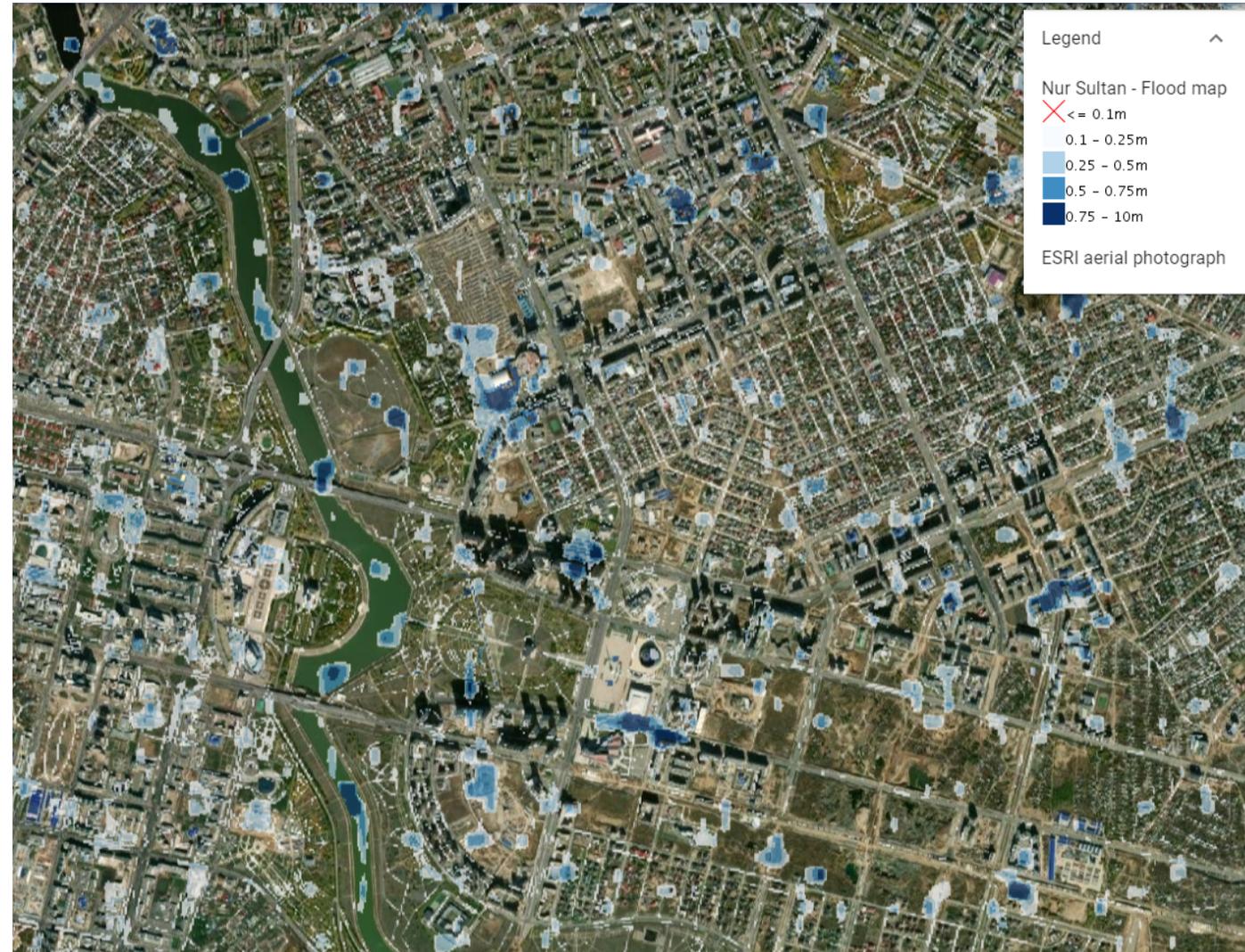
Stress testing

- Vulnerability scan at the core of adaptation planning,
- This scan should address:
 - Physical vulnerability by water and climate
 - Stakeholders and governance vulnerability
- Opportunity scan

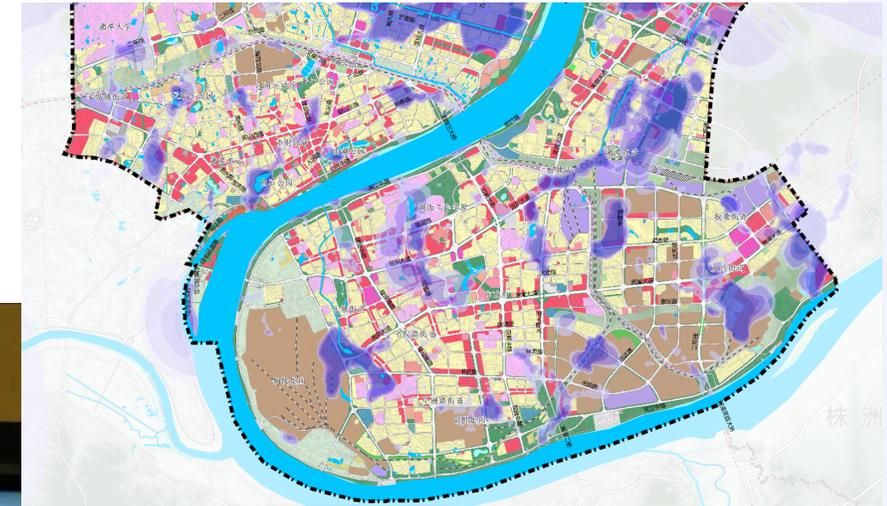
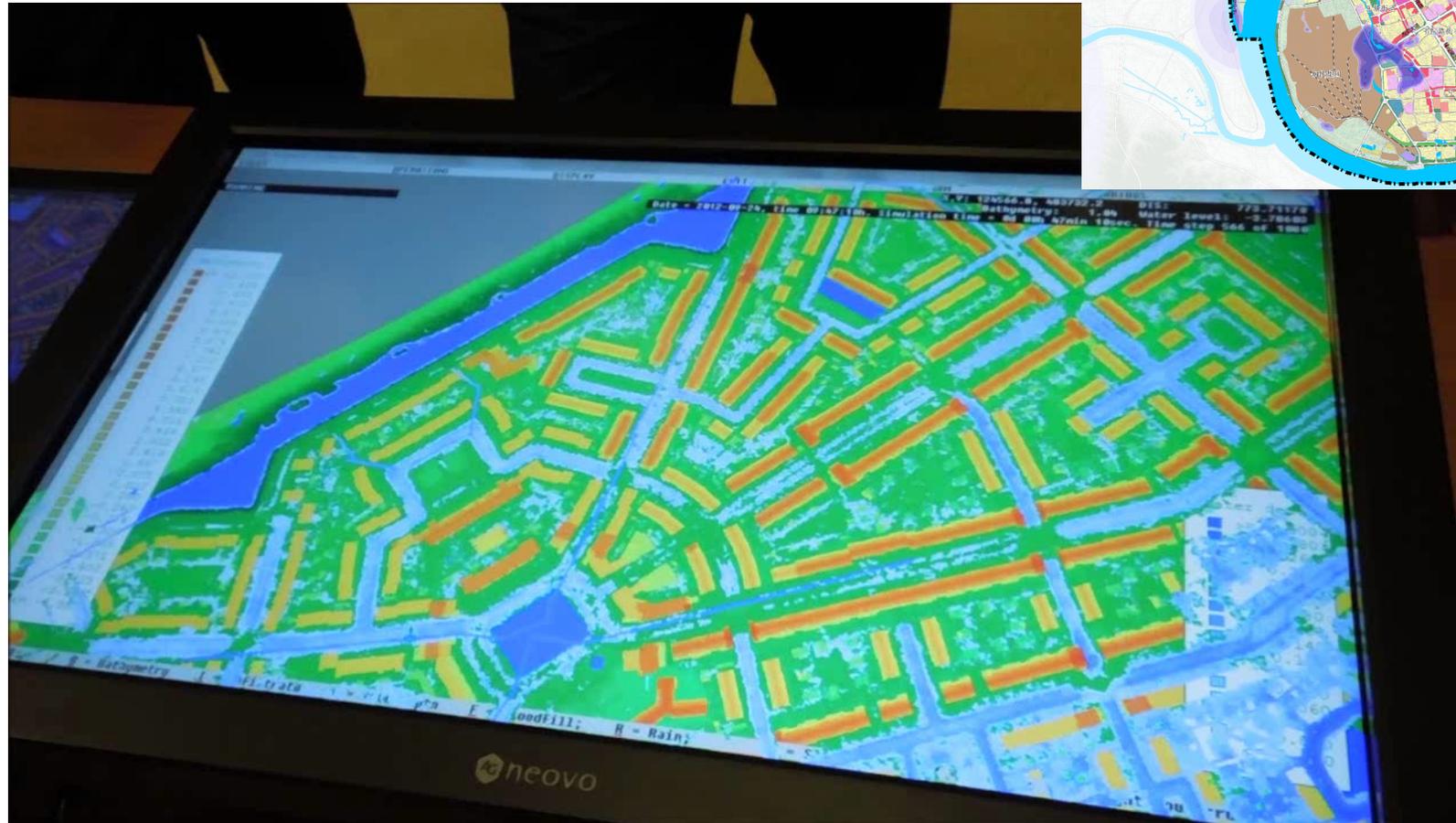


