

# The Sponge City Concept

## Implementation Potentials in Sub-Saharan Africa

### Webinar – Connective Cities



**Institute of Sanitary Engineering  
and Waste Management**

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# **Table of Contents**

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Issue: The city in (climate) change

- What is a *water-wise future* Sponge City?

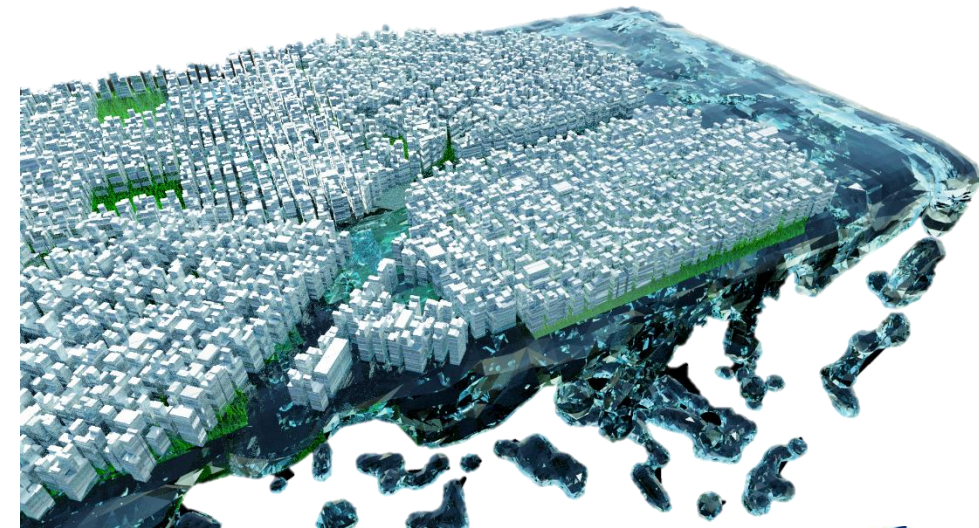
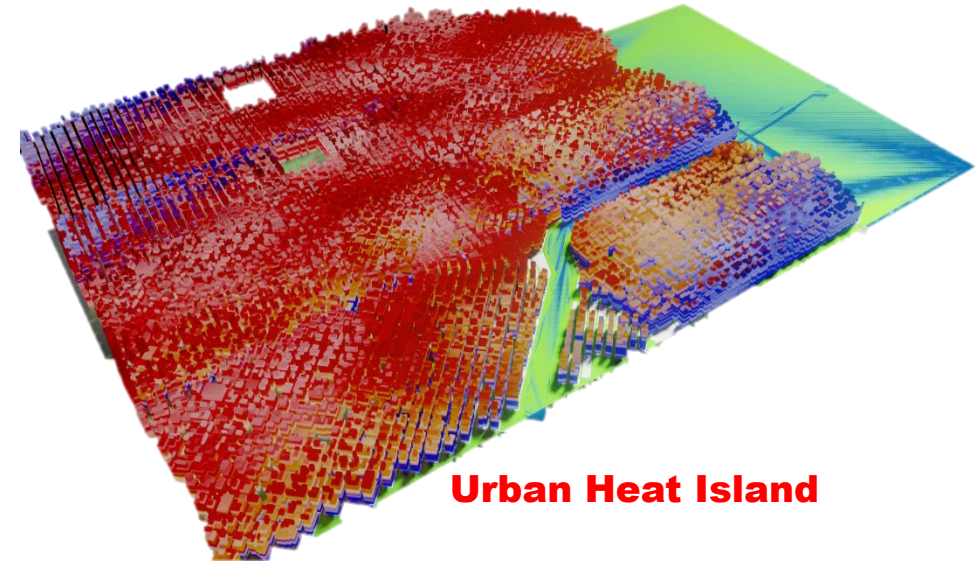
Our R&D missions

- the blue-green Sponge City as a complementary water supply component
- Concrete design and construction proposals for the blue-green Sponge City

# The city in (climate) change

- Against the backdrop of climate change, cities show a particular vulnerability, which is also reflected in the Sustainable Development Goals of the United Nations.
- In particular, hydrometeorological impacts associated with climate change negatively affect cities.
- The following increasingly severe climate extremes are considered relevant:
  - **Severe drought & heat**
  - **Heavy rain & urban flash floods**

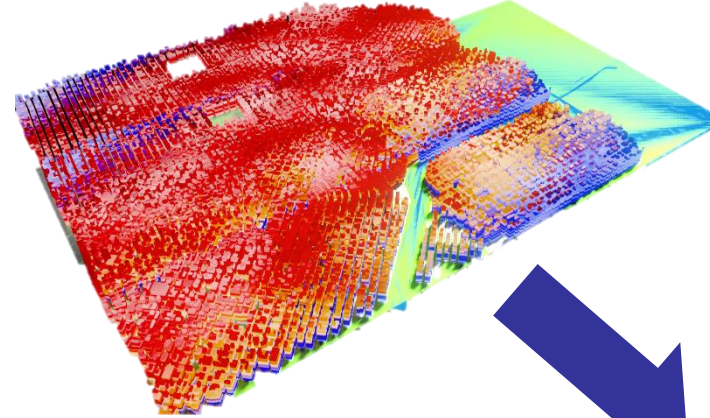
**There is a need for urban transformation**



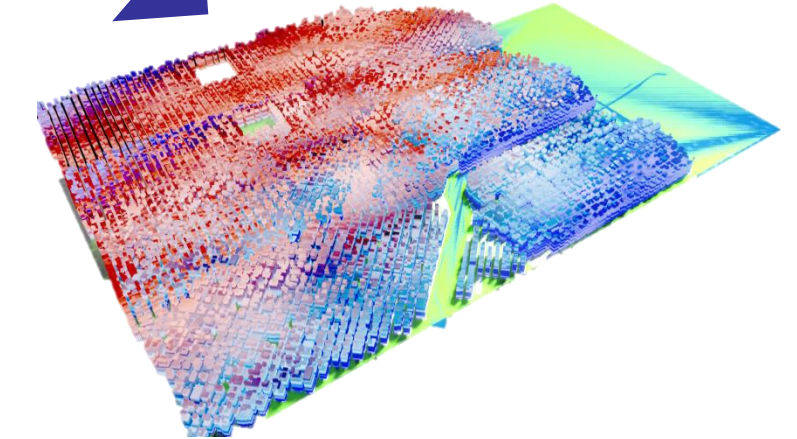
Symbol for urban flash floods

# The future belongs to the blue-green sponge city

- SUDS = Sustainable Urban Drainage Systems
- LID = Low Impact Development
- BMP = Best Management Practices
- WSUD = Water Sensitive urban Design
- (B)GI = (Blue) Green Infrastructures
- SCM = Stormwater Control Measures
- RRWH = Rooftop Rainwater Harvesting
- IUWM = Integrated Urban Water Management



**Urban Heat Island**



**A cooler City**

- **To combine all trends and initiatives**
- **The "blue-green" Sponge City** is considered a promising approach to significantly increase the resilience of cities to aggravating climate change.

