Water Security: the foundation for achieving the Sustainable Development Goals

Jan Hofman
Water Innovation and Research Centre
University of Bath

Where is Bath?

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& Research
Centre

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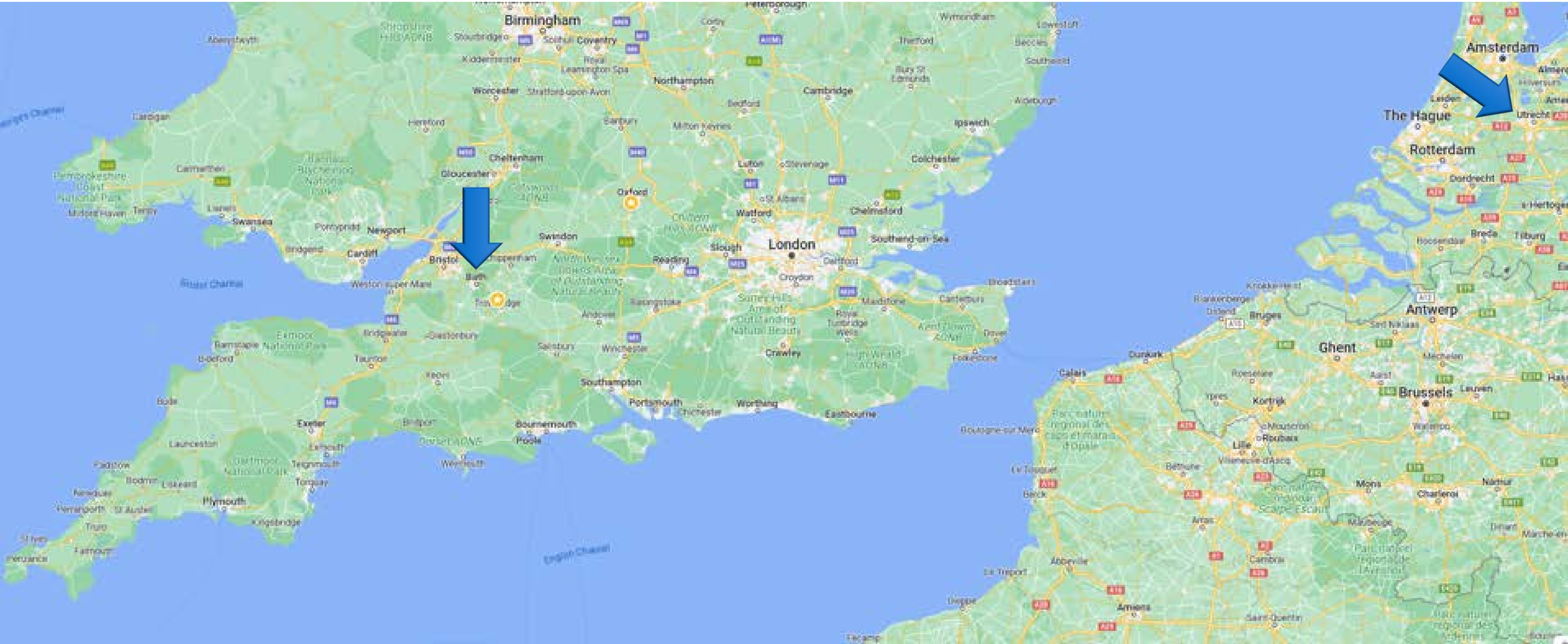

Bath UK

Water Innovation & Research Centre

UNIVERSITY OF BATH

Bath Abbey

William Herschell

Jane Austen

Roman baths

Royal Crescent

University of Bath

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Students

- 15000 undergraduates
- 5800 postgraduates
- 32% international, 158 nationalities

Research portfolio

- £169 million
- 92% world leading or internationally excellent

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Creating a Water-Wise Society where…

- The true value of water is under-stood, recognised and realised.
- Water is valued for wellbeing and public and environmental health.
- Water management avoids water scarcity and pollution.
- Water and resource loops are closed for optimal resource efficiency.
- Resilience is created against climate impact and population growth.
- All underpinned with digital tools.

Cross Campus Community

Prof Jan Hofman
Director

Dr Tom Arnot
Co-Director

Prof Barbara Kasprzyk-Hordern
Co-Director

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Wessex Water YTL GROUP FOR YOU. FOR LIFE.

Water Europe Technology & Innovation
GW4 Water Security Alliance
unesco Intergovernmental Hydrological Programme
BRITISH WATER water industry forum now part of British Water

Water is abundantly available on our planet,
in oceans, ices masses, aquifers, in the atmosphere

1 400 000 000 000 km^3

71% of the surface is water

Only 3% is freshwater, mainly fixed in ice and groundwater

About 0.01% is available for humans and freshwater ecosystems

Mentimeter

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Instructions

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Join at menti.com use code 8611 028

Do you know what Wate
is?

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How would you define W
Security?

Water security

Too much, too little, too polluted water

Definitions, scales, perspectives, approaches

Assessment

- Measures leading to actions

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What is the value of water ac
you?

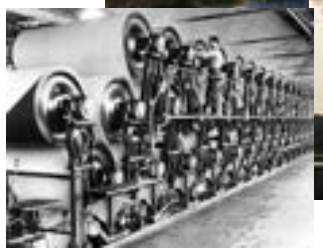
Waiting for responses ...

Value of water

Ecosystems (services)

Public health

Business/manufacturing



Food production

Value of water

Flint water crisis – Lead corrosion

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Flint water crisis

Flint mayor calls for immediate removal of corroded lead pipes

Other US mayors join call to 'get the lead out of Flint right now' after Michigan governor said replacing pipes amid water crisis was not on 'short-term' agenda

Alex Kellogg in Flint, Michigan

Tuesday 2 February 2016 23.28 GMT

Shares 1,086 Comments 21

Save for later

Flint mayor Karen Weaver: 'We are here to take a stand to get the lead out of Flint right now.' Photograph: Mandel Ngan/AFP/Getty Images

Joined by other former and current mayors, the mayor of Flint, Michigan, called for immediate action to remove corroded lead pipes from the city's contaminated water distribution system on Tuesday.

"We are here to take a stand to get the lead out of Flint right now," said Mayor Karen Weaver of the city's water crisis, which has exposed an untold number of children and adults to high levels of lead. "We want to make sure we identify every place that is high risk. This is where we want to start."

Republican Michigan governor Rick Synder said this week that removing the corroded lead pipes isn't on his "short-term" agenda.

"It's a lot of work to take out pipes, to redo all of the infrastructure, that's a whole planning process," the governor said at a press conference.

Morning Mix

Manslaughter charges possible in Flint water crisis, says top investigator

A 154 Save for Later Reading List

By Michael E. Miller February 10

Sarah Truesdail holds her five-year-old daughter, Gabriella Venegas, who screams as a health official pricks her finger with a needle for a free lead test on Monday, Feb. 8, 2016 in Flint, Mich. (Jake May/The Flint Journal-MLive.com via AP)

Cape town 2018

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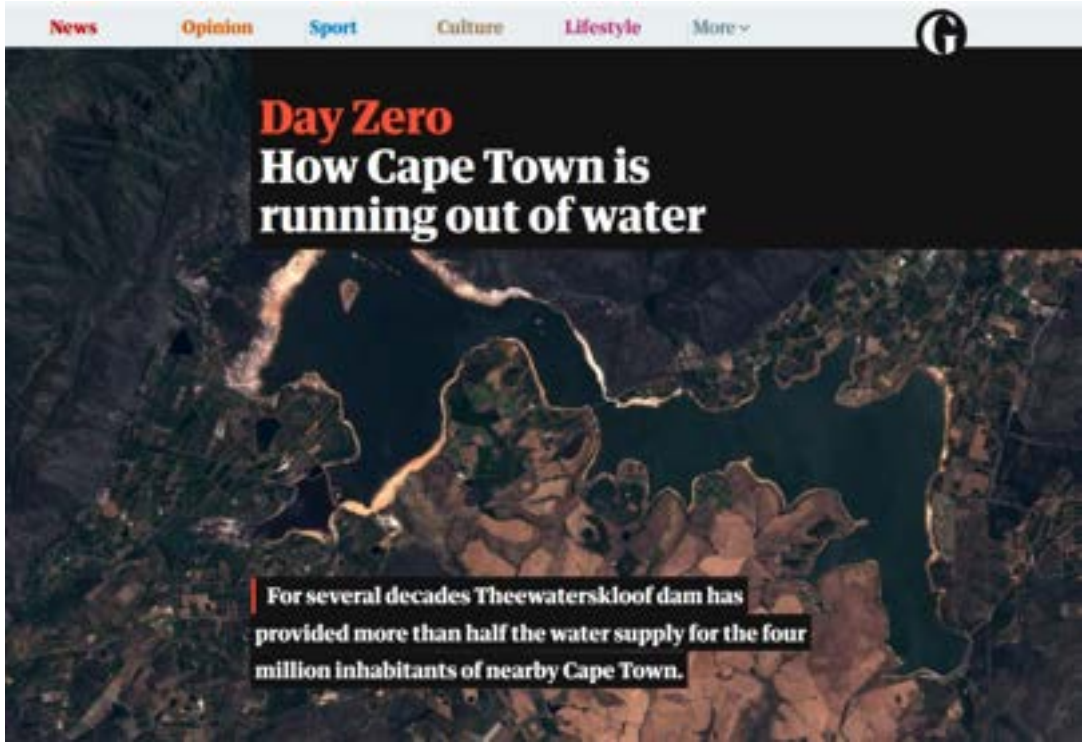