It starts with: understanding the system, its developments and hazards

Flood hazard map Nur Sultan



Flood hazard assessment



Heat stress hazard



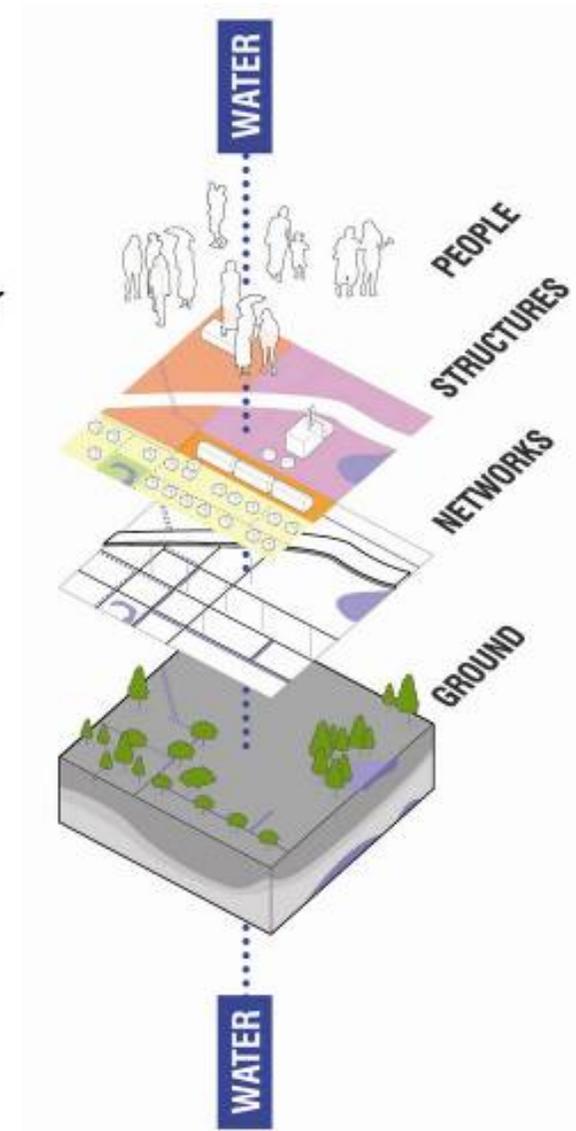
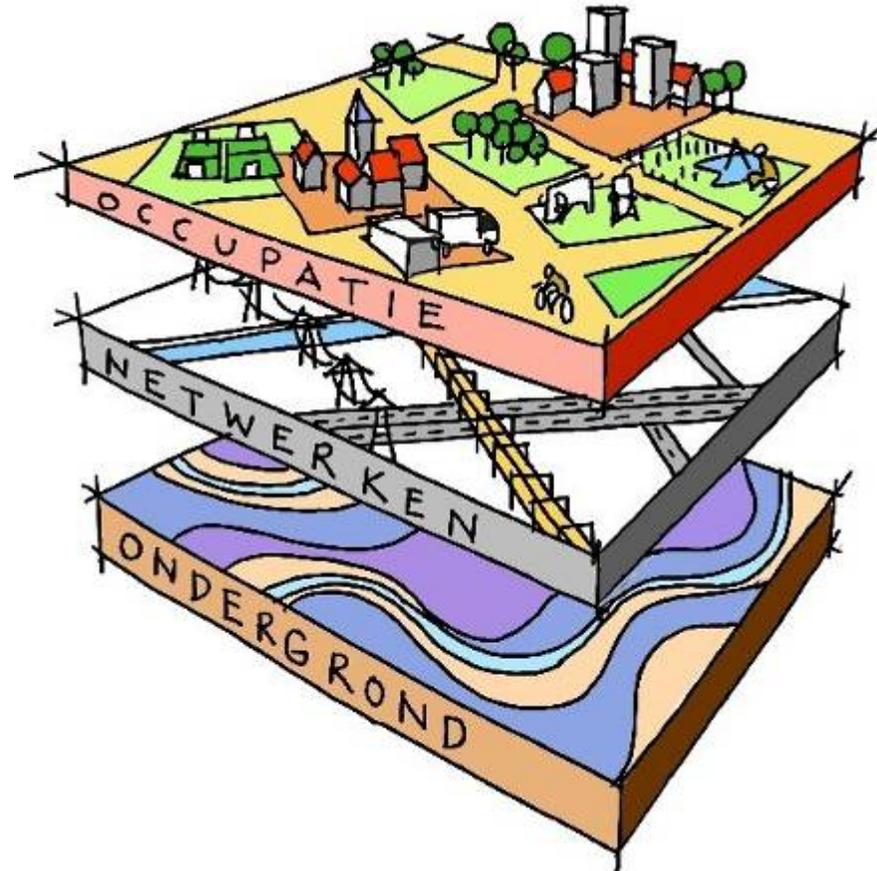
Expected temperature differences in Groningen city (NL) during heat waves

Translate hazards to risks

occupation

networks

subsurface

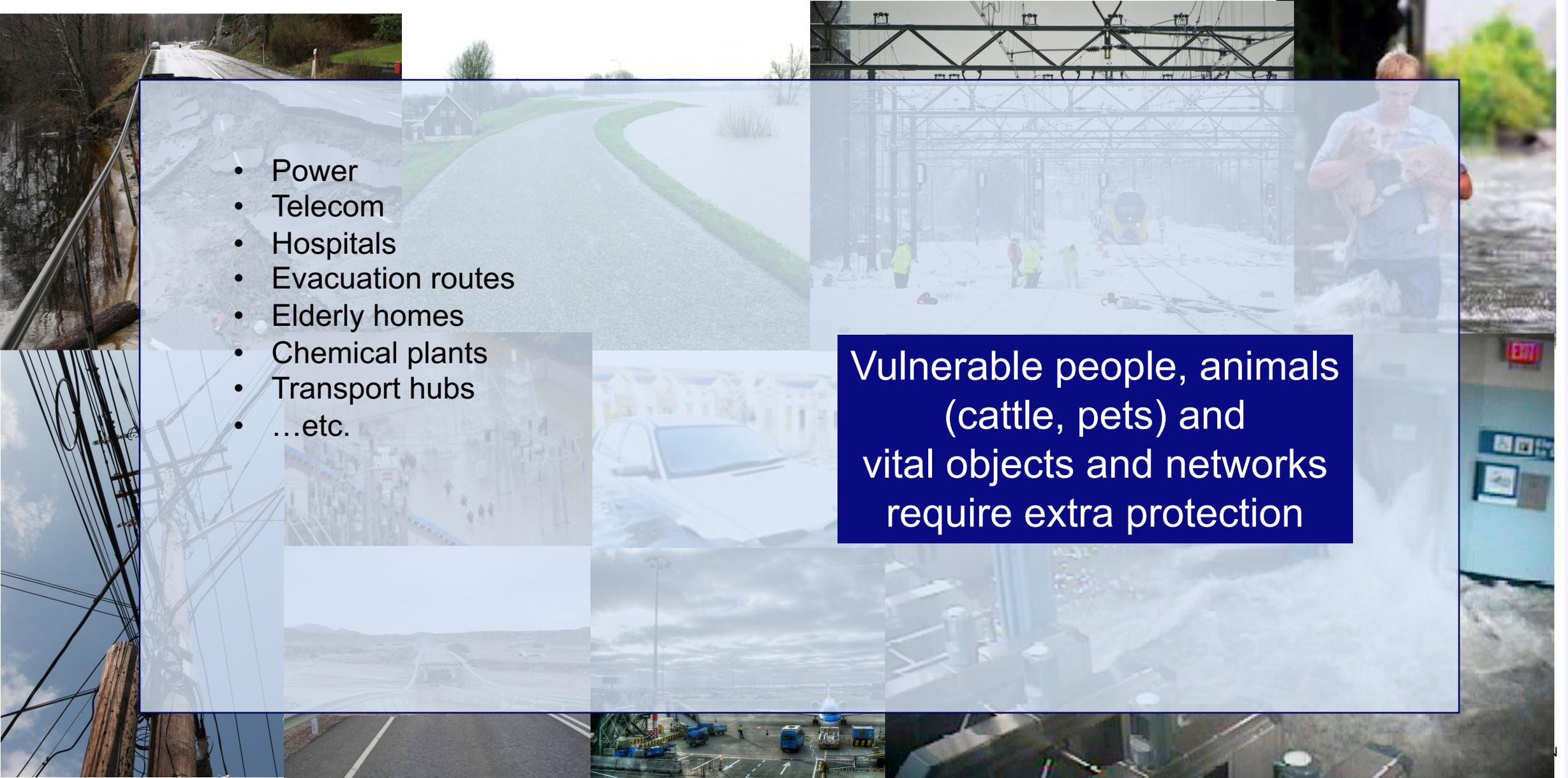


Layer model for urban development

... keeping an eye on vulnerable objects, networks

- Power
- Telecom
- Hospitals
- Evacuation routes
- Elderly homes
- Chemical plants
- Transport hubs
- ...etc.