**Green Facades**

**Amsterdam**



**Retention Elements**

**Amsterdam**



**Retention Elements**

**Amsterdam**



**Wetlands**

**Jiaxing**



**Green spaces**

**Jiaxing**



**Green Facades**



**Amsterdam**



**Blue-green Sponge City**

**Green spaces**

**Jiaxing**



**Green Roofs**

**Shenzhen**



Source: ISAH

**Permeable Pavements**



**Multifunctional Spaces**

**Amsterdam**



**Urban Waters**

**Essen**



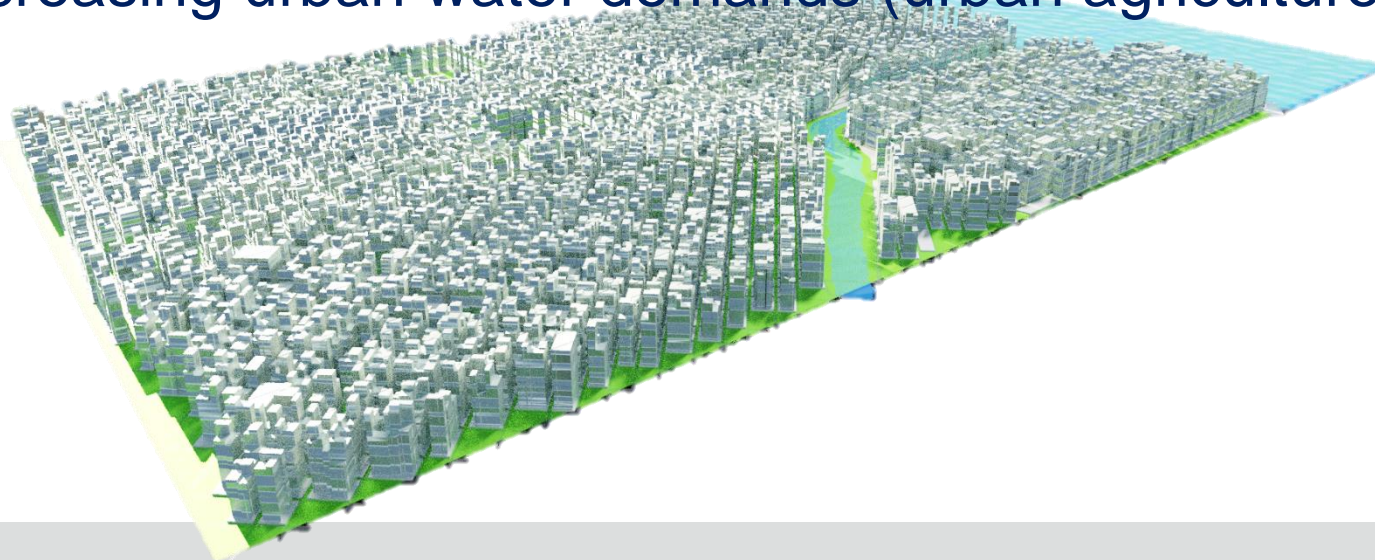
# What is the current situation?

**No green without blue - No future city without sufficient water**

**-> The water supply problem of the Sponge City**

In Sponge Cities, there is a water supply problem for the (functional) maintenance of the blue-green infrastructure.

- **lack of rainwater harvesting**
- **scarce drinking water**
- **further increasing urban water demands (urban agriculture)**



# **Our R&D Objectives**

## **Ensuring the self-preservation of the sponge city**

- **Leading Idea**

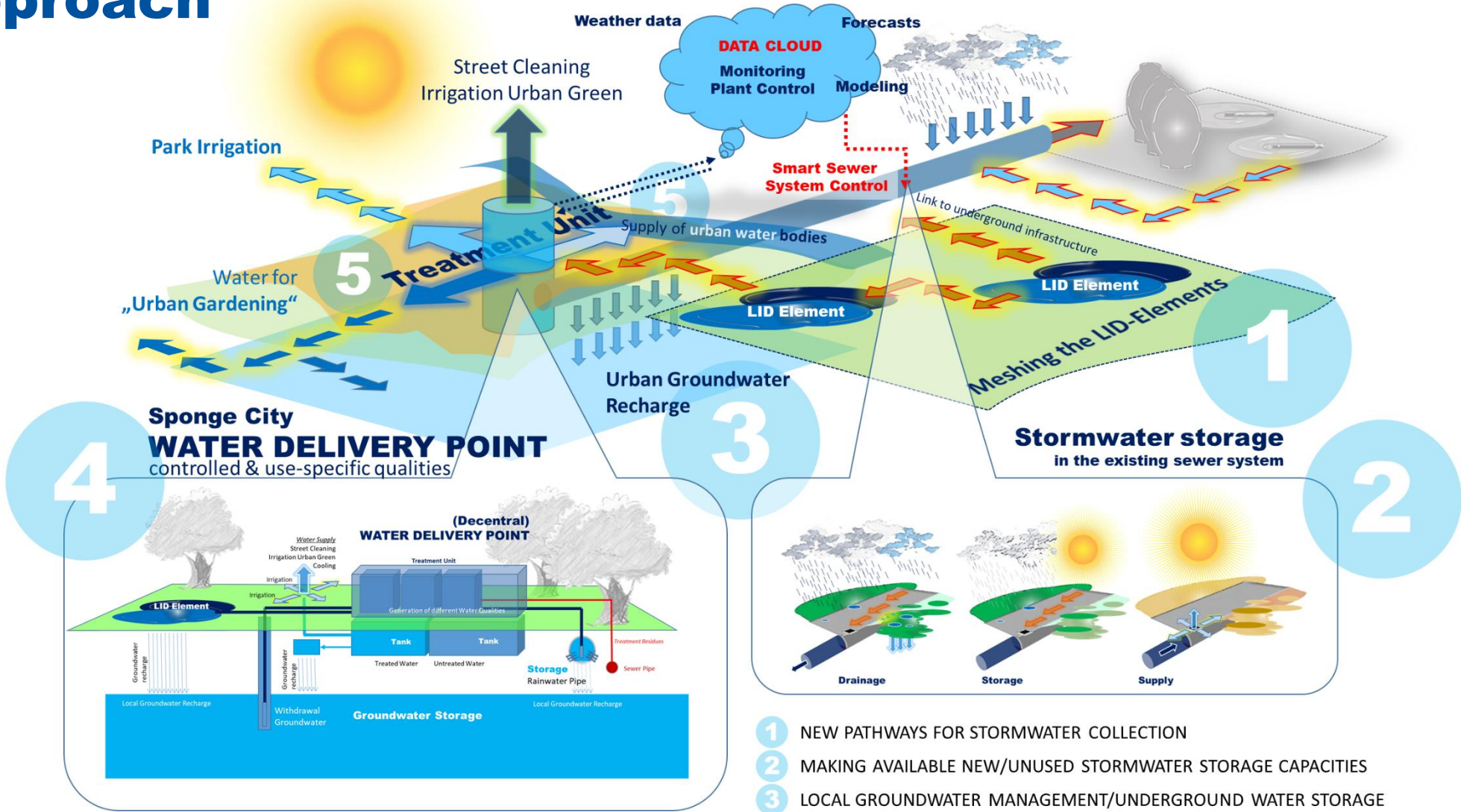
Robust and permanent utilization of stored rainwater for

- the self-preservation of the Sponge City and
- as further water supply component.

- **Our R&D Target**

Establishment of a complementary and quality-assured water supply infrastructure

# Our Approach

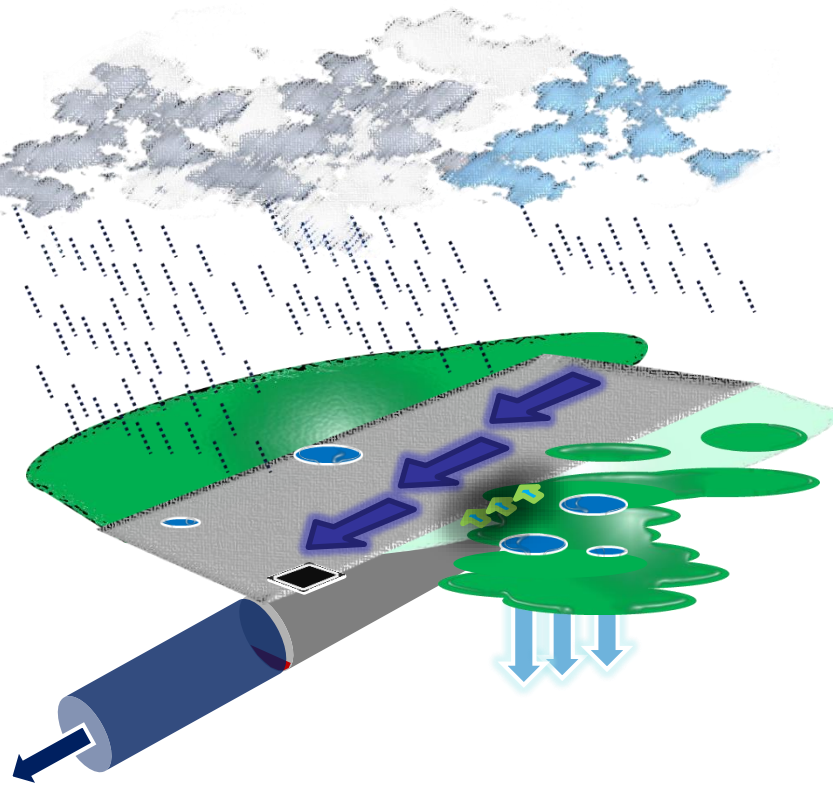


- 1 NEW PATHWAYS FOR STORMWATER COLLECTION
- 2 MAKING AVAILABLE NEW/UNUSED STORMWATER STORAGE CAPACITIES
- 3 LOCAL GROUNDWATER MANAGEMENT/UNDERGROUND WATER STORAGE
- 4 USE OF MODULAR STORM-/GROUNDWATER TREATMENT UNITS
- 5 NEW WATER DISTRIBUTION ROUTES