Catastrophes and disasters

NL, BE, GE
July 2021

Libya
Sept 2023

Population growth: world and sub-Saharan Africa

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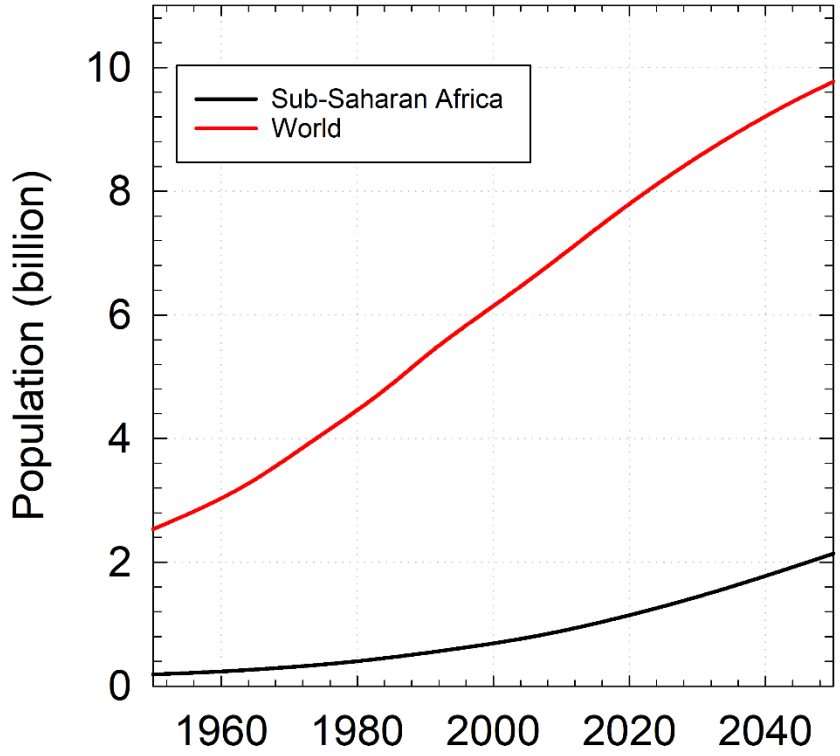
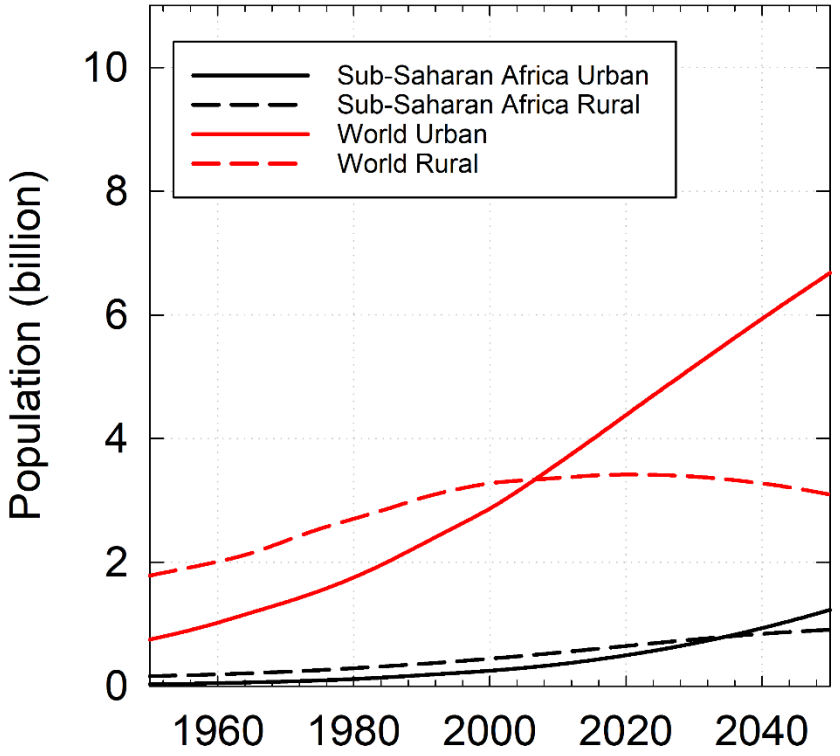
(A) Total



(B) Rural and urban



Mega cities (> 10M)

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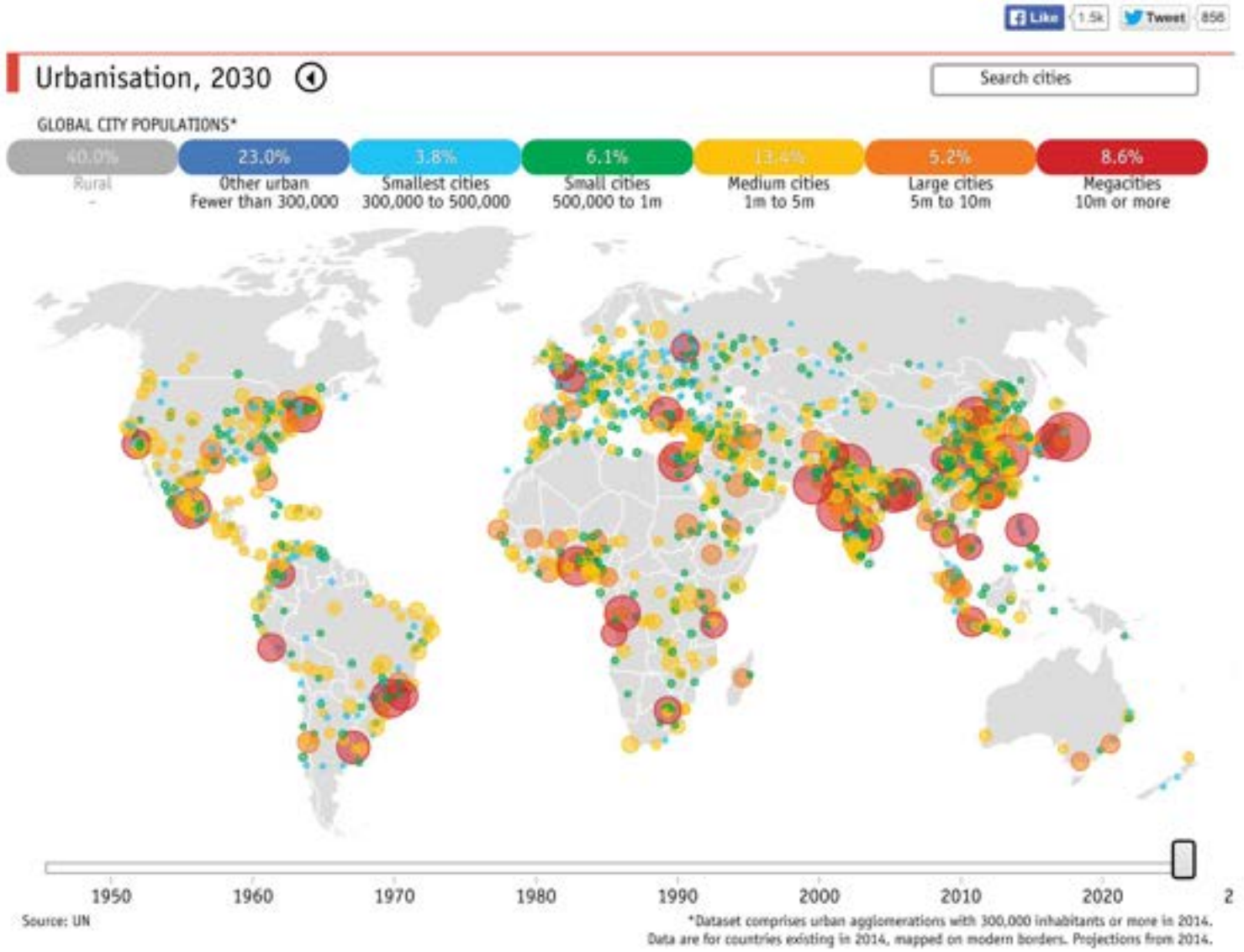

Urban context

- **68%** of the world population by 2050[1]
- **Complexity :** high population density, climate change, demand pressures and the co-existence of intricate infrastructure systems
- **Heterogeneous** conditions: inequality and diversity
- One score or average for an urban area: **overlooking realities?**
- Different perspective could provide new information for decision makers

Water security for whom... [2]


(C_Fernandes/Getty Images)

[1] Water, U. N. (2018). Sustainable Development Goal 6 synthesis report on water and sanitation. Published by the United Nations New York, New York, 10017.

[2] A. Y. Hoekstra, J. Buurman, and K. C. Van Ginkel. Urban water security: A review. Environmental Research Letters, 13(5), 2018.