Vulnerable people, animals (cattle, pets) and vital objects and networks require extra protection

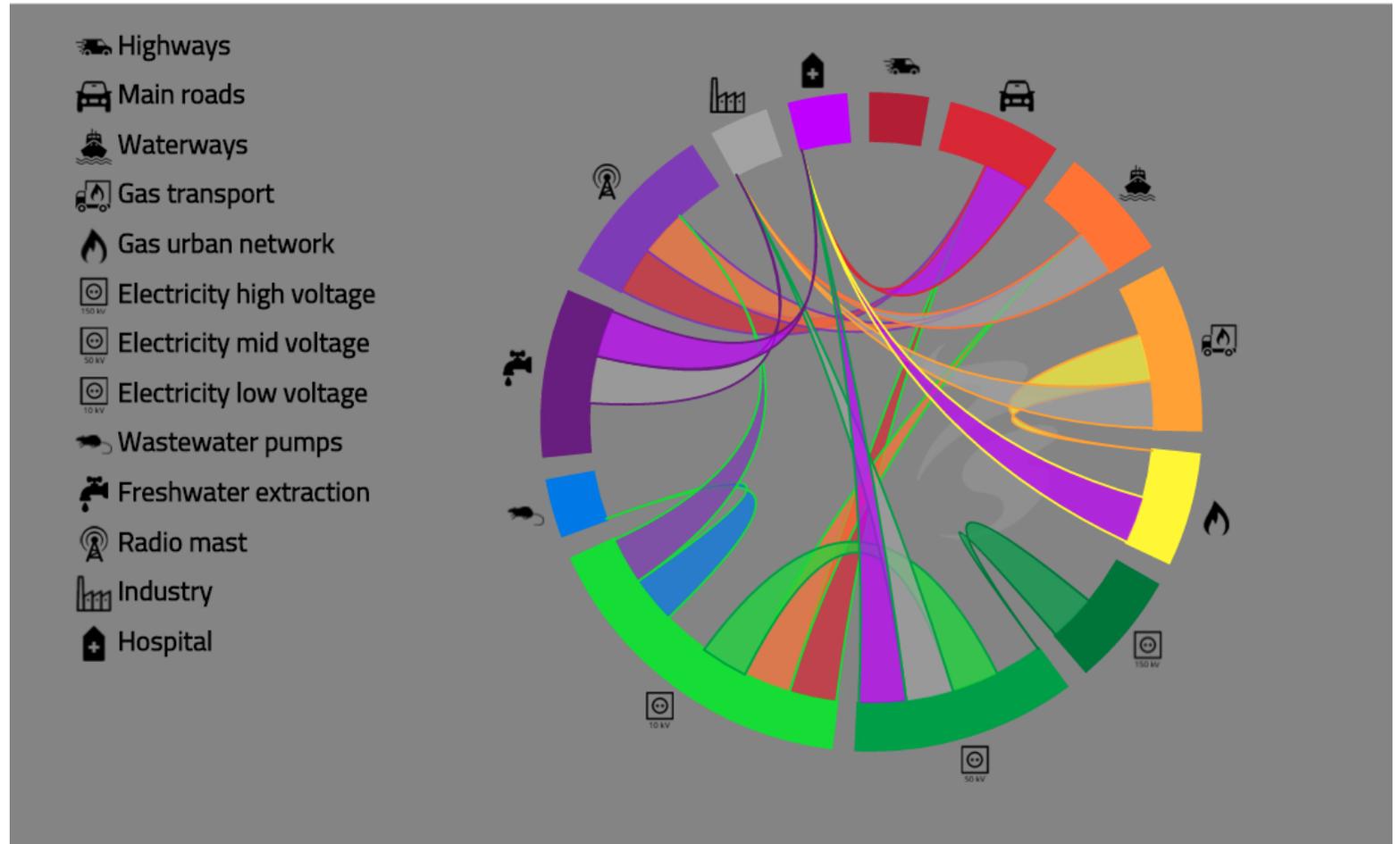


Analyse chain effects in vital infrastructure

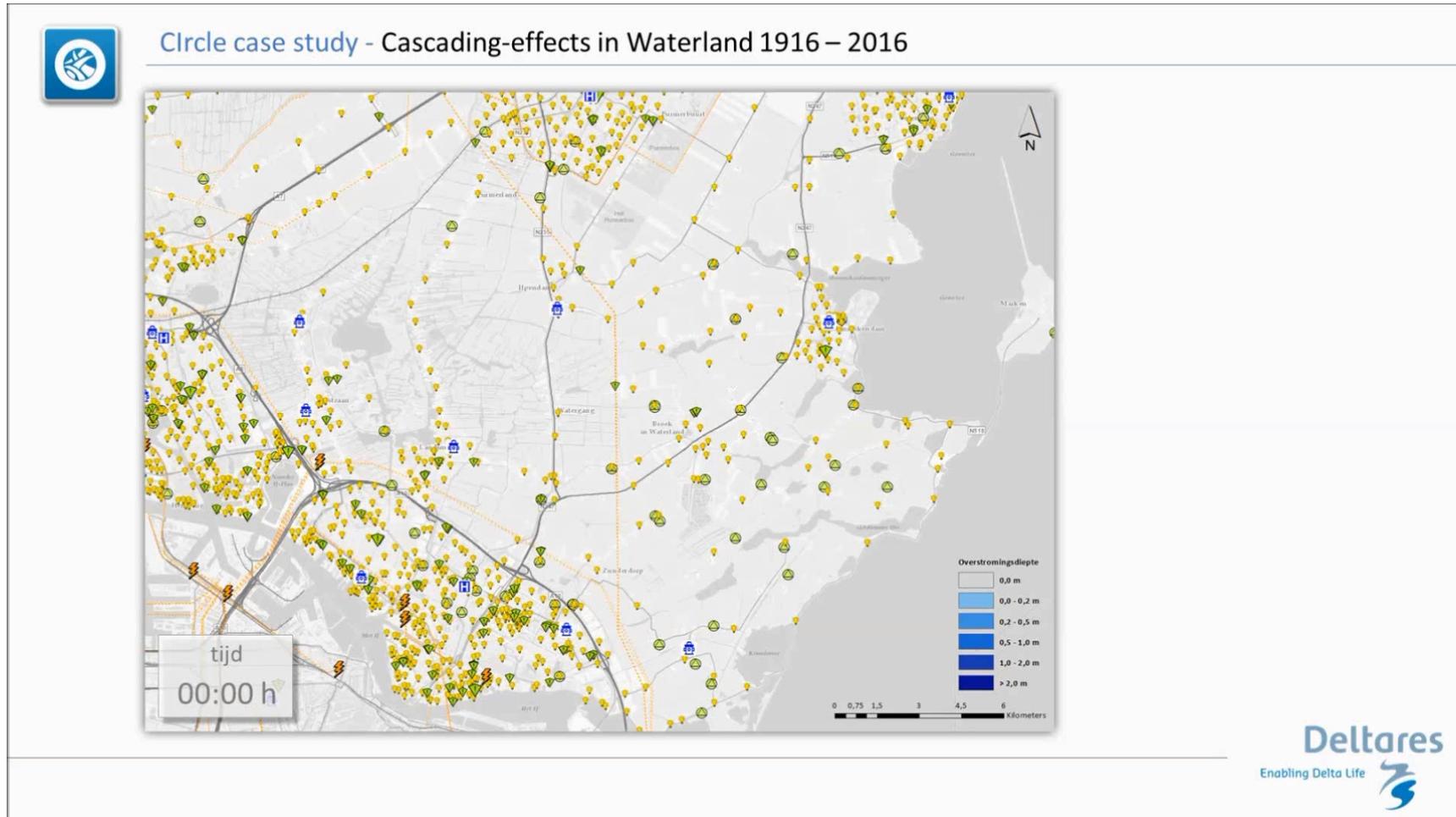


Circle - Critical Infrastructure: Relations and Consequences for Life and Environment

- Insight in cascading impacts of a variety of disasters
- An interactive, multi-stakeholder tool



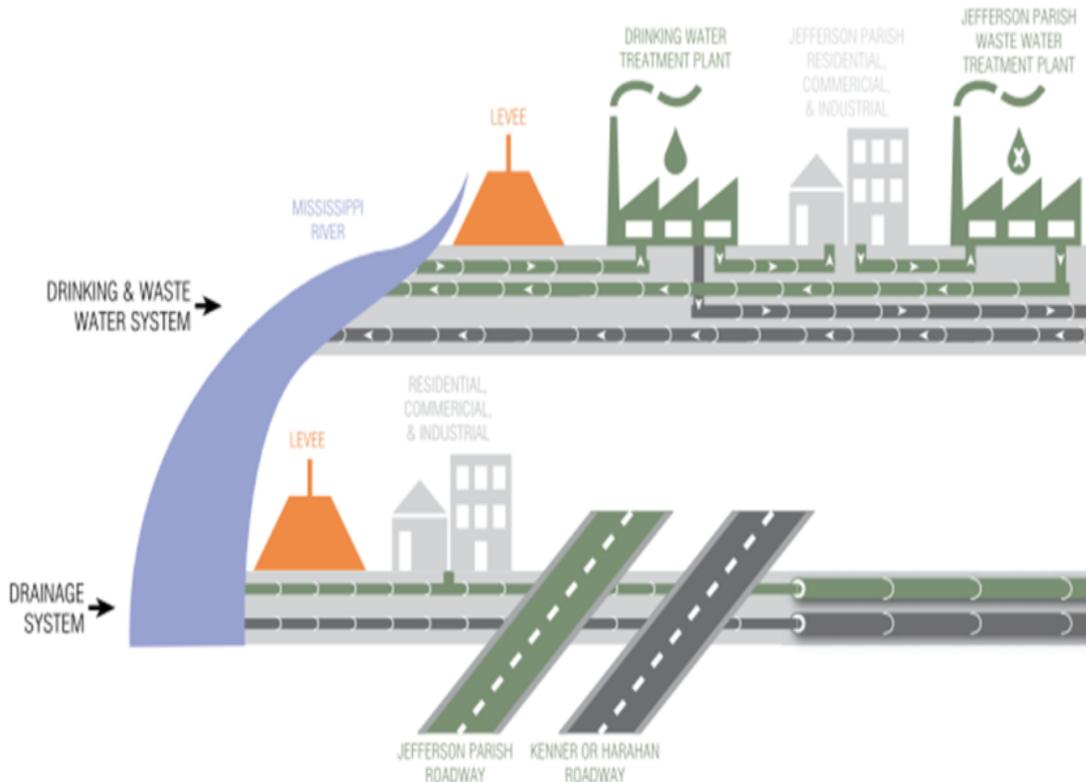
Example: What if the '1916 flood' occurred in Amsterdam in 2016?