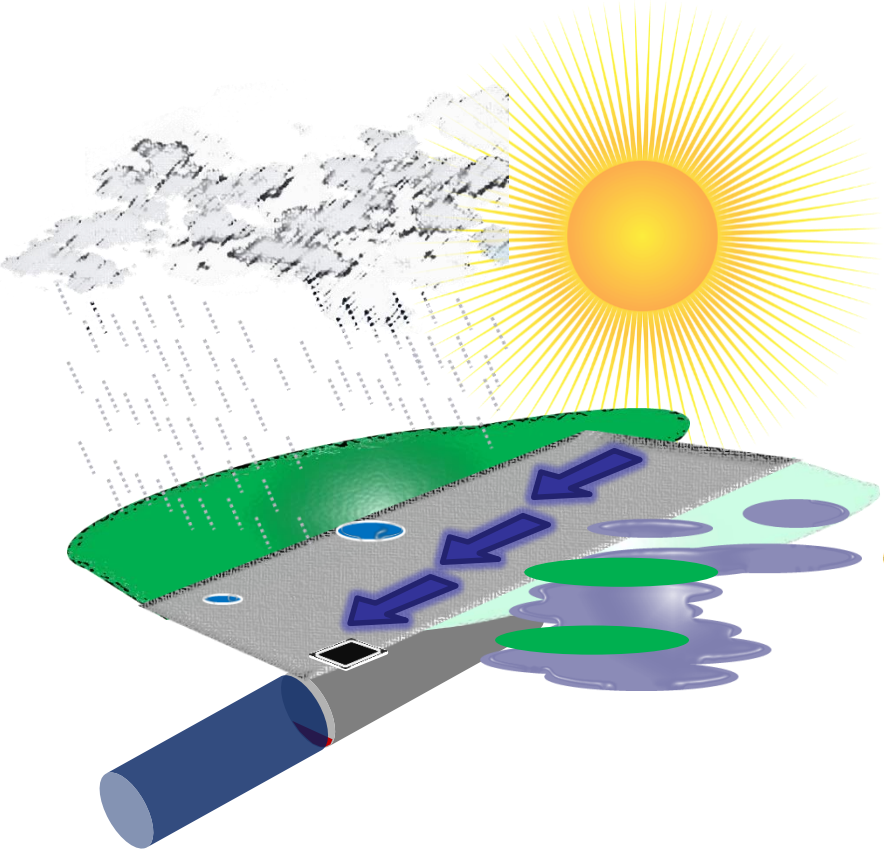


# Barrier 1: Expansion of the urban water storage capacity

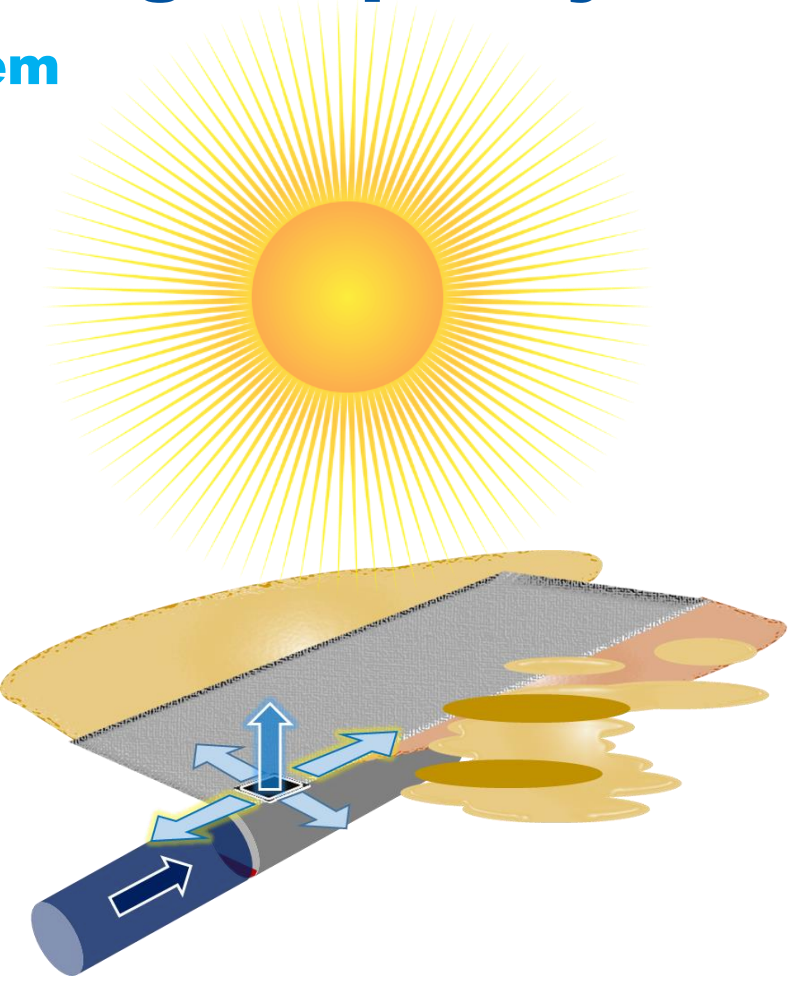
New management approaches of the existing sewer system