Water Scarcity beyond availability of resources

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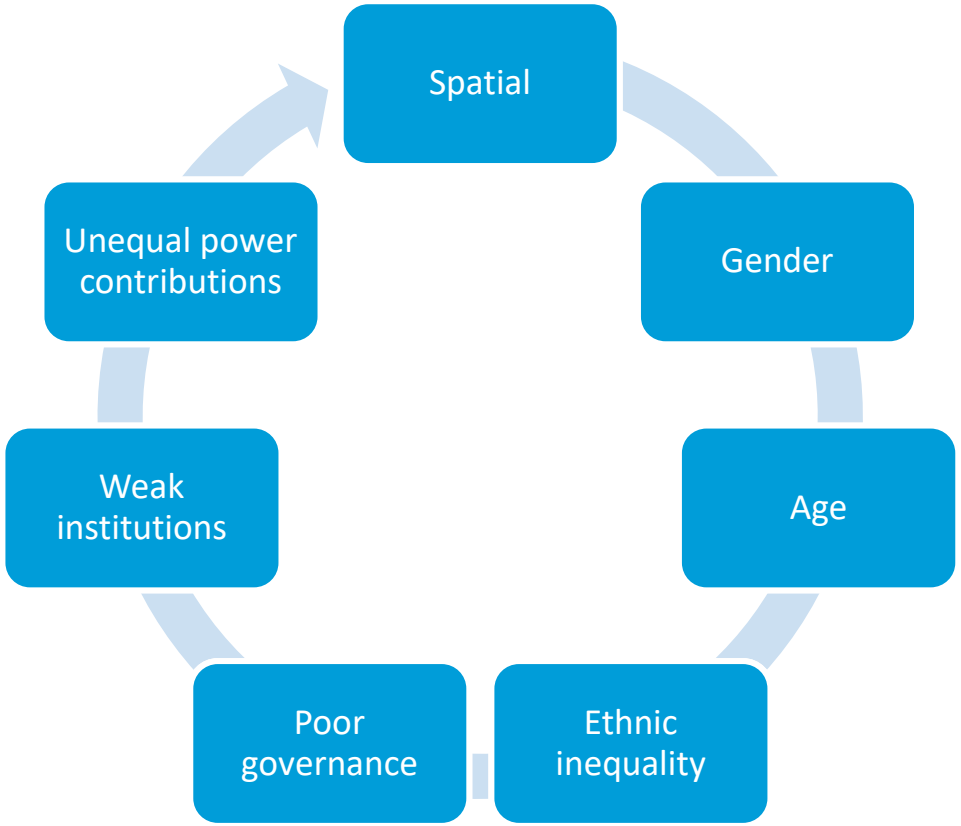
Human induced scarcity factors:



Water Scarcity is more than a mismatch between demand and supply, and availability of natural resources of water

Chitonge, H. (2020)
https://doi.org/10.1080/00020184.2020.1793662

Need to act and develop plans for Integrated Water Resources Management (IWRM) and governance to enable long-term water security

Rural-urban migration, without economic growth

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1. ‘push conditions’ for migration (such as deteriorating agricultural conditions worsened by climate change, natural disasters, mining activities or violent conflict)
2. slow development of the urban infrastructure that is lagging behind the urbanisation rate
3. high urban densities

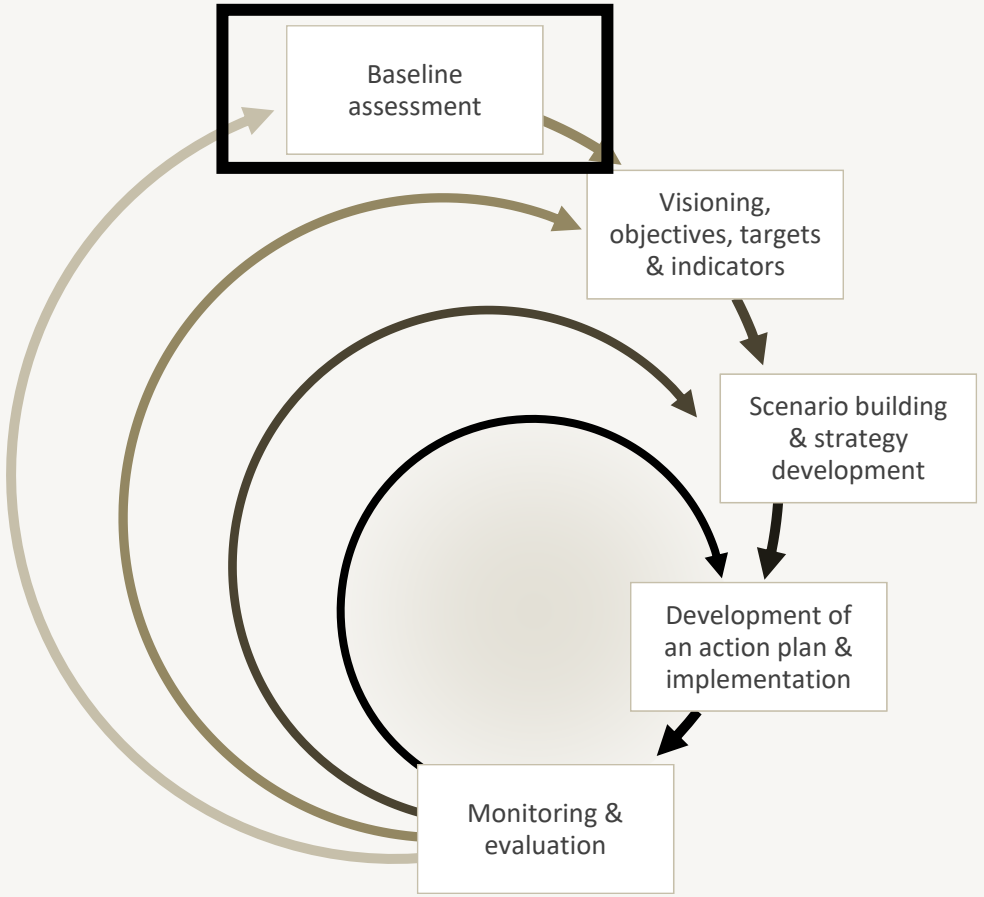
Fundamentally important to invest in urban infrastructure in the context of rapid urban expansion and demographic transformation to ease pressures of population growth.

Castells-Quintana, D. and Wenban-Smith, H. (2020) https://doi.org/10.1080/00220388.2019.1702160