Vulnerability scan – Stakeholders and Governance

Stakeholder analysis: Who is to be involved?

Note: different parties involved in each phase of a (re)development process !



Public

- State
- Ministries
- Province
- Departments
- Municipality
- Bureaus
- Departments
- Water Authorities

Private

- Owner-occupier
- Real estate developers
- Housing associations
- Water supply companies
- Power companies
- Telecom companies
- Insurance companies
- Mortgage banks

Stakeholder vulnerability

New Orleans' residents income levels related to:

- Land level
- Flood damage claims



ground level

+



income levels



damage claims

+



income level

Governance analysis

- SWOT analysis of governance chain



- ... as strong as its weakest link!

Adaptation planning: Step 2

Three steps:

1: Vulnerability scan

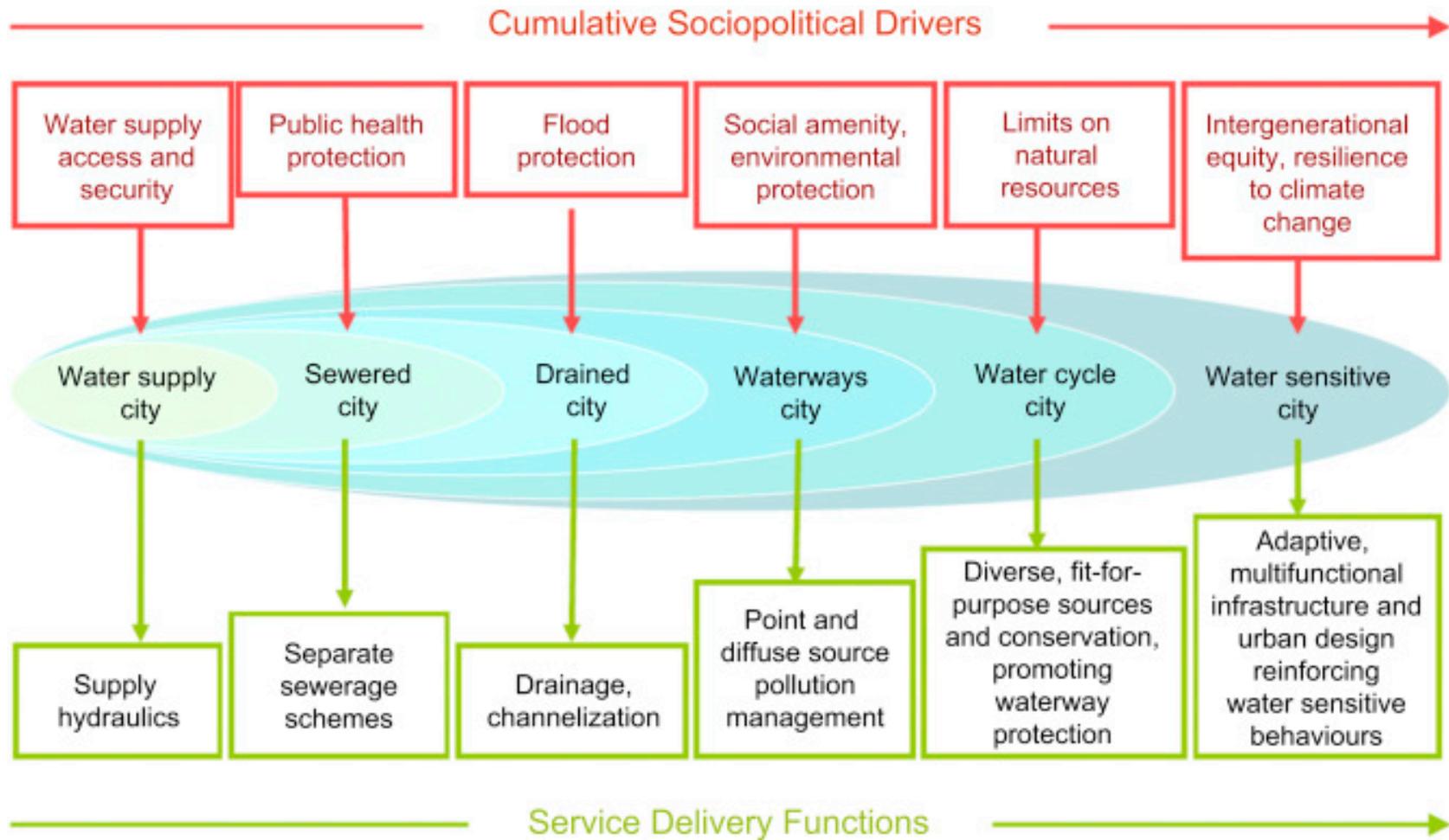
2: Strategy to reduce vulnerability and set targets

3: Select set of adaptation measures

Addressing:

- Adaptation assignment
 - Adaptation objectives, targets
 - Capacity of the sponge
- Vulnerability reduction strategies

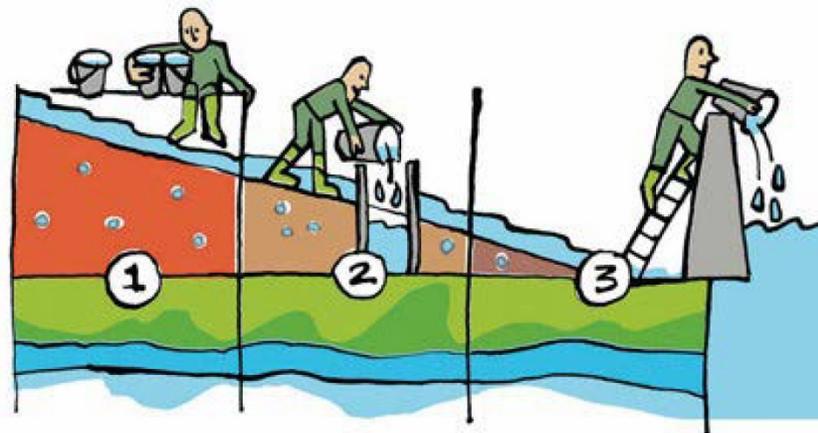
Water Sensitive Urban Design (WSUD)



Retain – Store - Drain strategy:

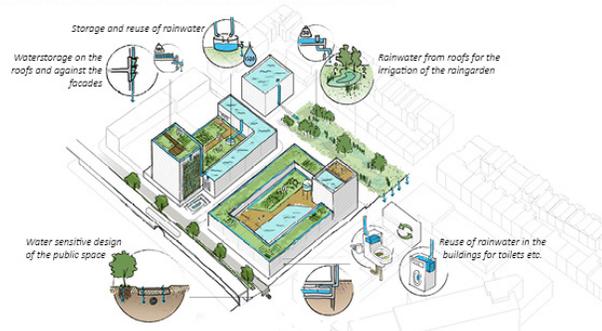
Retain and Detain and Store at the source to avoid overloading the drainage capacity downstream

Retain Store Drain



NEVER
SHIFT
PROBLEMS
!

CLIMATE ADAPTATION IN THE NEW DEVELOPMENTS IN THE ZOHO-DISTRICT



De Urbanisten

LOD (Lokalt omhändertagande av dagvatten)



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



Terminology: EbA, SUDS, GI, BGI, NBS, Sponge city, ...