**Drainage**

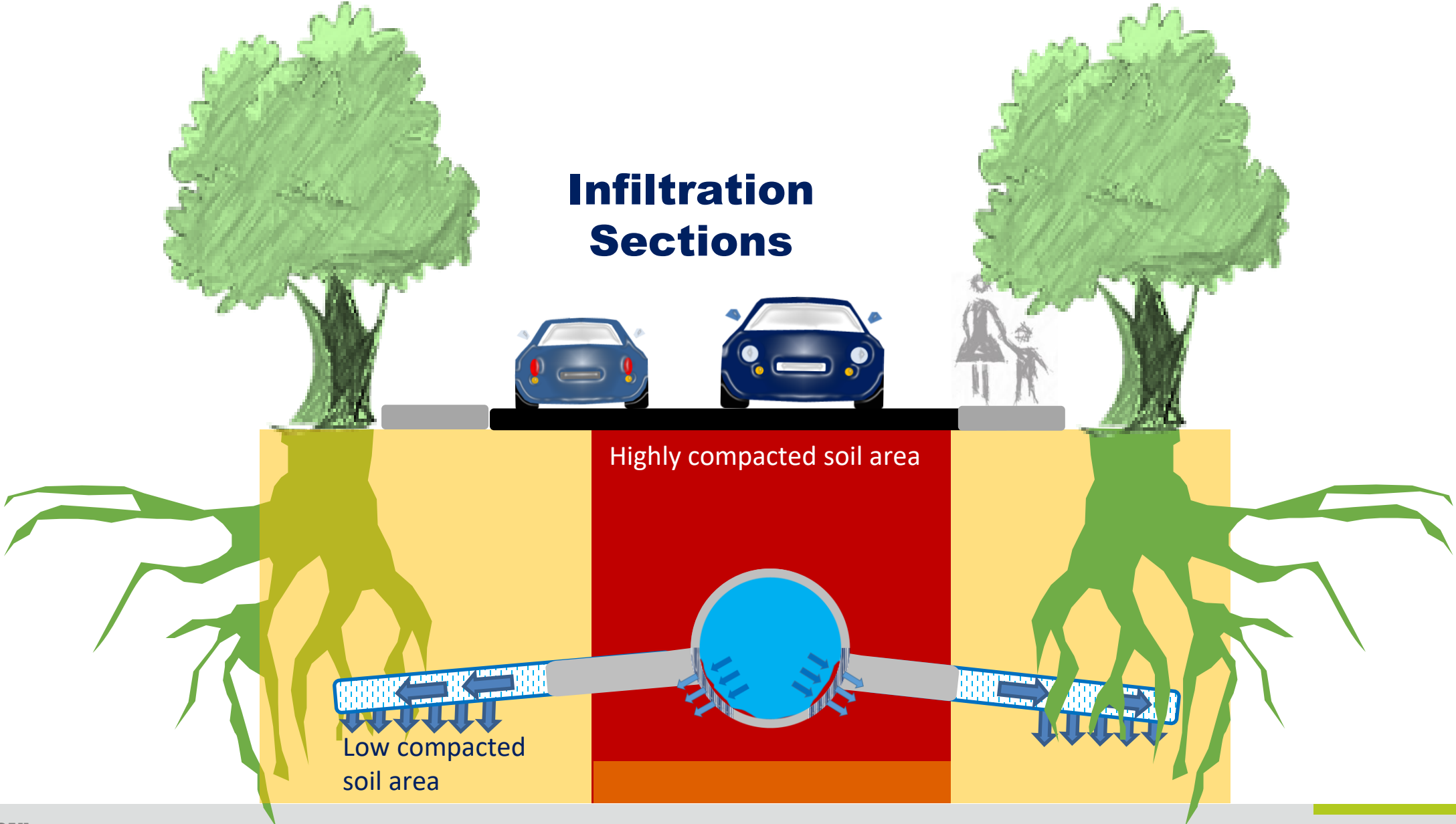


**Storage**

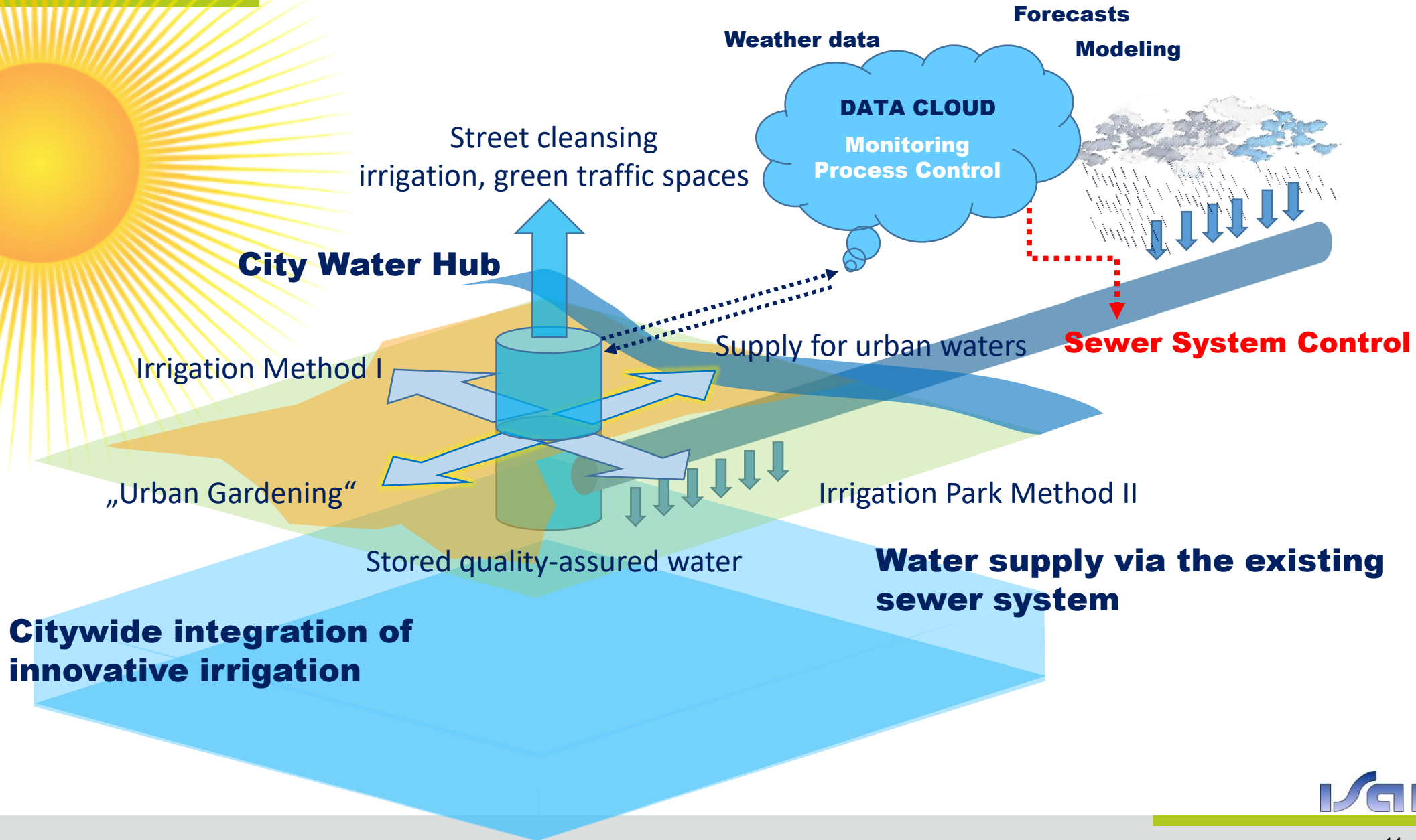


**Supply**

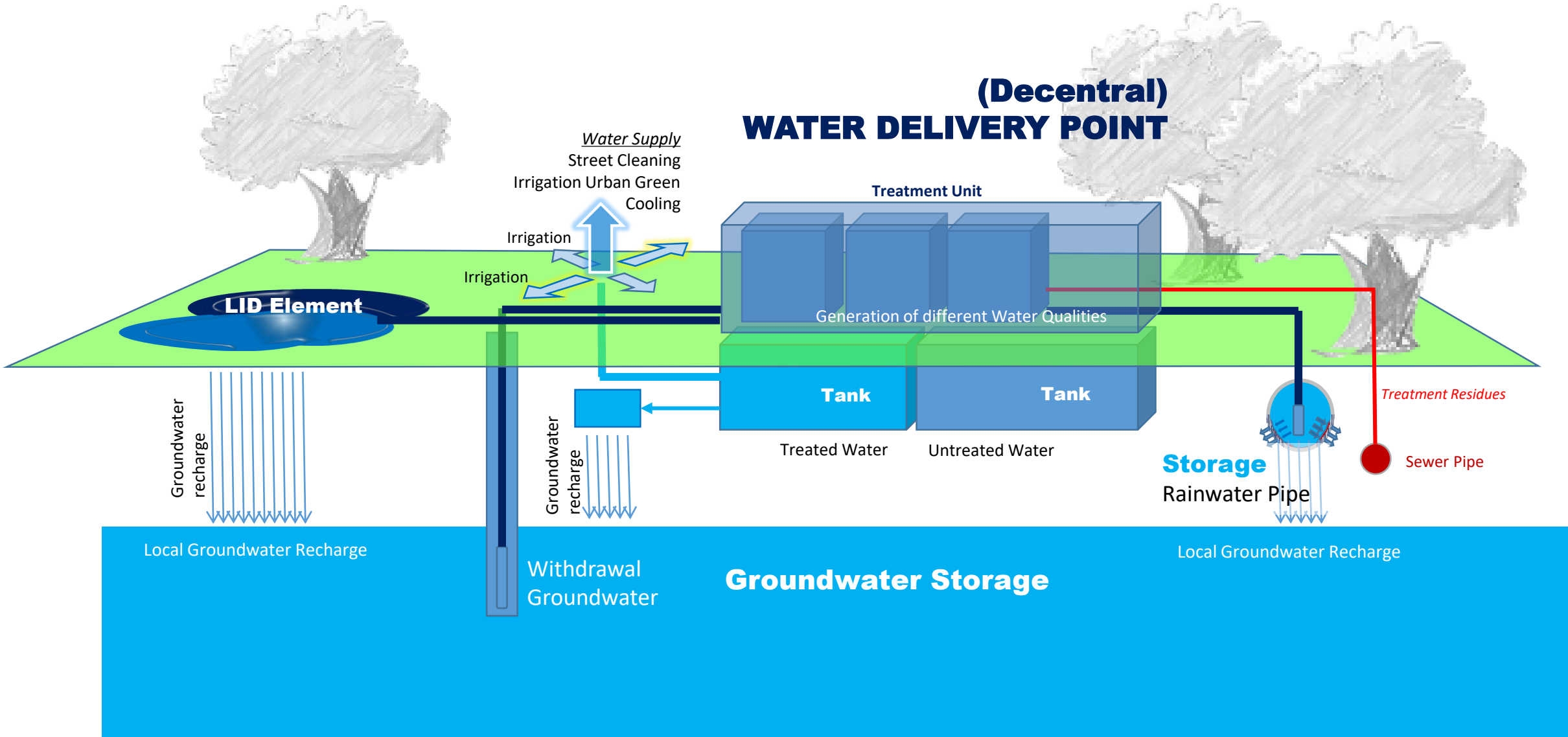
# Barrier 1: Water supply for trees plus GW recharge