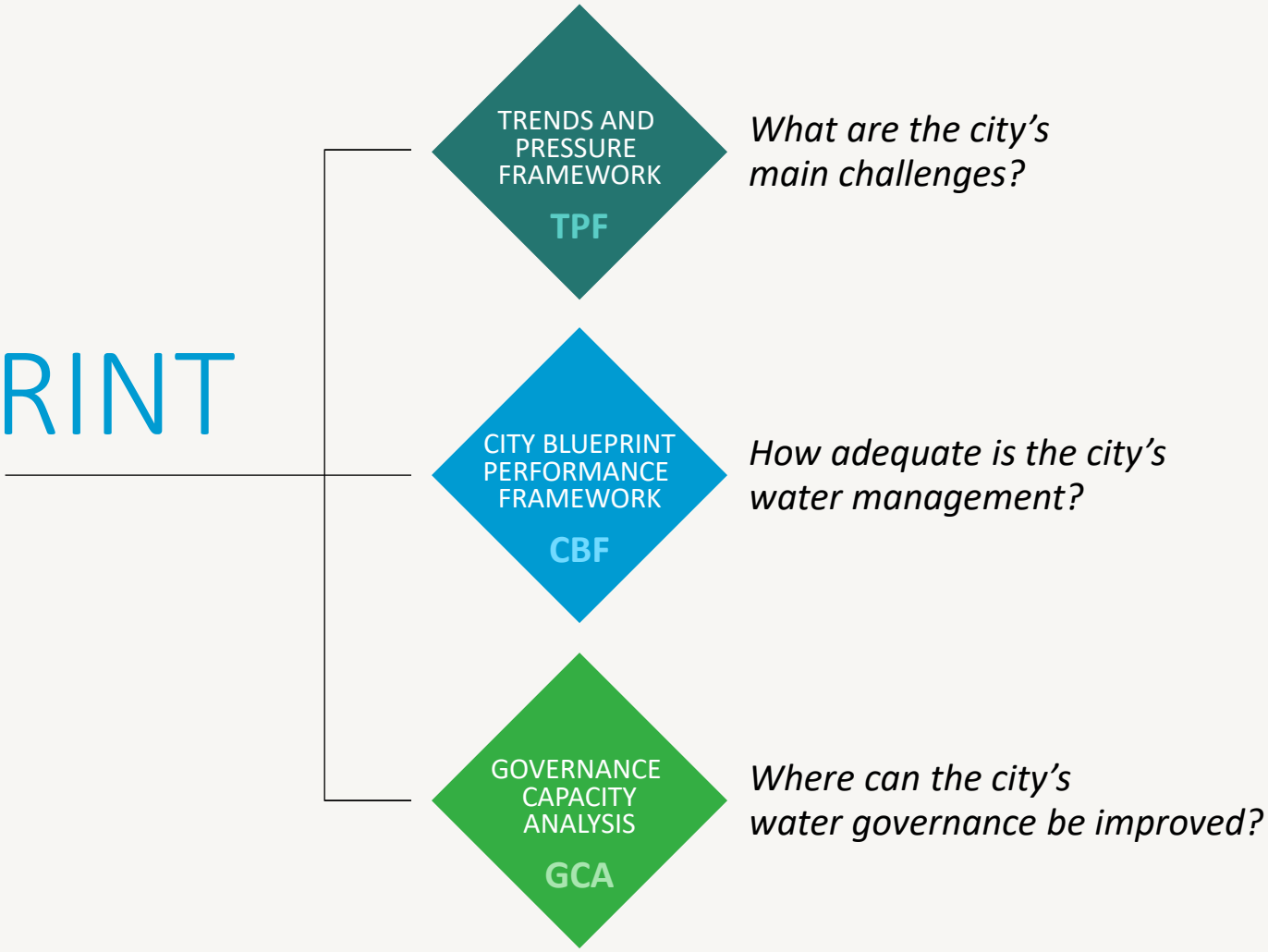
City Blueprint®


Stef Koop Kees van Leeuwen

KWR Water Research Institute



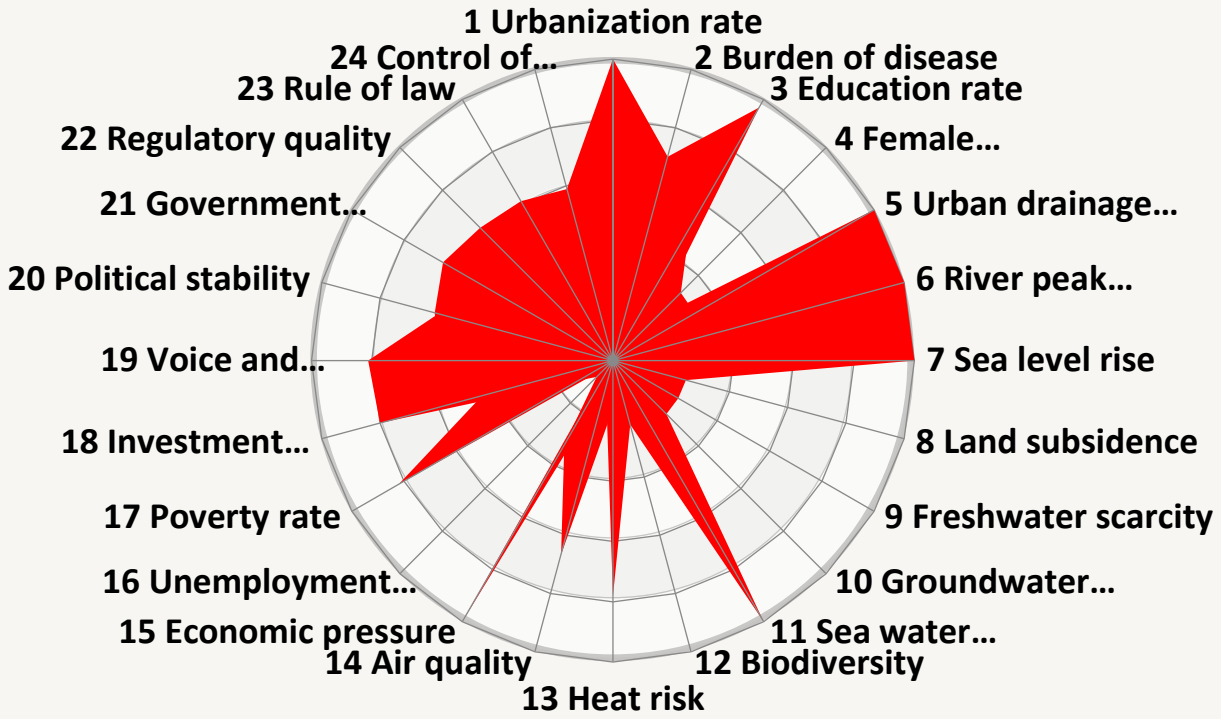
CITY BLUEPRINT APPROACH



Trends and Pressures Framework 	**Goal**	**Baseline assessment** of the sustainability of Urban Water Resources Management
	Indicators	Twenty-four indicators divided over four categories: 1. Social 2. Environmental 3. Financial 4. Governance
	Data	Public data or data provided by the (waste) water utilities and cities based on a questionnaire
	Scores	0 (no concern) to 10 (serious concern)
	TPI	Trends and Pressures Index, the mean of 24 indicators which varies from 0 to 10
	Stakeholders	Water utility, water board, city council, companies, NGOs, etc.
	Process	Interactive with all stakeholders involved early on in the process