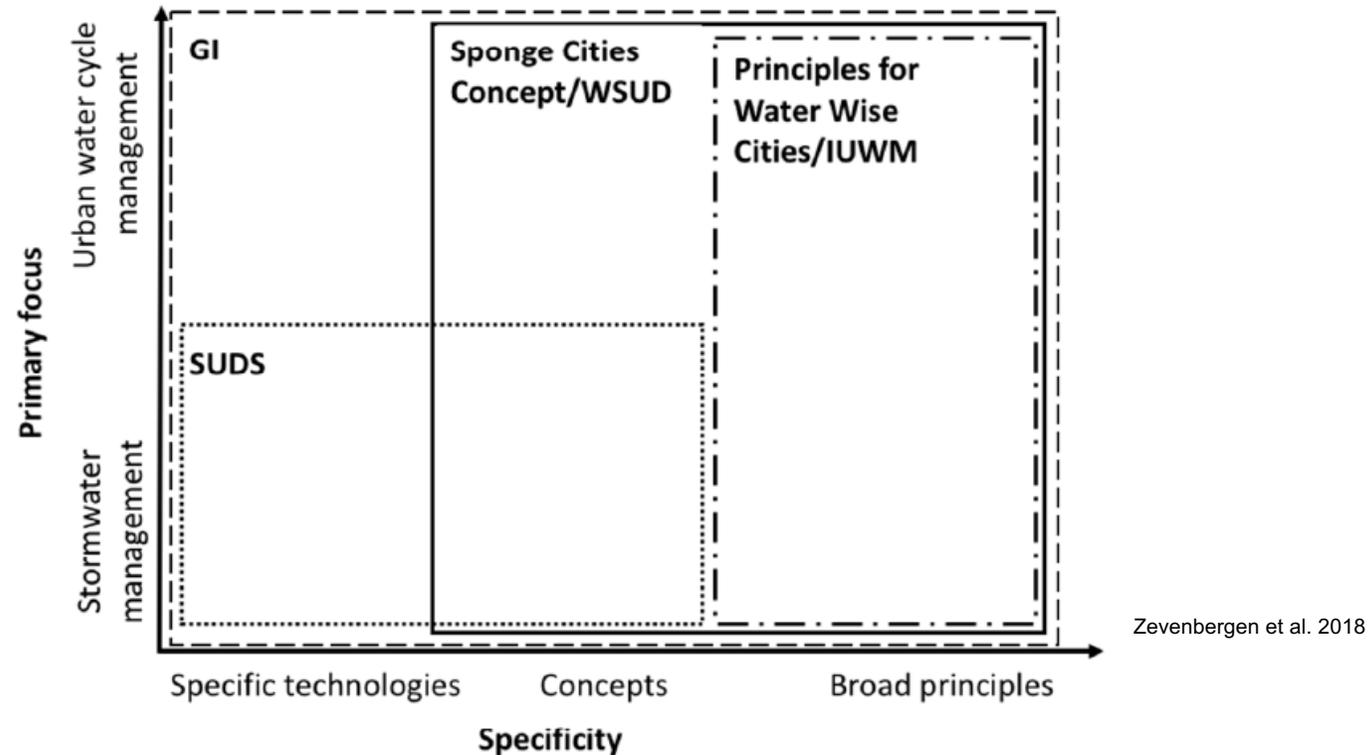
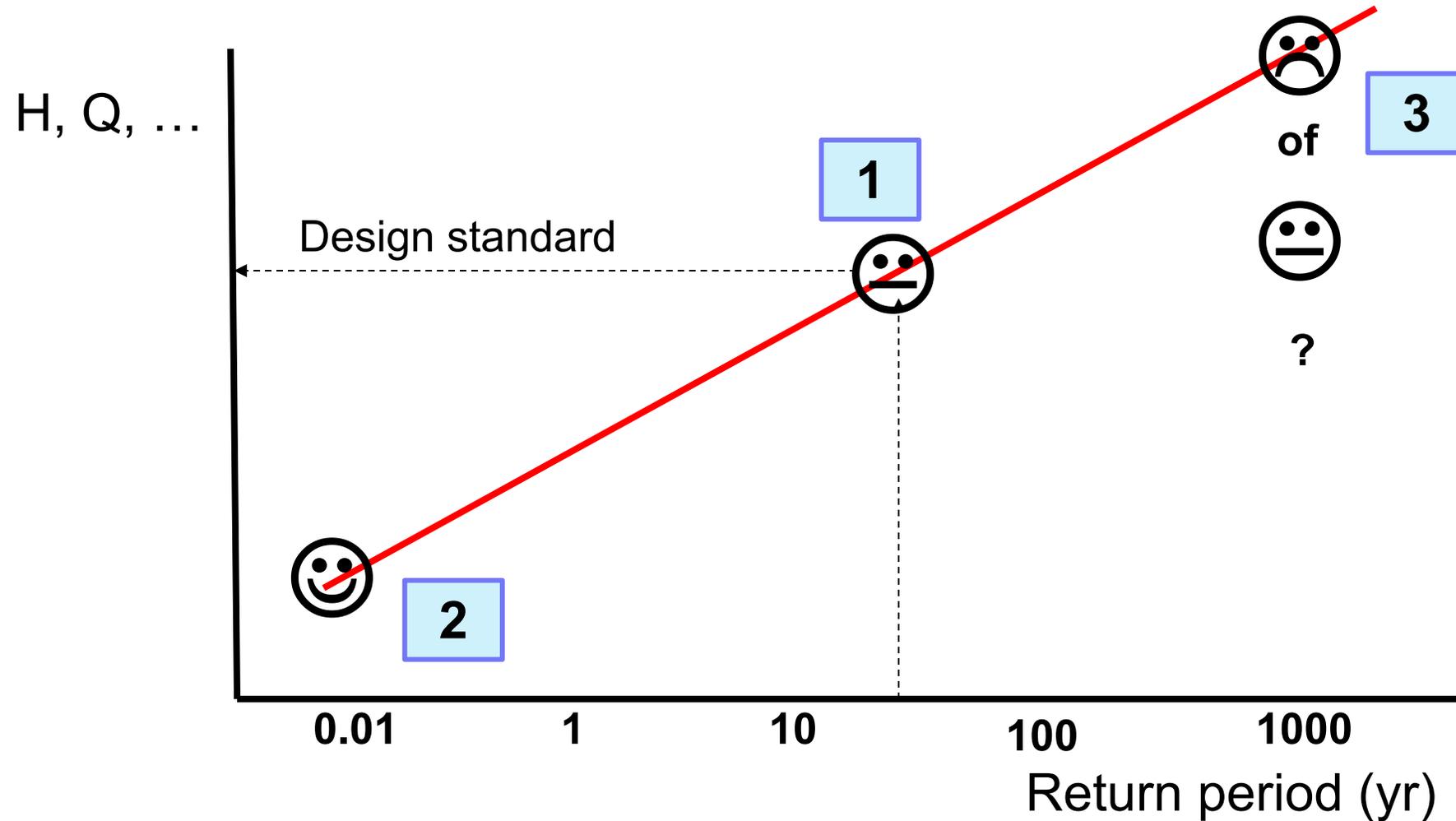


Figure 1. A classification of terminology related to the domain of integrated urban water management (IUWM) according to the terms' specificity and their primary focus (modified from [24]). GI, green infrastructure; SUDS, sustainable urban drainage systems; WSUD, water-sensitive urban design.

Strategy to reduce vulnerability: Three-point approach



Adaptation assignment; setting the targets

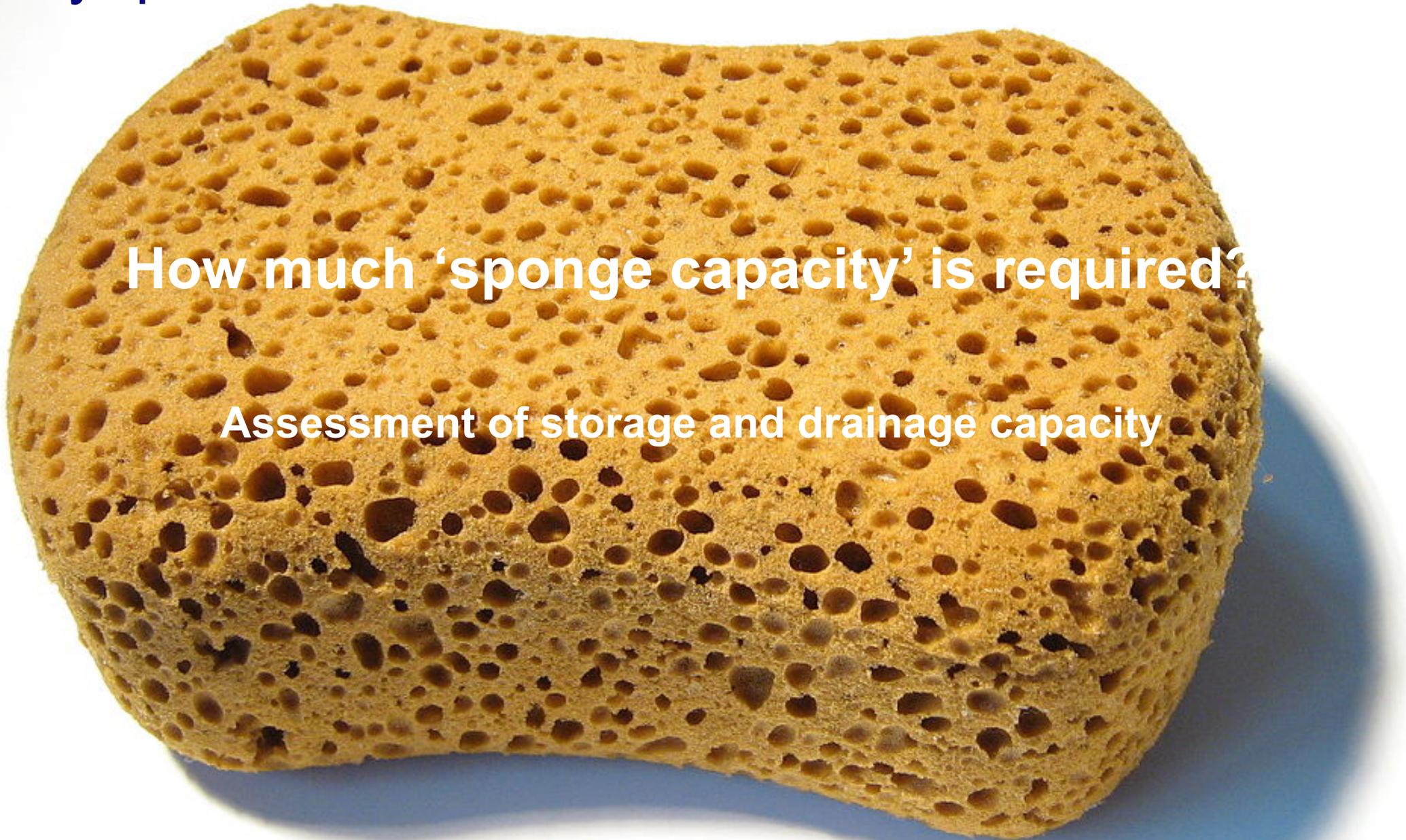
- What is the Adaptation assignment?
 - How to define adaptation objectives, set adaptation targets?
 - How much 'sponge capacity' is required?