# Barrier 2: City Water Hubs

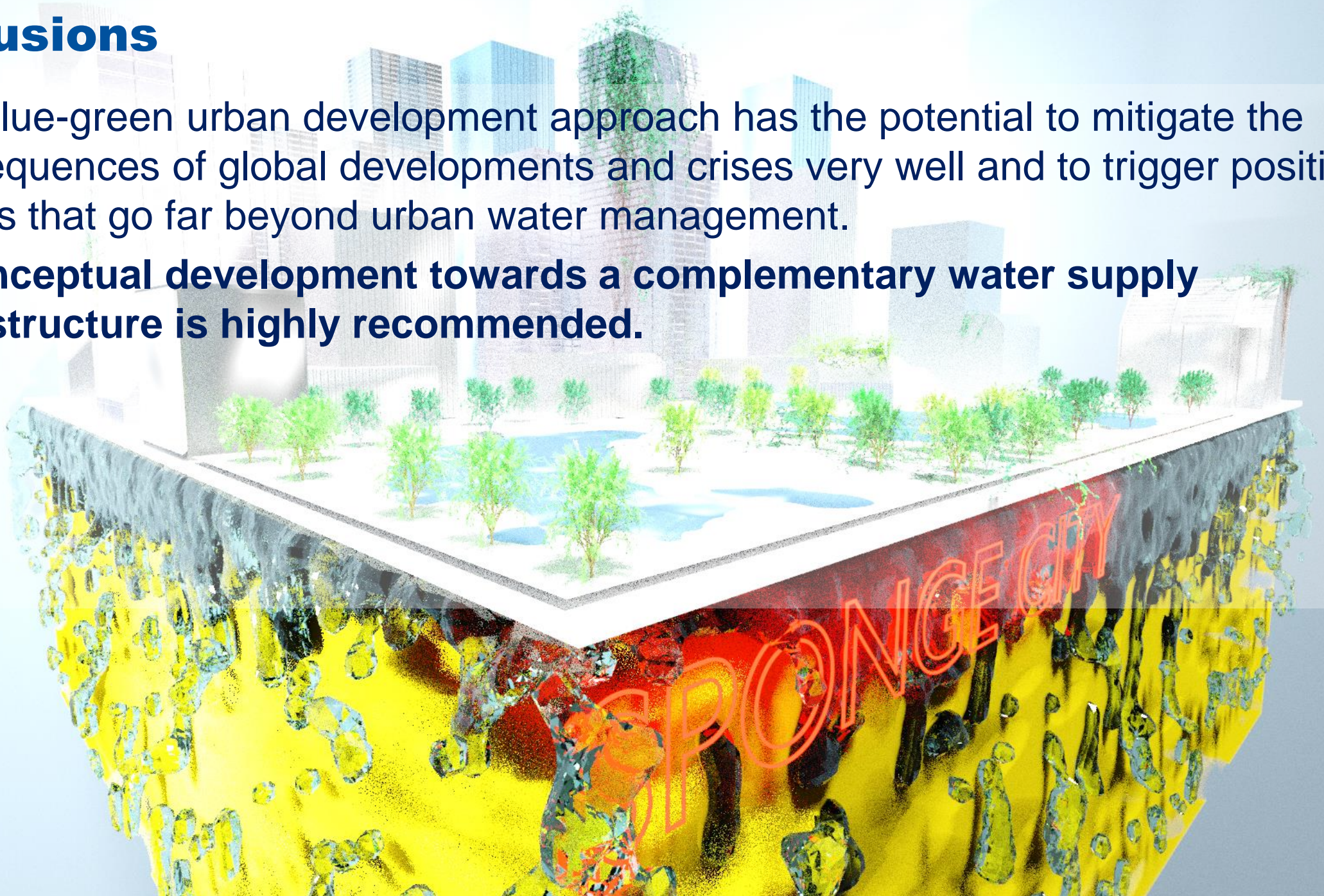


# Barrier 2: City Water Hubs



# Conclusions

- The blue-green urban development approach has the potential to mitigate the consequences of global developments and crises very well and to trigger positive effects that go far beyond urban water management.
- **A conceptual development towards a complementary water supply infrastructure is highly recommended.**



# Introduction

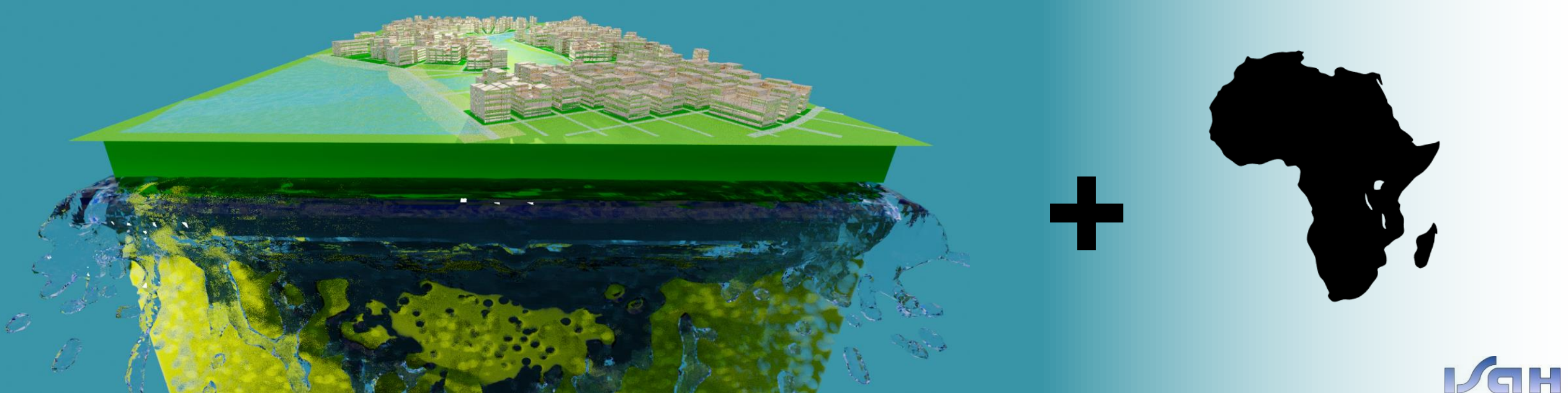
## Anna Thoms M.Sc.