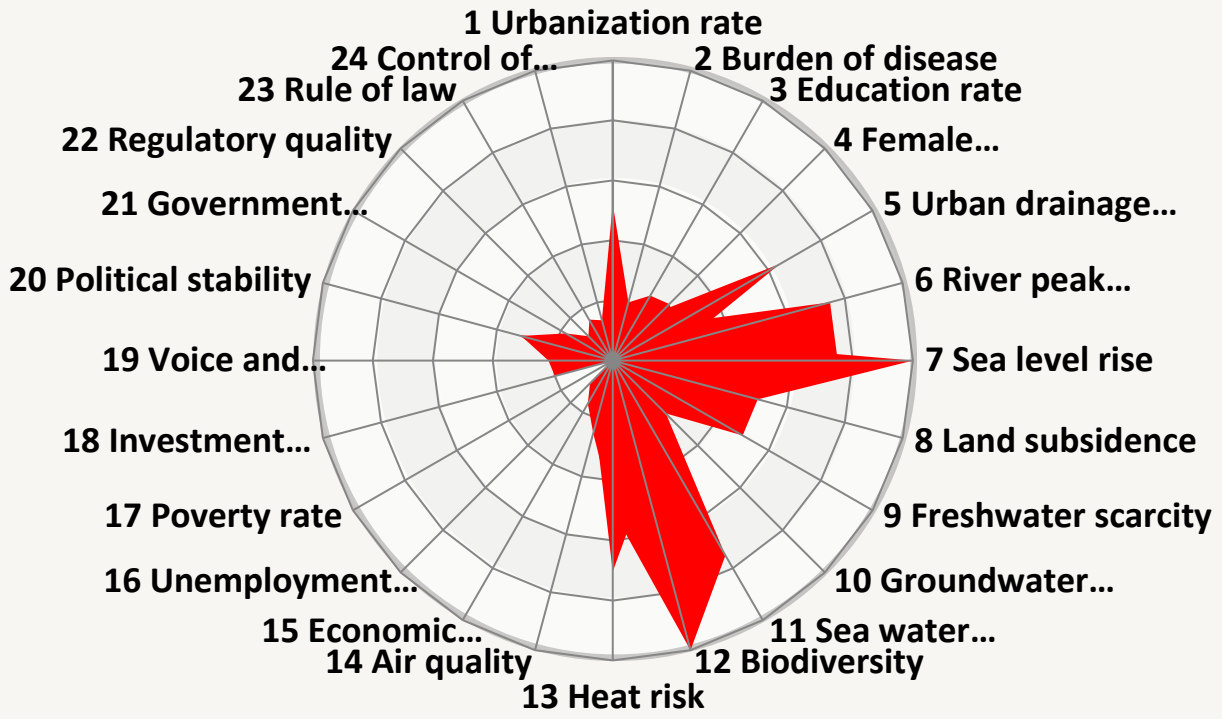
TPI 6.1

Dar es Salaam



TPI 2.9

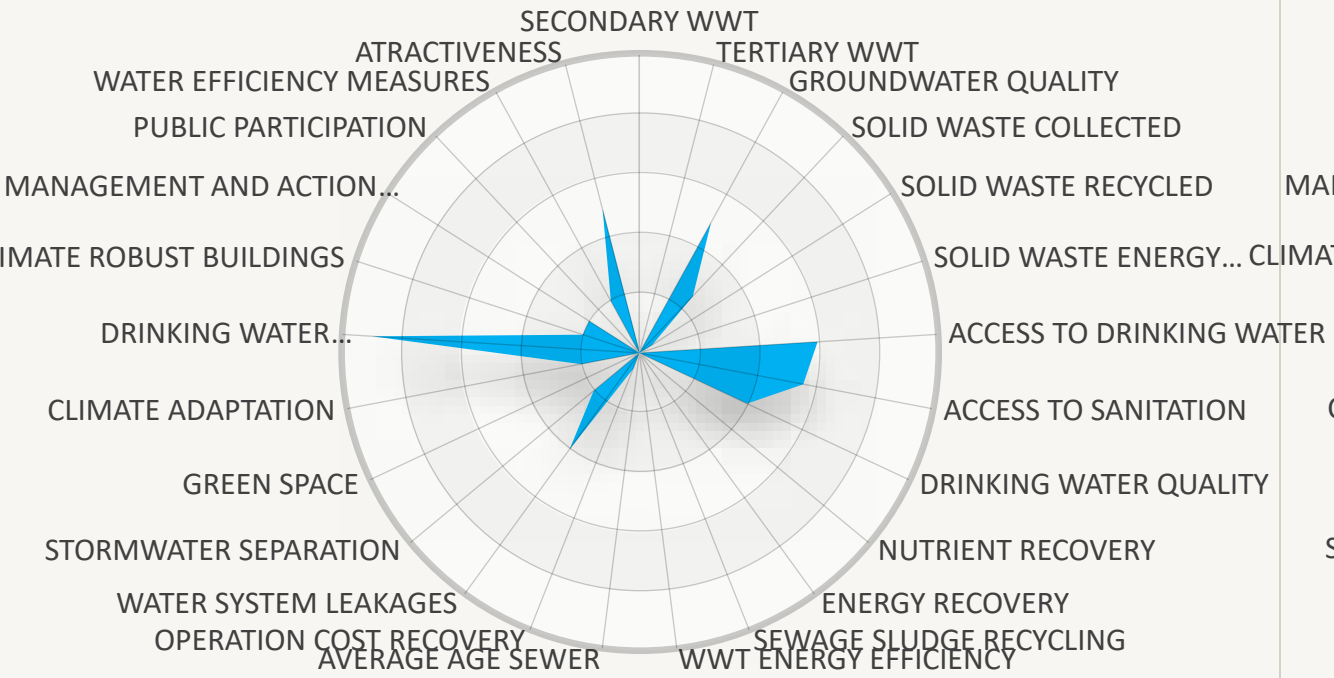
Melbourne



City Blueprint Performance Framework 	**Goal**	**Baseline assessment** of the sustainability of Urban Water Resources Management
	Indicators	Twenty-four indicators divided over seven categories: 1. Basic water services 2. Water quality 3. Wastewater treatment 4. Water infrastructure 5. Solid waste 6. Climate adaptation 7. Plans and actions
	Data	Public data or data provided by the (waste) water utilities and cities based on a questionnaire
	Scores	0 (concern) to 10 (no concern)
	BCI	Blue City Index, the geometric mean of 24 indicators which varies from 0 to 10
	Stakeholders	Water utility, water board, city council, companies, NGOs, etc.
	Process	Interactive with all stakeholders involved early on in the process