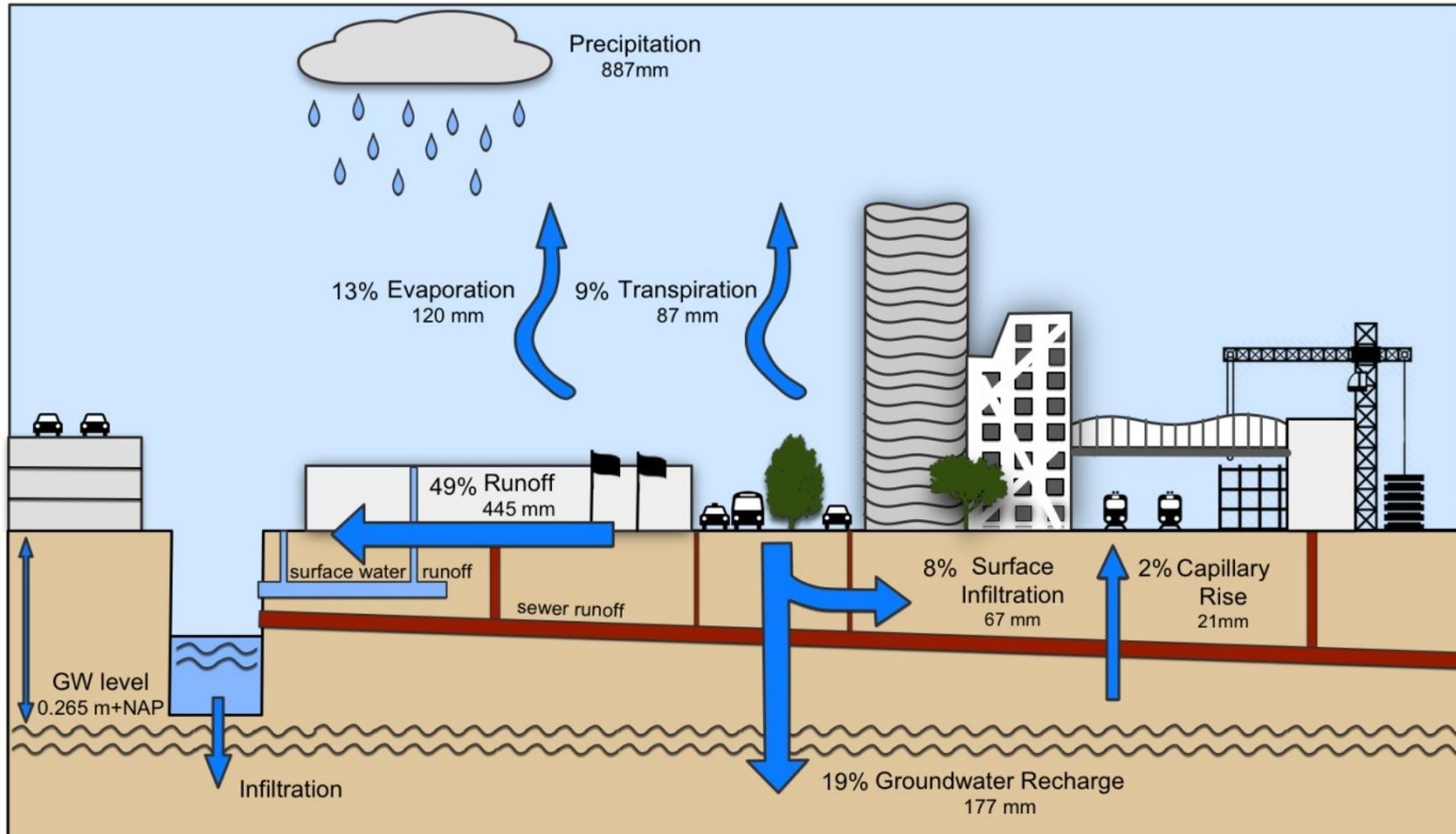
Key question:

How much 'sponge capacity' is required?

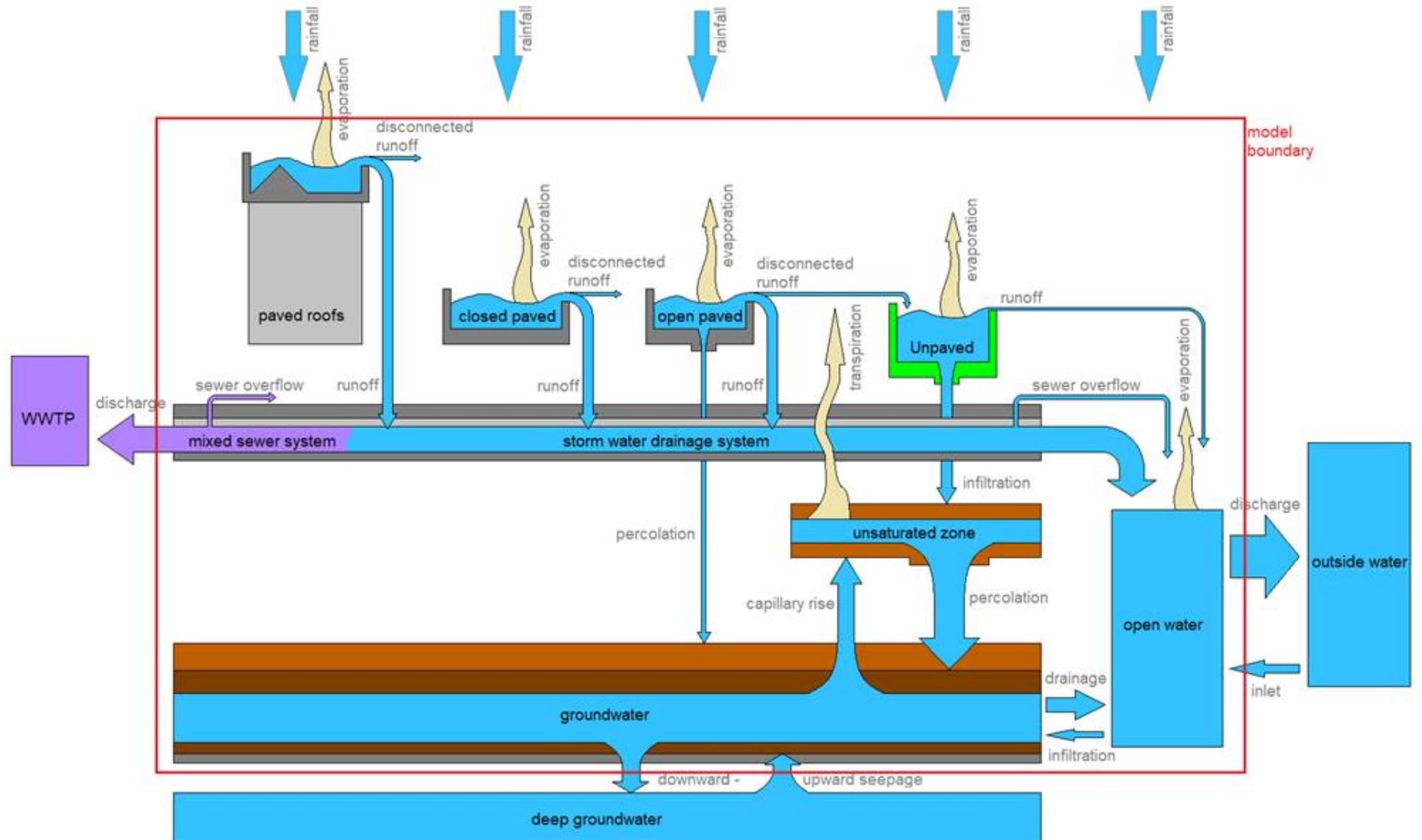
Assessment of storage and drainage capacity



Conceptual model of the sponge



Conceptual model of the sponge Dynamic Urban Water Balance Model



Storage – Discharge – Frequency curves

Input:

- land use data
- soil property data
- long series rainfall data
- long series evaporation data
- climate change assumptions
- **system discharge capacity**

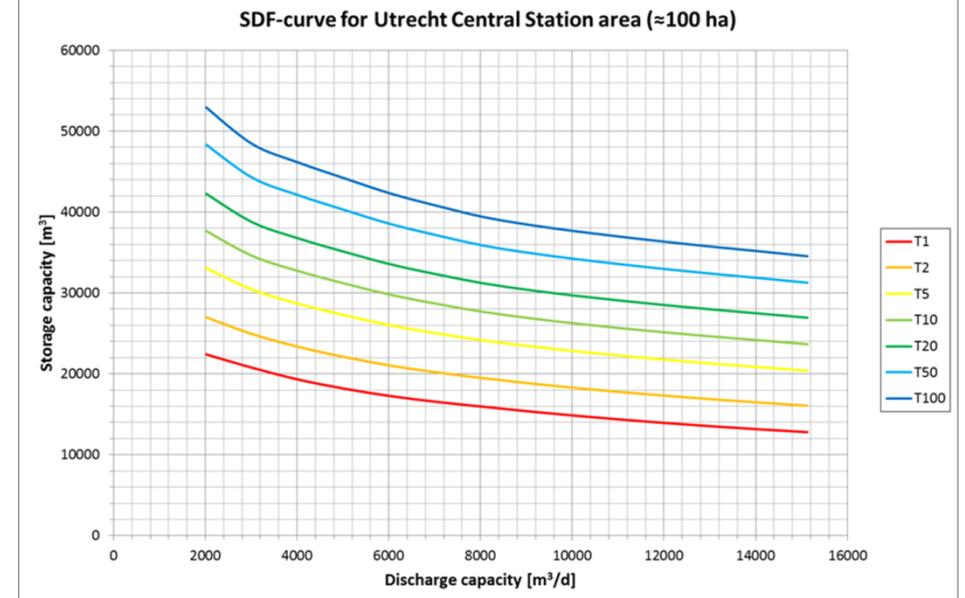
UWBM
Model

Output:

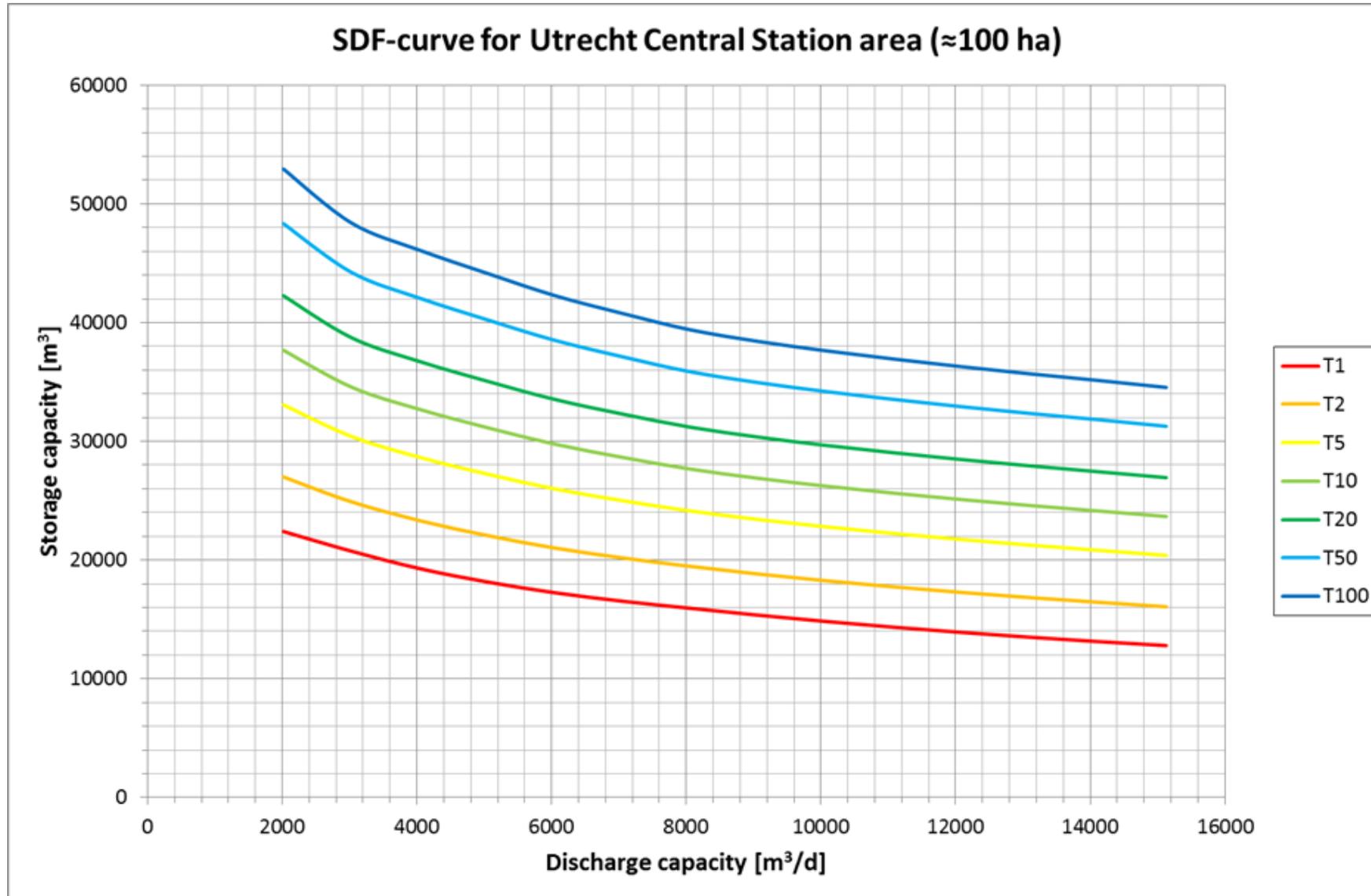
- long series of stored volumes for specific discharge capacity

extreme value statistics

Storage – Discharge – Frequency (SDF)



Stormwater detention assignment



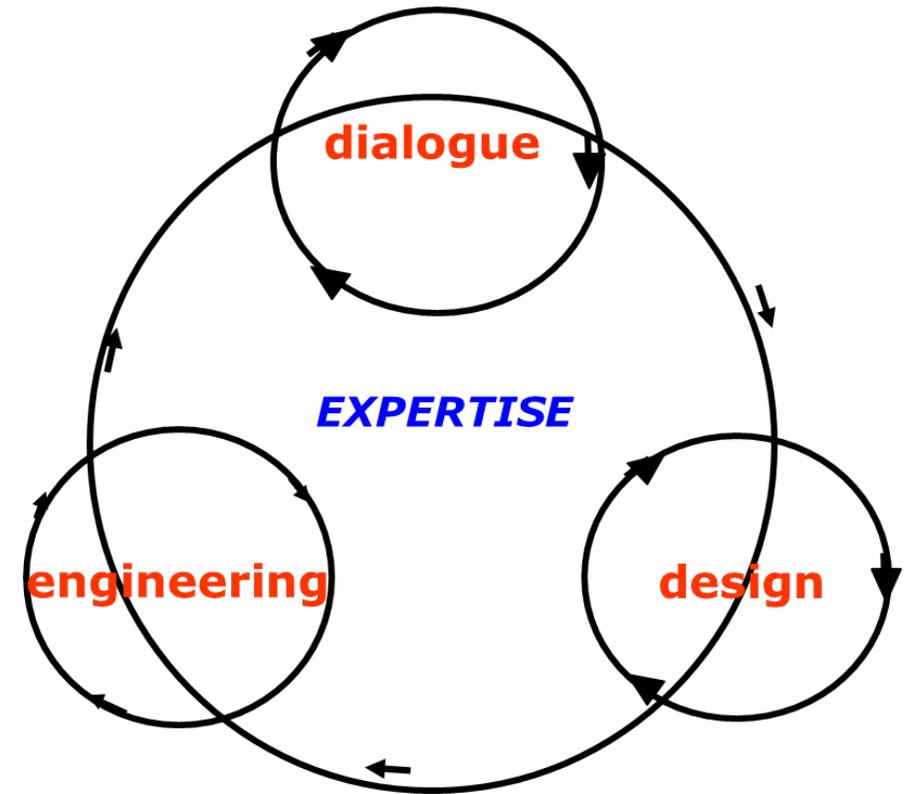
Adaptation planning; Step 3

Three steps:

1: Vulnerability scan

2: Strategy to reduce vulnerability

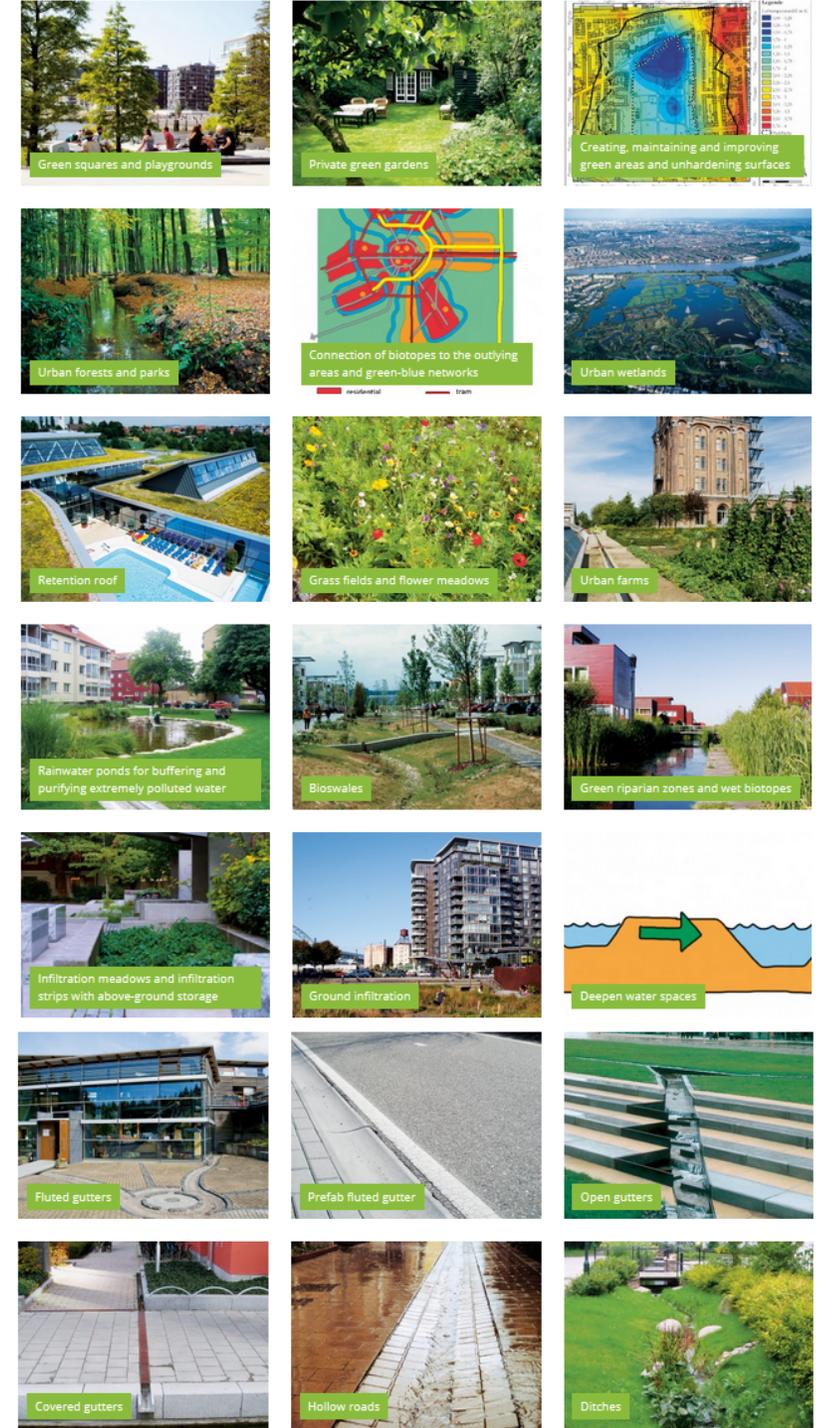
3: Select adaptation measures



Selecting the 'best' set of adaptation measures

Selection and planning process

- Many options => hard to make choices
- Local, institutional and personal preferences
- Collaborative planning; co-design of solutions; link with other expertise and policy fields (energy, mobility, IT, urban greenery, housing...)
- Inter-/multidisciplinary planning and design
- Need for Planning support tools
- → Training 2



Adaptation planning process



Initiative phase

research and analysis
program development

Design phase

conceptual design
preliminary design
site plan
implementation plan
construction

Activities

Vulnerability scan
Strategy, approach

Selection of measures

....