- 2014 - 2015      **Voluntary year at ONG MEV**  
Porto-Novo, Benin
- 2015 - 2020      **Civil- and Environmental Engineering (B.Sc.)**  
Leibniz University, Hannover
- 2020 - 2023      **Environmental Engineering (M.Sc.)**  
Leibniz University Hannover
- Since 2023      **Junior Researcher**  
Institute of Sanitary Engineering and Waste  
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# Untapped Potential: rainwater harvesting → city water supply

Little information on implementing the Sponge City concept in sub-Saharan African cities



## Potentials for Sponge City Implementation in Sub-Saharan Africa (2022):

<https://www.mdpi.com/2071-1050/14/18/11726>



Article

### Potentials for Sponge City Implementation in Sub-Saharan Africa

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**Abstract:** Despite the growing interest in implementing sponge cities (SPC), their potential is not yet being tapped in many fast-growing Sub-Saharan African cities. This is remarkable because SPC interventions can contribute considerably to increasing water safety and availability in a city. By means of a three-stage potential assessment, this study provides the first analysis of what concrete options can be identified for implementing the SPC concept in Sub-Saharan cities. The methodology was filled with information obtained especially from expert interviews, literature reviews, and satellite imagery. Thus, the analysis also considers what obstacles impede SPC implementation, and, in particular, what technical and socioeconomic constraints need to be taken into account. The cities of Hawassa (Ethiopia), Beira (Mozambique), Kigali (Rwanda), Ouagadougou (Burkina Faso), and Cotonou (Benin) are examined in detail. Additionally, a local SPC implementation was conceptualized and evaluated for two districts in Ouagadougou and Cotonou. The first finding is that, when geographical and socioeconomic aspects such as climatic patterns, migration flows, health risks, and existing infrastructure are sufficiently taken into account, SPC interventions would massively help African cities to mitigate current and urgent challenges such as water scarcity and urban flooding. In terms of water safety, the second key finding is that rainwater harvesting solutions at the household level could be implemented quickly; however, there would be substantial difficulties such as lack of financing and maintenance as well as claims of ownership, especially in informal settlements and slums. Thus, it seems quite promising to directly strive for a rapid “centralization” of SPC implementation in individual neighborhoods. This neighborhood approach paves the way for SPC measures to receive public acceptance and constant maintenance. When this mosaic of implementations comes together, many individual instances of SPC implementation can help to improve urban resilience and living conditions for the city dwellers as is here demonstrated for the districts in Cotonou and Ouagadougou.

**Keywords:** sponge city; green infrastructure; Sub-Saharan Africa; urban rainwater management; flood protection; urban planning; rainwater harvesting; climate change; urban growth; African urbanization



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# Methods



## Elaboration and Evaluation of applicable Sponge City Interventions

Type of Data:



Literature



Topographical maps



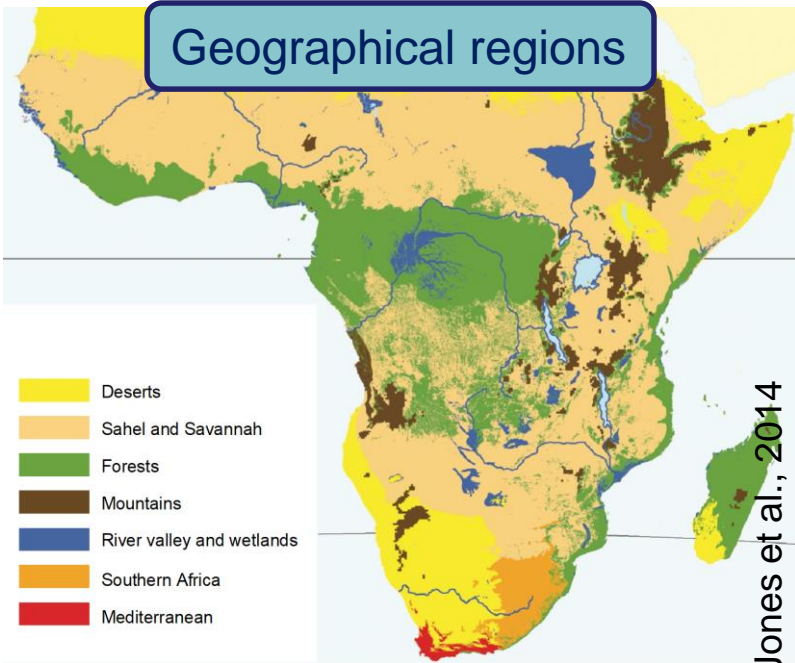
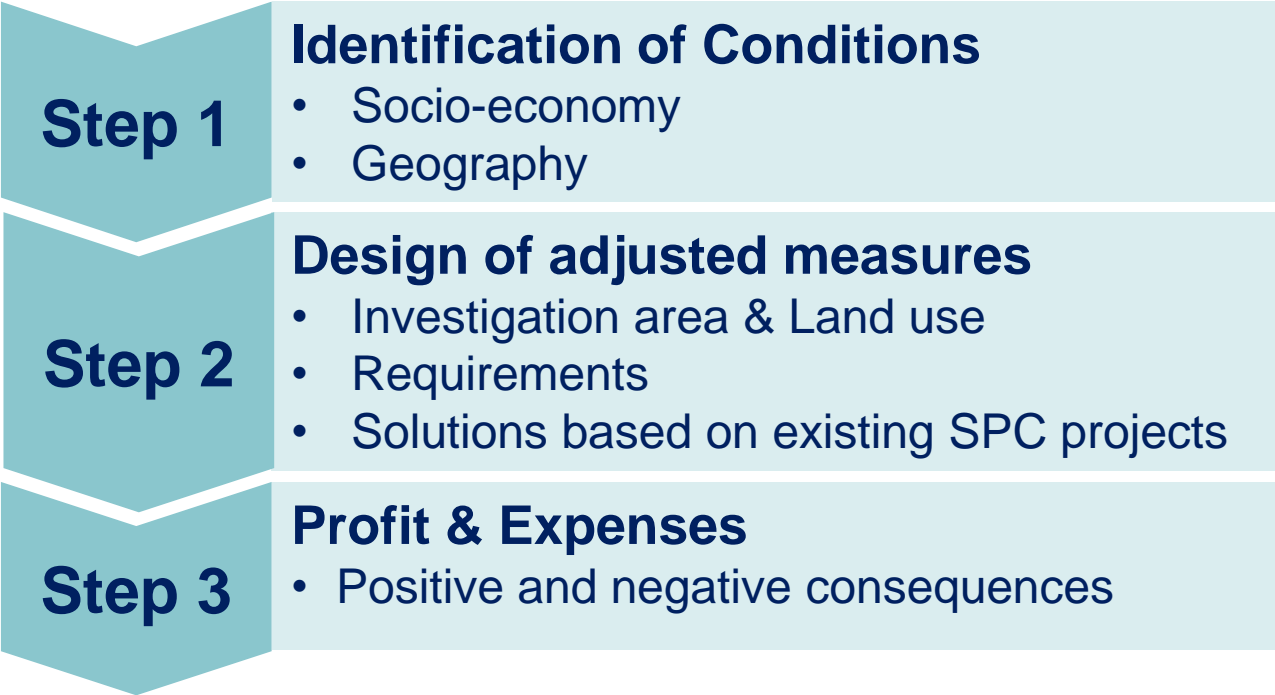
Satellite pictures