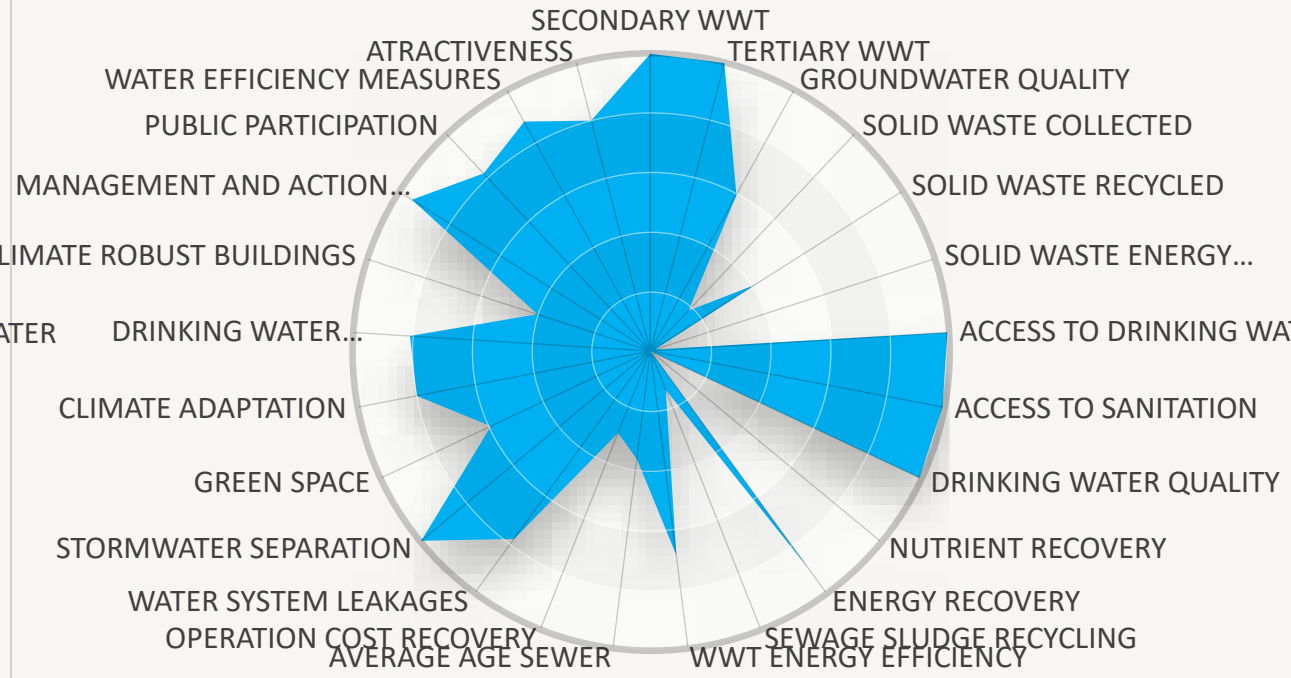
BCI 1.5

Dar es Salaam



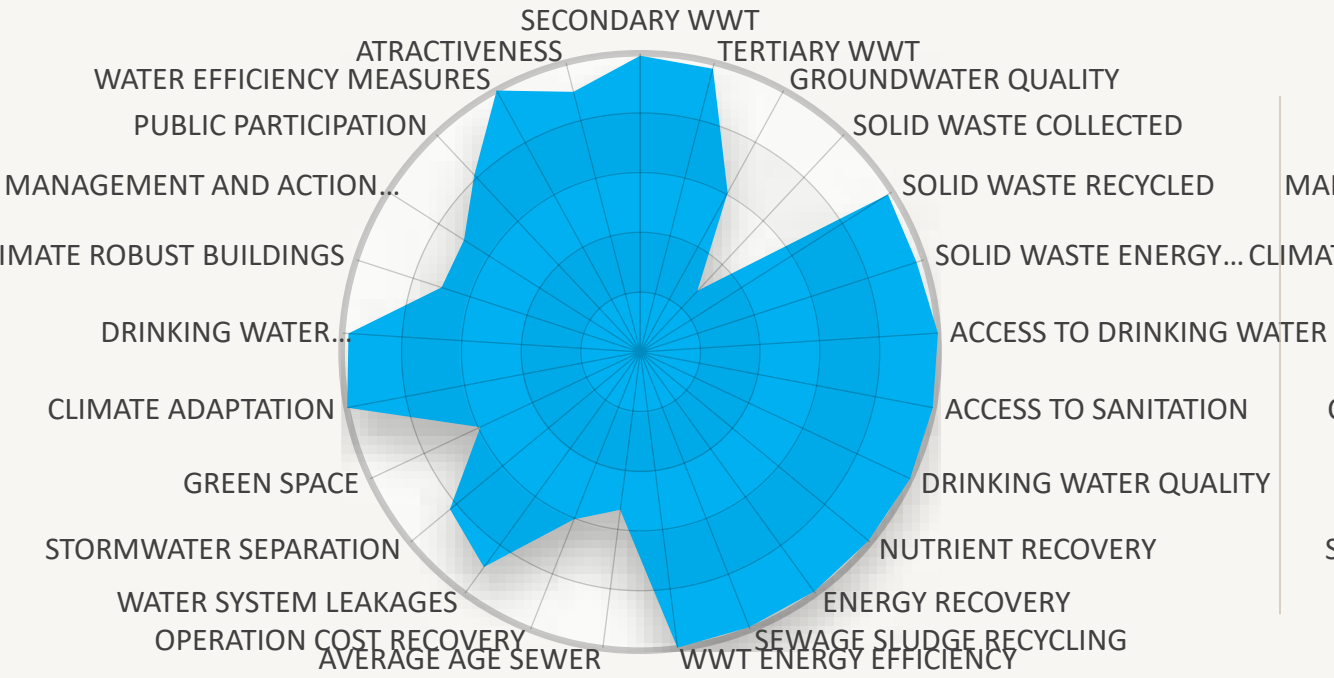
BCI 6.2

Melbourne

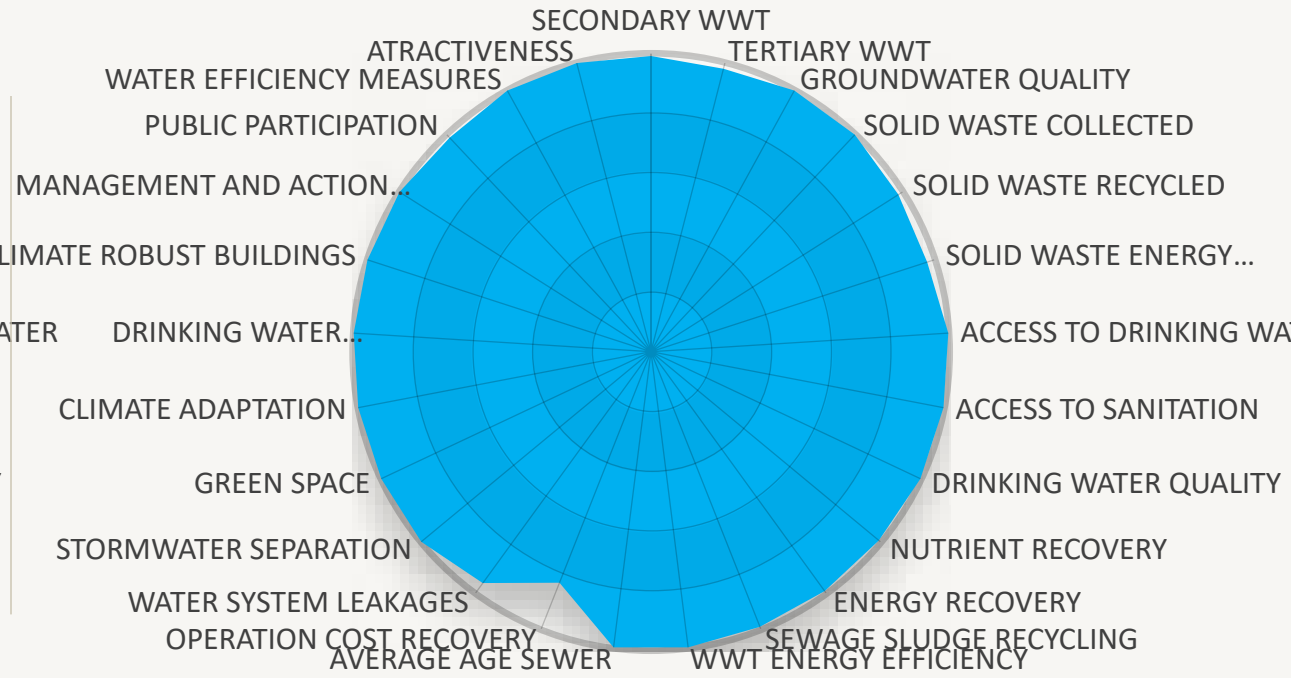


BCI 8.7

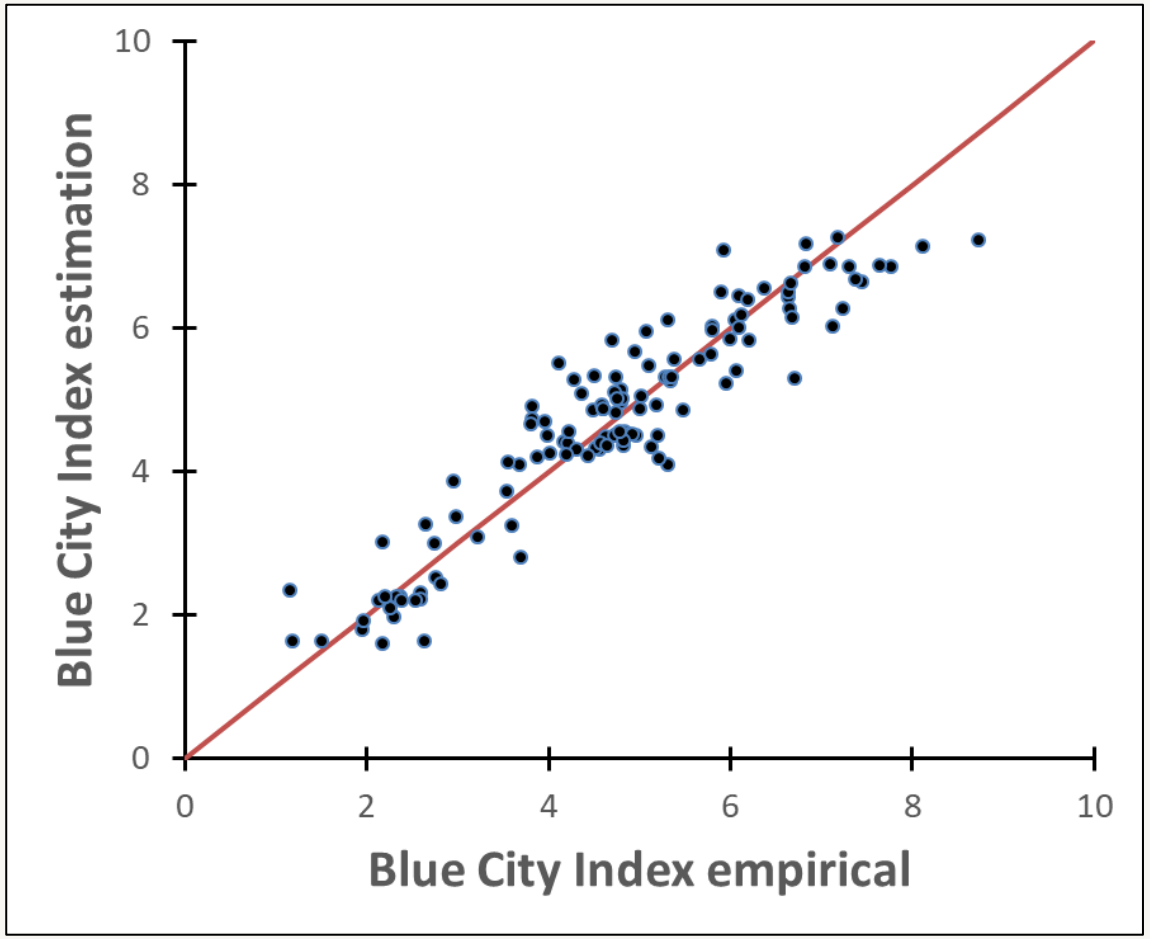
Amsterdam



THE BEST SCORES FOR EACH INDICATOR OF 125 CITIES



Blue City Index can be predicted in a reliable manner

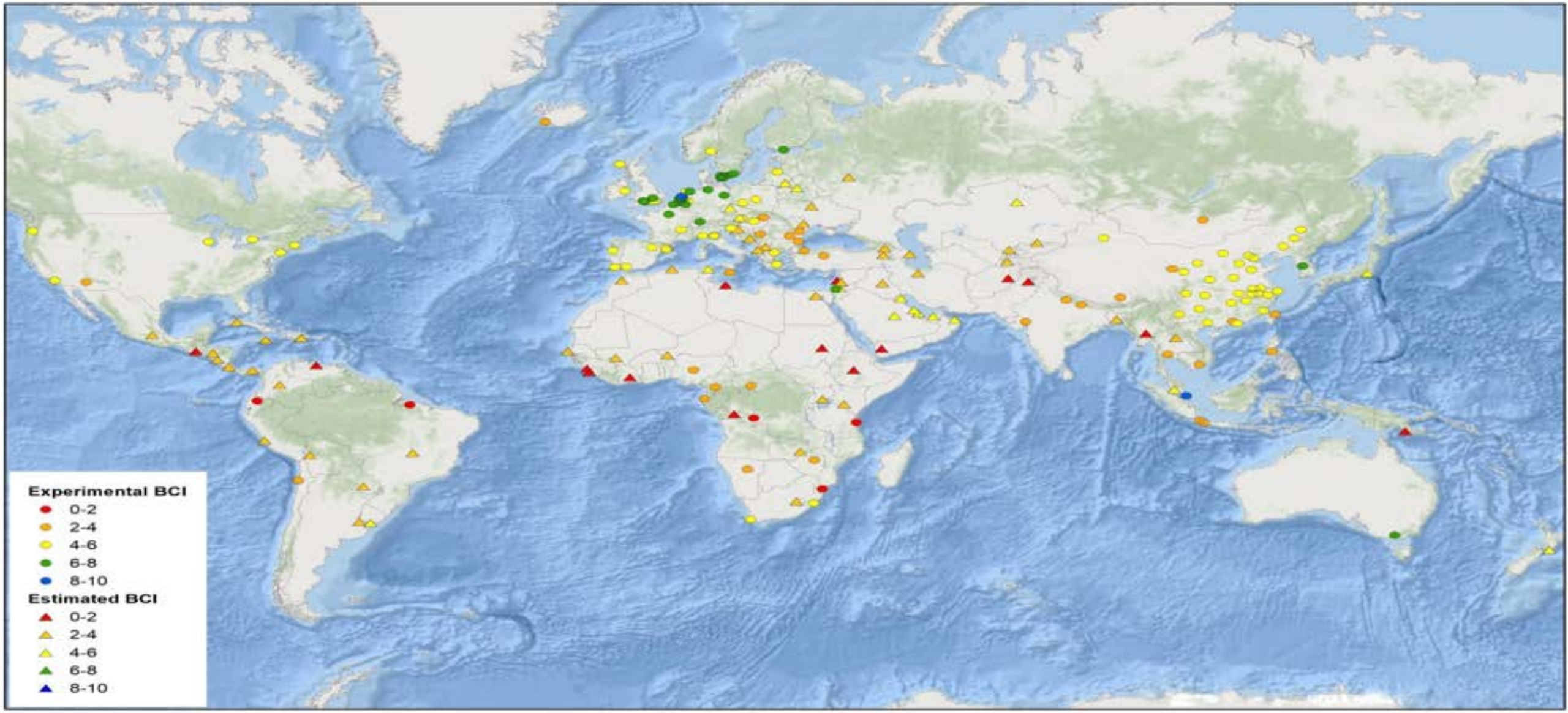


Estimation model developed by Chloe Grison based on 6000 data points

BCI* = *4.25 - 0.396*TPF21 [Government effectiveness] + 0.195*CBF4 [Secondary WWT] + 0.111*CBF8 [Energy recovery]*

With a PI of ± 1.31, with 95% confidence (Adjusted R^2 = 0.827)

Chloé Grison; Stef Koop; Steven Eisenreich; Jan Hofman; I-Shin Chang; Jing Wu; Dragan Savic; Kees van Leeuwen, **Integrated Water Resources Management in Cities in the World: Global Challenges**. *Water Resour Manage* **37**, 2787–2803 (2023). https://doi.org/10.1007/s11269-023-03475-3


Experimental BCI
0-2
2-4
4-6
6-8
8-10
Estimated BCI
0-2
2-4
4-6
6-8
8-10

The project

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- Assess IWRM in African capitals
- Baseline diagnosis of IWRM and Water Governance
- First step in strategic planning of water management and governance
- Training of Young Professionals to use the CBA and connect with stakeholders in the city
- Develop a database on African cities to identify water management priorities and create learning opportunities
- Create political awareness and empower Young Professionals through network building and education.