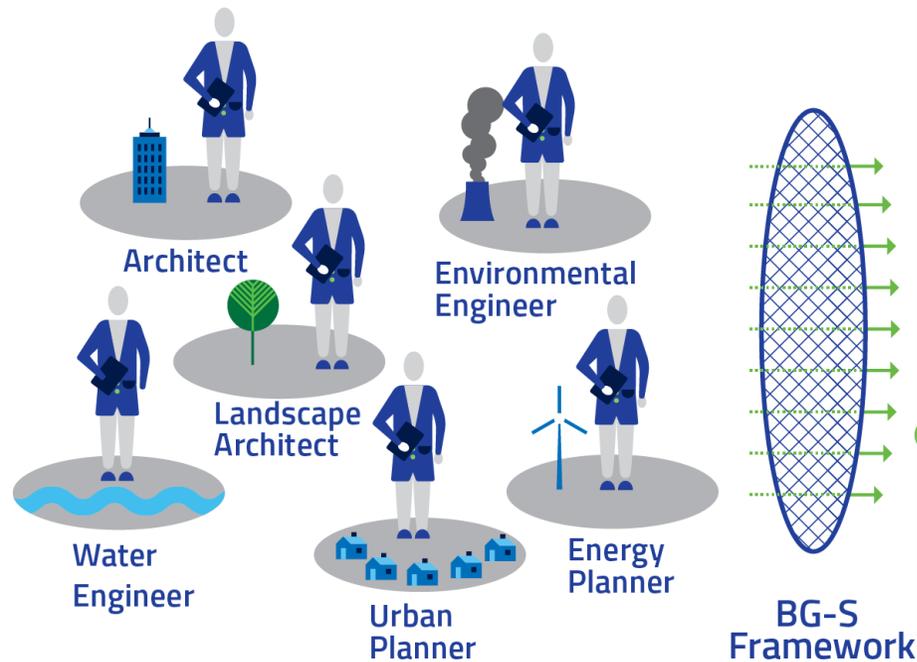
.... design

.... construct

.... operate and maintain

Collaborative planning

experts from many disciplines (+ local stakeholders)

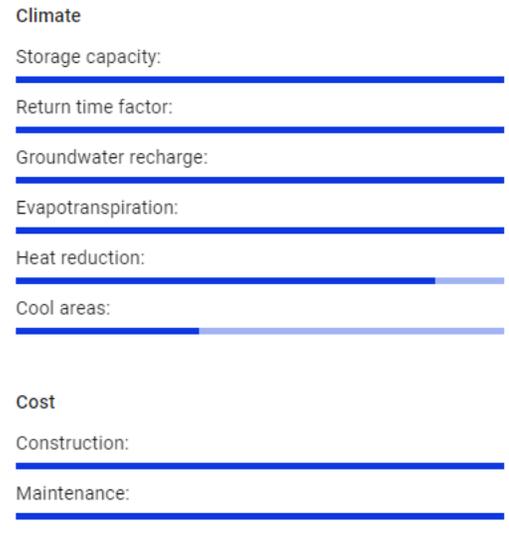


Applied Measures

- Adding trees to streetscape
- Fountains, waterfalls, water facades
- Green roofs
- Infiltration fields and strips with surface storage
- Urban forest
- Infiltration boxes
- Water roof
- Green roofs with drainage delay
- Storage tank or underground water storage



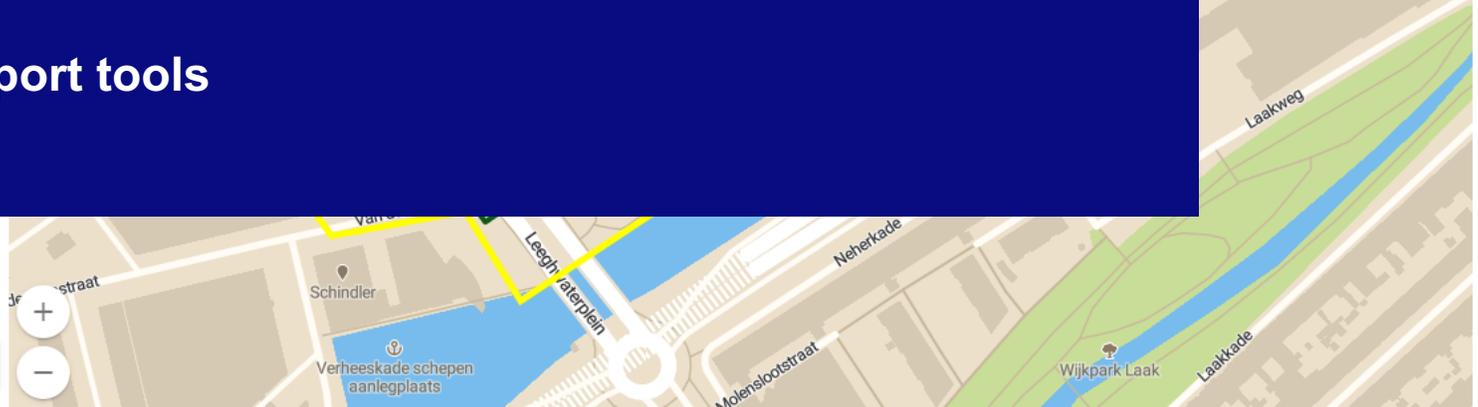
Results



VIEW AS TABLE

5. Planning support tools

+ MEASURE



Planning support tools

- Various tools to support adaptation planning
 - Models for stress testing
 - Adaptation planning support toolbox
- Required:
 - Involvement of relevant stakeholders
 - Understanding of the local system
 - Willingness to co-design
 - Willingness to apply innovative measures

→ **Climate Resilient City Toolbox**



Thank you for your attention

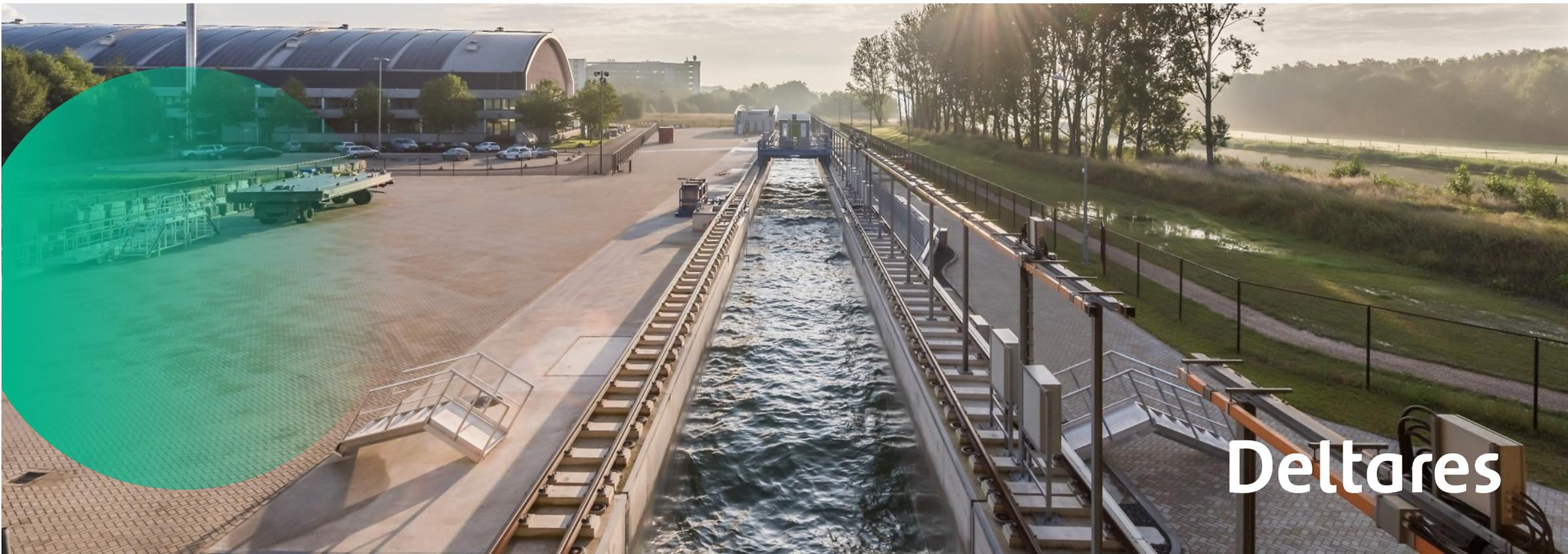
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