GIS

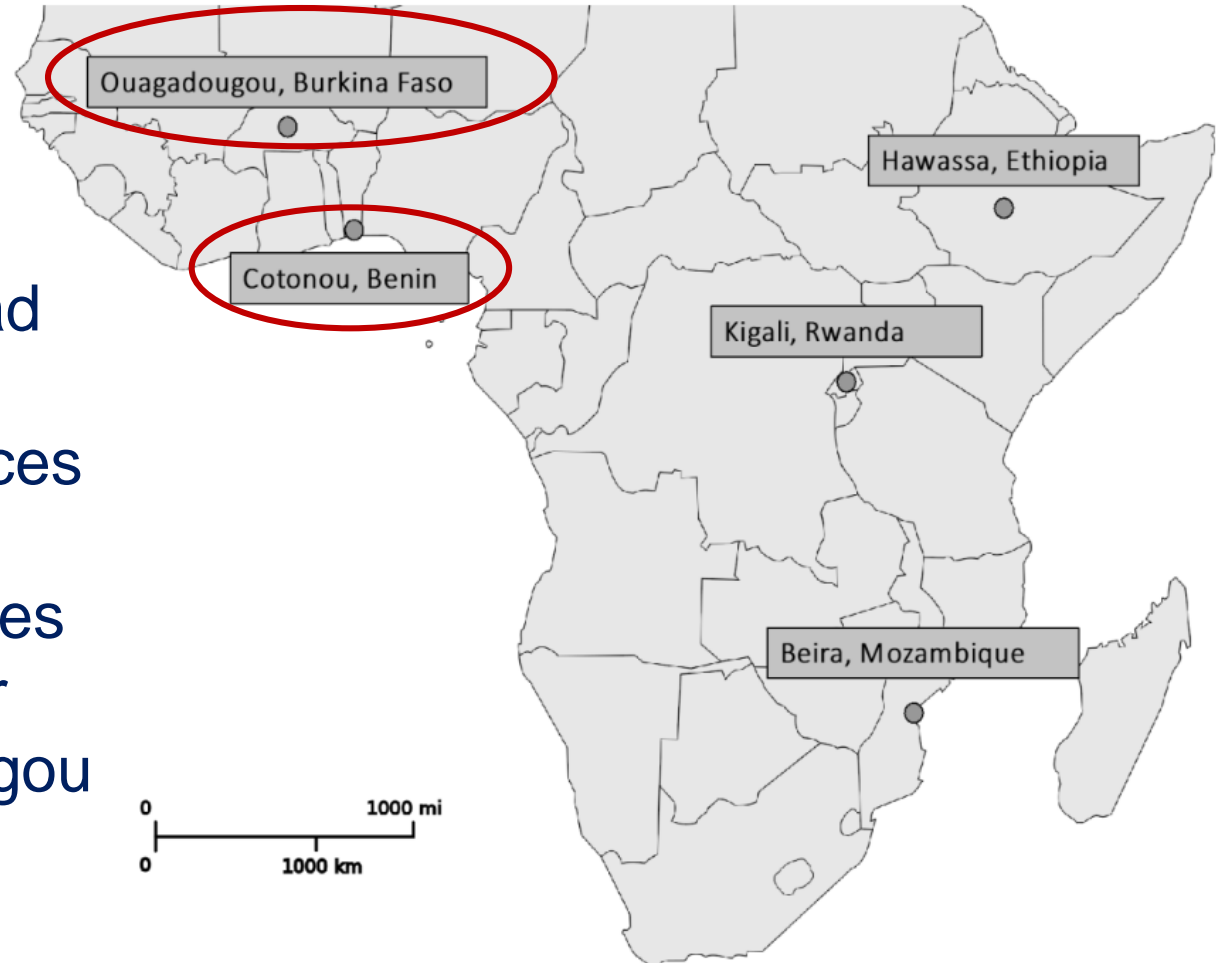


Expert Interviews



# Investigation Areas

- Selection of 5 pilot cities being spread across the countries  
→ Data preparation from multiple sources
- Exemplary implementation possibilities  
→ Elaboration of concrete concepts for districts in two pilot cities (Ouagadougou and Cotonou)



Location of the chosen pilot cities in Sub-Saharan Africa (source (map): Wikimedia)

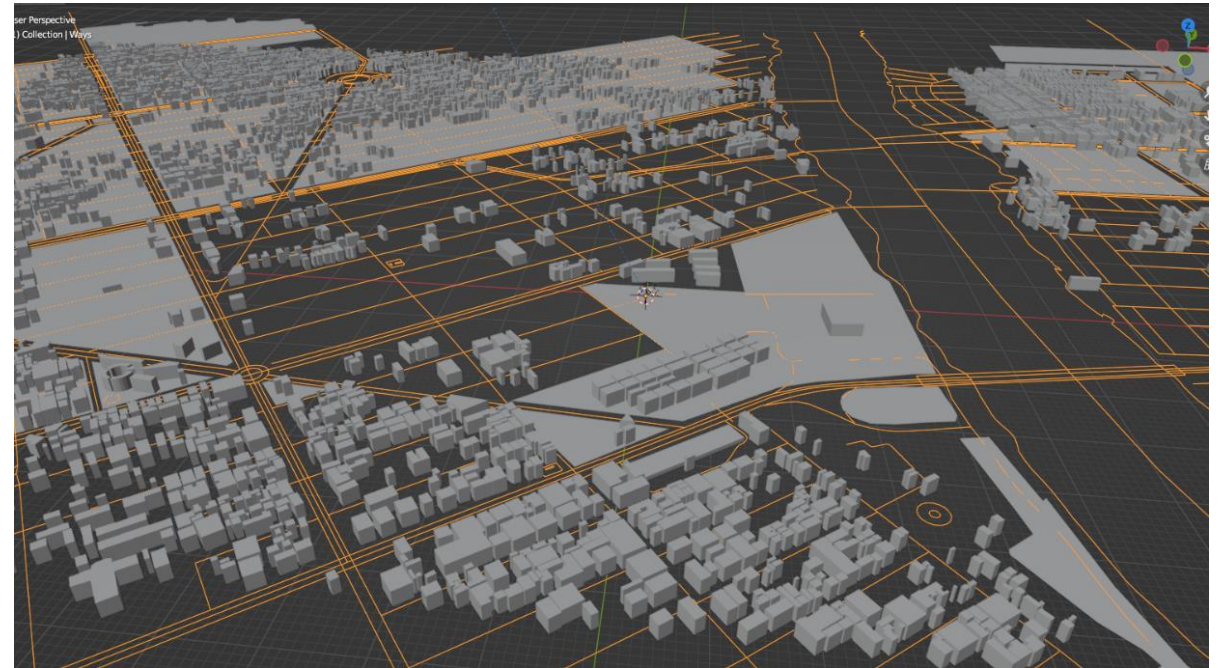
# **Special Features in sub – Saharan Africa**

- **Uniform high solar radiation**
- **High temperatures** → No frost
- **Vegetation period** throughout the whole year
- **Lack of water services** (water supply/drainage system)
- **Water-/vector-borne diseases**
- **High urban growth rates** (especially in intermediate cities)