Approach

1. Preparation
   - Reading material on CBA
   - Initial city scoring based on publicly available data
2. Kick-off webinar
   - French and English webinars to explain CBA method
3. Fieldwork and individual feedback
   - Assessment and connecting to stakeholders
4. Quality assurance
5. Workshop with young professionals
   - Network development
   - Translating results to messages for stakeholders and decision-makers
6. City workshops
7. Follow-up activities

Results – Trends and pressures

Indicator	Abuja	Bangui	Harare	Libreville	Windhoek	Yaoundé
1 Urbanization rate	9.3	5.5	4.8	5.7	9.1	7.8
2 Burden of disease	10.0	10.0	9.0	7.0	6.0	9.3
3 Education rate	9.4	9.7	9.7	9.9	8.2	9.3
4 Female participation	5.2	3.5	2.1	5.4	4.2	2.8
5 Urban drainage flood	5.4	6.9	5.4	7.5	10.0	10.0
6 River peak discharges	0.0	0.0	0.0	0.0	7.5	10.0
7 Sea level rise	0.0	0.0	0.0	0.0	0.0	0.0
8 Land subsidence	0.0	0.0	0.0	0.0	0.0	10.0
9 Freshwater scarcity	1.0	0.0	4.0	0.0	0.0	0.0
10 Groundwater scarcity	2.5	0.0	2.5	0.0	0.0	0.0
11 Sea water intrusion	0.0	0.0	0.0	7.5	0.0	0.0
12 Biodiversity	3.8	3.0	3.2	2.9	5.1	5.8
13 Heat risk	5.0	4.8	5.0	5.0	4.4	0.0
14 Air quality	10.0	8.9	2.9	6.6	3.4	10.0
15 Economic pressure	9.8	10.0	9.8	7.6	9.2	9.9
16 Unemployment rate	4.0	1.4	2.1	10.0	10.0	1.2
17 Poverty rate	8.9	10.0	5.7	0.6	2.2	4.0
18 Investment freedom	5.5	5.5	7.5	4.0	3.5	7.0
19 Voice and accountability	5.8	7.4	7.3	6.9	3.9	7.2
20 Political stability	9.4	9.6	6.4	5.5	3.9	9.6
21 Government effectiveness	7.0	8.4	7.4	6.6	4.8	8.4
22 Regulatory quality	6.8	7.7	8.2	6.8	5.2	6.6
23 Rule of law	6.8	8.4	7.5	6.4	4.4	7.2
24 Control of corruption	7.1	7.5	7.5	6.7	4.3	7.3
TPI	**5.5**	**5.3**	**4.9**	**5.1**	**4.6**	**6.0**

All cities have strong similar and strong pressures, leading to medium concern

High scores for

- 2 Burden of disease
- 3 Education rate
- 15 Economic pressure

Strong governance issues except in Windhoek

Results IWRM

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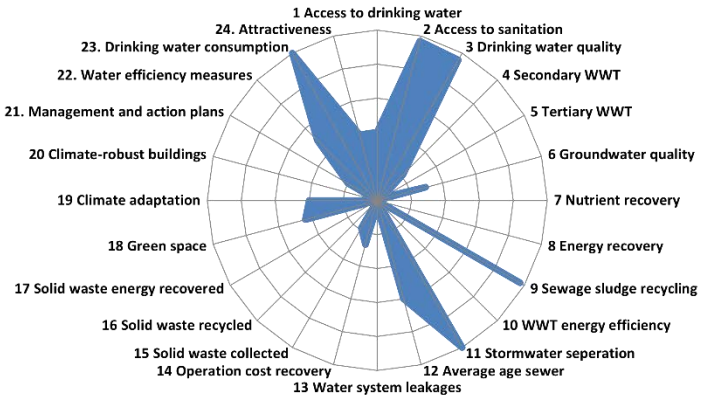
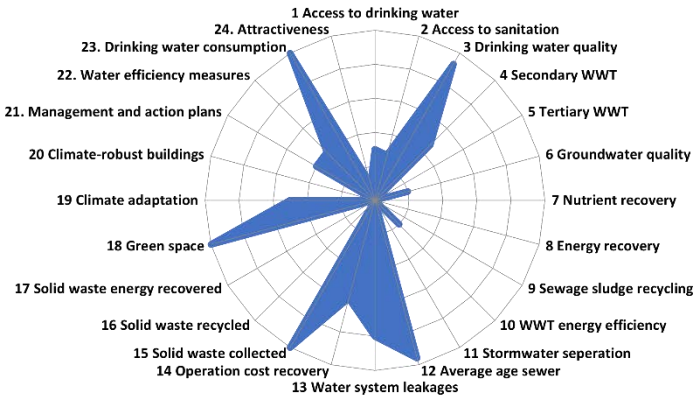
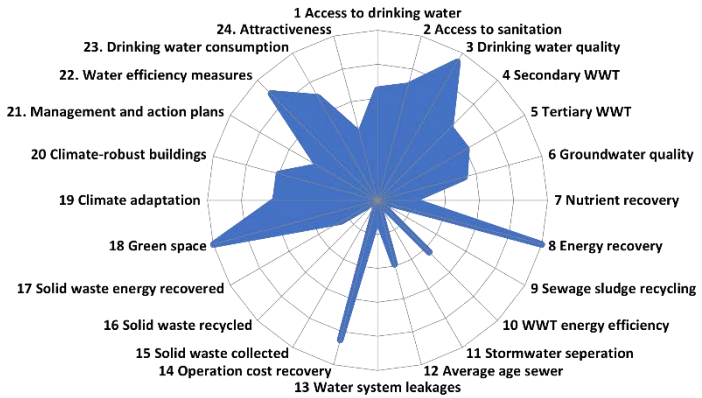
Abuja



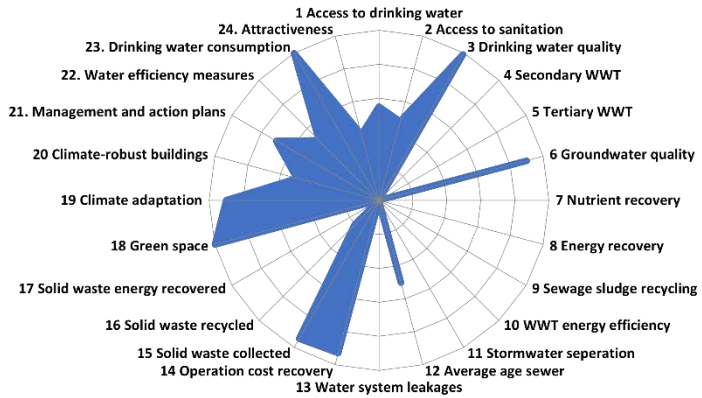
Bangui



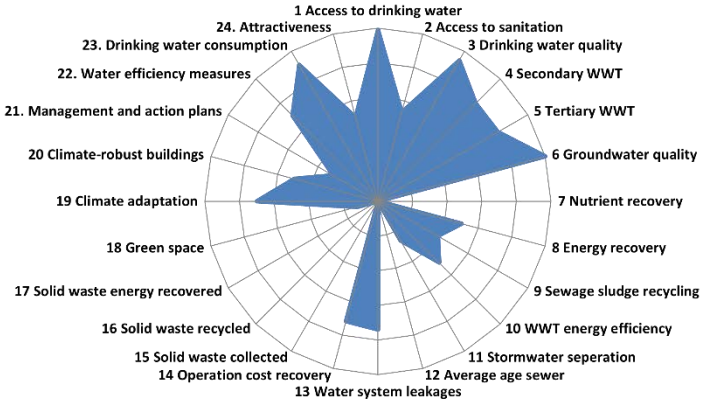
Harare



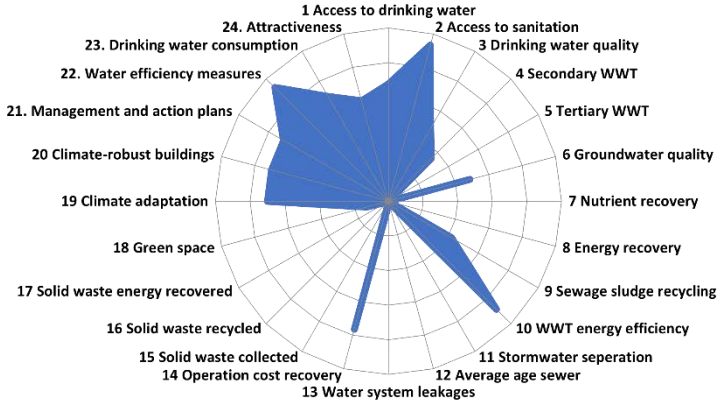
Libreville



Windhoek



Yaoundé



Governance capacity analysis

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Three major challenges: water pollution, flooding, water scarcity