# Example Cotonou, Benin

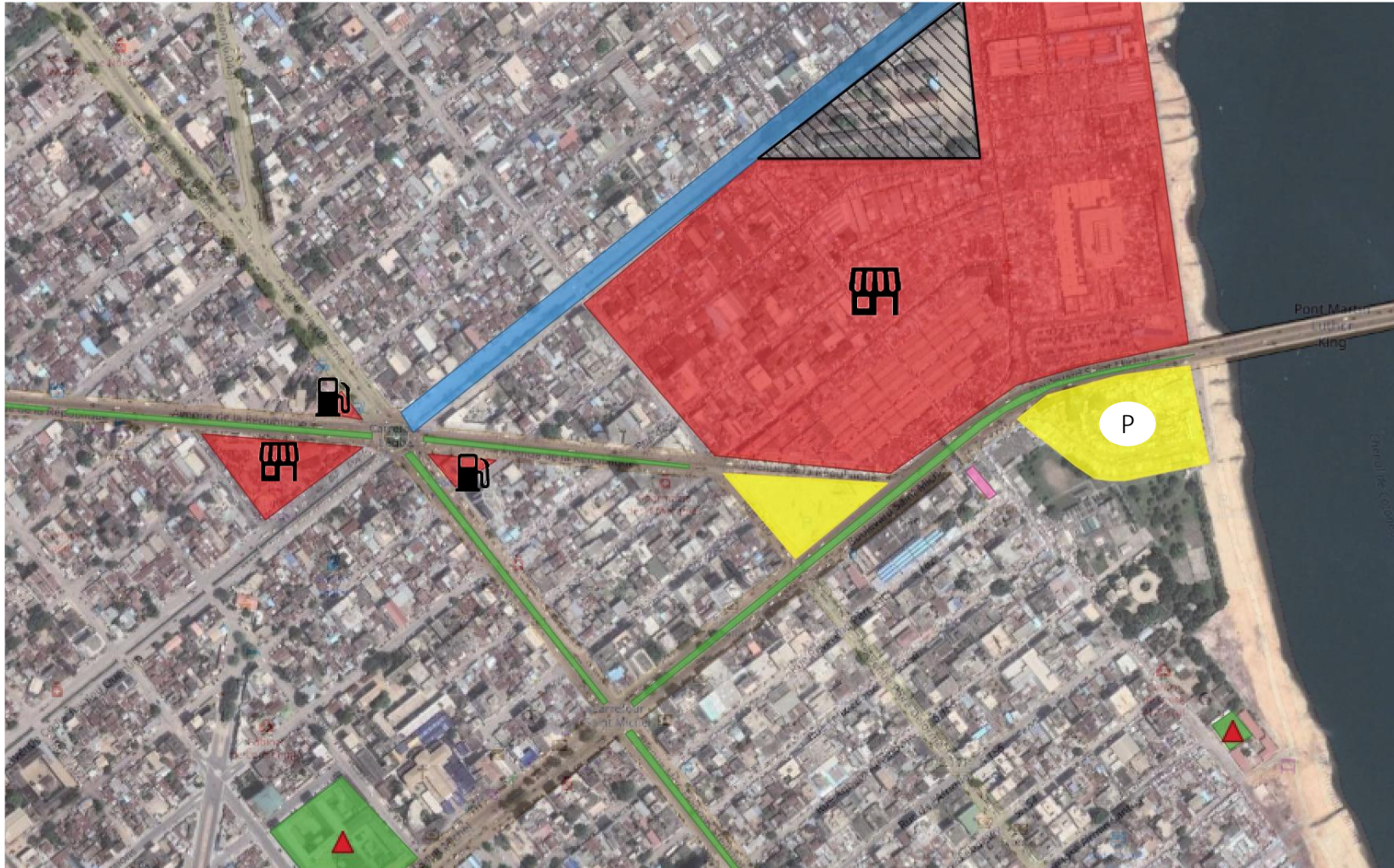
Location	Dantokpa Market Cotonou, Benin
Description	Biggest market in West Africa Situated next to a lagoon Low elevation level Streets mostly paved
Land use	Stores, restaurants, market area, parking spaces
Precipitation	1208 mm/a
Soil type	Mostly Sand
Freshwater source	Groundwater
Water availability (2014)	56 % (water supply), 81 % (wells)

Sources: Maliki (1993), Yamazaki et al. (2021), Hounkpe et al. (2014), Dr. Roos (2022)



Investigation Area: Dantokpa market, Cotonou Benin (2,3 km<sup>2</sup>), ISAH

# Example Cotonou, Benin



- Water catchment areas ■
- Vegetation/low elevation belt ■
- (Re-) activation of water bodies ■
- Multifunctional use ■

- Land use:
- Mosques
  - ▲ Educational institutions
  - ◆ Sports field
  - ⬮ Market
  - ⛽ Gas station
  - Ⓟ Parking lots

# Example Cotonou, Benin



Unused areas (road circles, road medians, etc.)

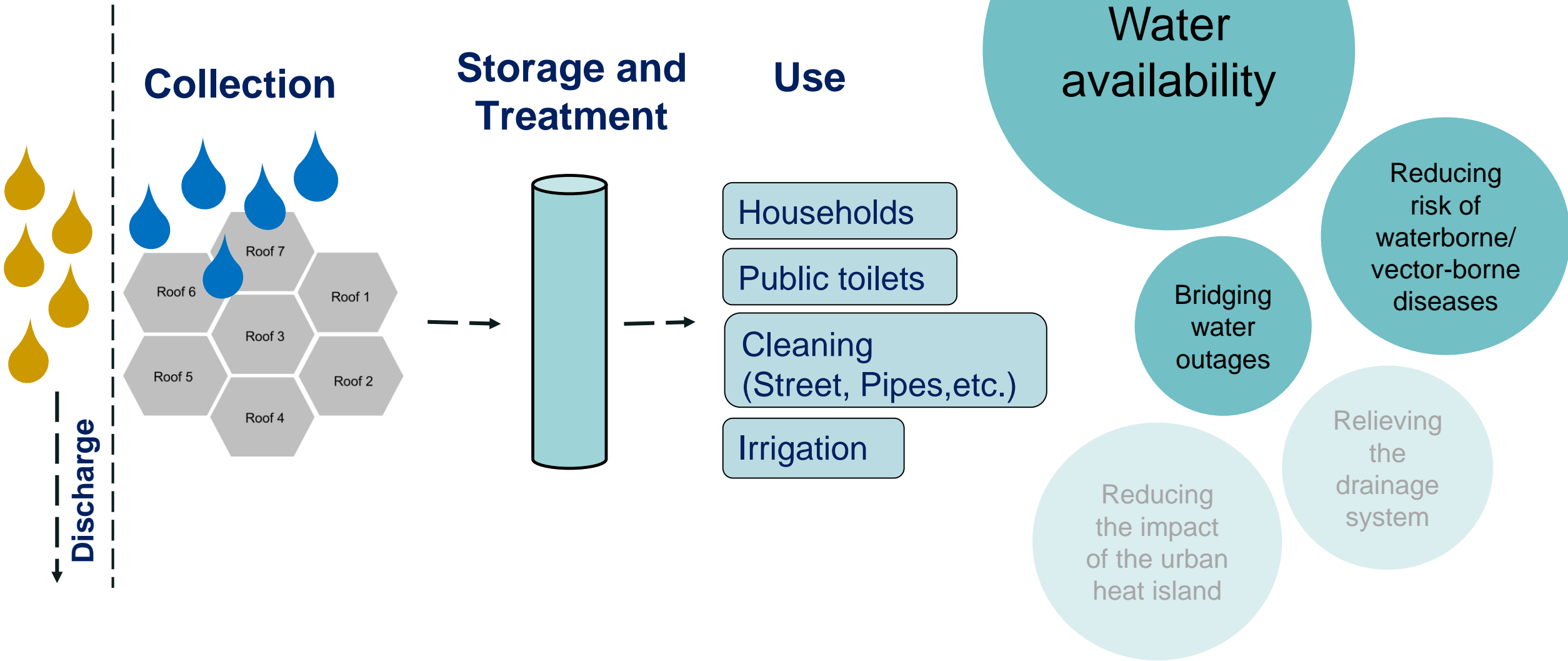


# Recommendations

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- Increase of freshwater availability in urban areas  
→ Rainwater = New water supply component
- Use of only low polluted rainwater (→ quality based drainage)
- Use of solar powered treatment technologies → UV irradiation by using PV installations vs. SODIS method
- Implementation: Use of public spaces (e.g. market areas)
- "Centralisation" of the Sponge City implementation at district level  
→ Connecting individual measures

# Concrete Potentials

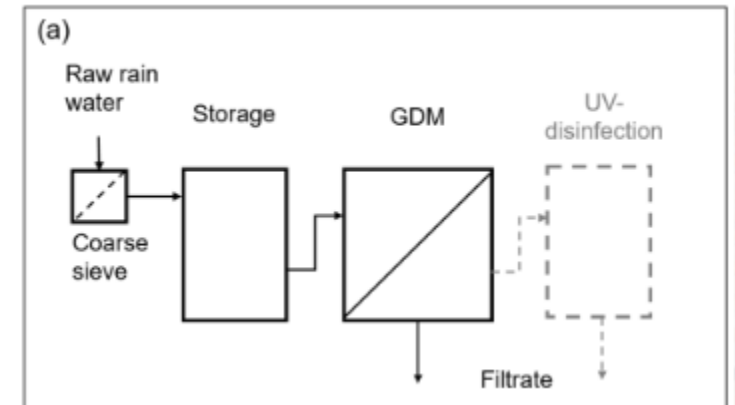




# Concrete Potentials

## Low Energy Technologies

- Previous field studies to examine rainwater treatment technologies at the ISAH



# Concrete Potentials

- New Source of (Drinking) Water



# Conclusions II

- Sponge City Development seems to be promising approach also in sub-Saharan African cities
- Opportunity to use rainwater as a complementary water supply component
- Consideration of **low polluted rainwater as an additional freshwater resource at public district level**
- Use of low energy treatment technologies
- Sponge City is a flexible concept that allows adaptation to site conditions

# Any Questions?

## SPONGE CITY DEVELOPMENT

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