GCA on Water Pollution

- Key role in social and economic development
- Very limited information and monitoring
- Limited effects of policies
- Limited financial resources and human capacity

Investment in strengthening professional expertise is required

Libreville

Strengths: resourcefulness, continued water supply, collaborative approaches

Governance challenges for IWRM:

- Implementation capacity for legislation
- Lack of financial continuation
- Technical expertise
- Accountability

Legislation are Eurocentric, which does not always fit in Namibian context

Windhoek

Governance of Water Scarcity and Urban Heat Island are well developed. Flood risks, wastewater treatment and solid waste are limited

Projects need better monitoring and evaluation, and efforts for cross-stakeholder learning

This will lead to strengthening accountability and compliance

Yaoundé

Synthesis and summary

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Severe urban water management challenges in African capitals

- Access to water supply
- Very limited wastewater treatment
- Solid waste handling
- Climate adaptation is very concerning

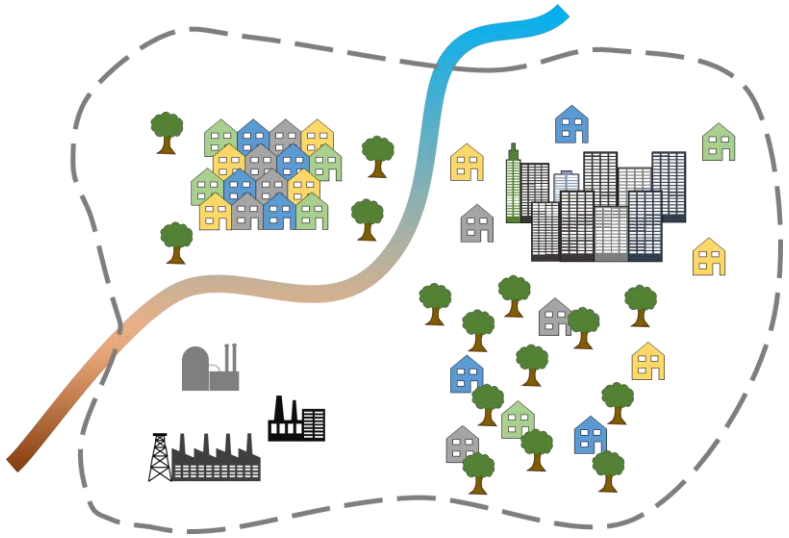
→ Flood risks
Burden of disease

Economic pressure and low political stability are discouraging, lack of data and monitoring are hindering development

The bottom-up approach, empowering young professionals is encouraging.

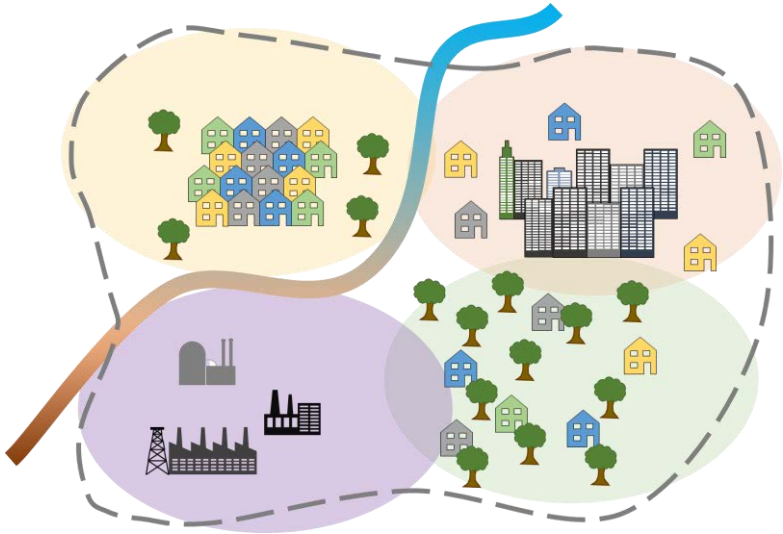
CBA is ideally suited for capacity development and information disclosure

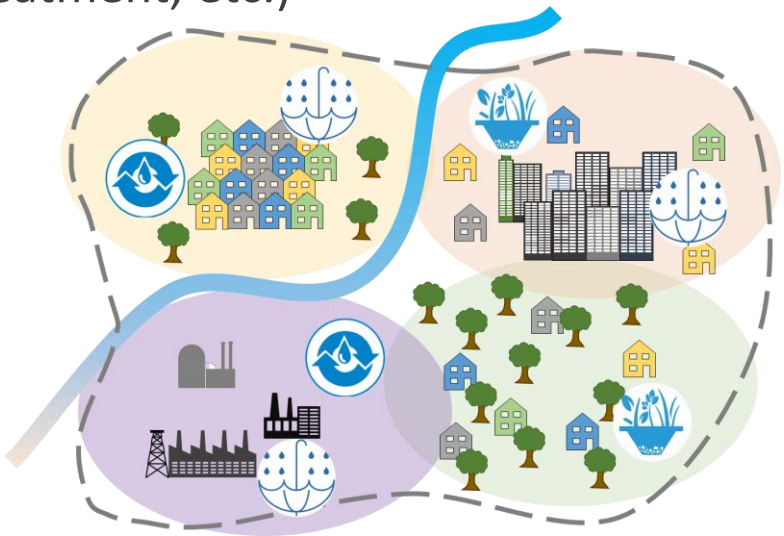
→ Support decision making
Empower local YPs
Transparent, open, verifiable

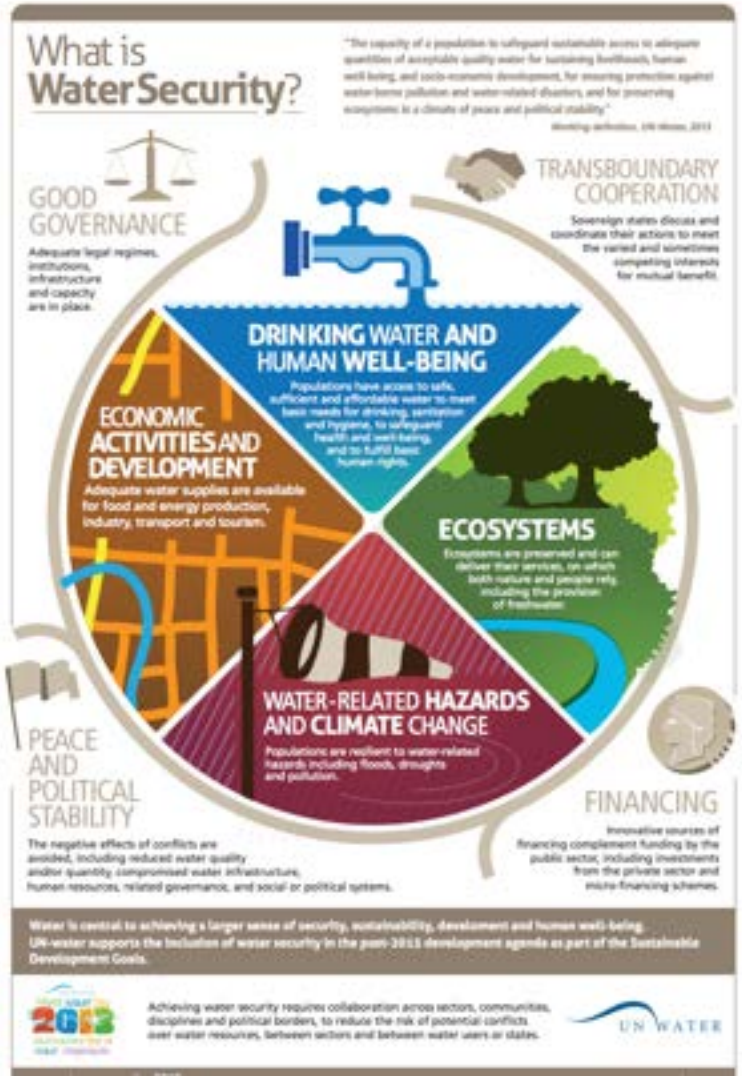


Multi-level assessment approach

- Downscaling the assessment
  - Sectors in the city **- spatial distribution** of water security
- Specific realities and needs
- Guidance for decentralized actions (rainwater harvesting, SUDS, wastewater treatment, etc.)







Urban water security assessment

- Considering the definition from UN-WATER
- Framework based on 4 dimensions - indicators

Economic Activities and Development
Water for economic development
Governance, stakeholders engagement, investments
Socio-economic aspects

Water-related hazards and climate change
Hazards and vulnerability, affected area
Prevention, preparedness and response
Pollution incidents

Drinking water and human well-being
Water quantity and quality
Access to water services and infrastructure reliability
Water recycling/reuse
Hygiene, public health and wellbeing

Ecosystems
Water resources and river health
Pollutants discharge, quality and quantity of effluents
Vegetation cover and biodiversity
Sustainability

Case study

Campinas - Brazil

- Population - 1,213,792 (2020) [3].
- Territory - 794,571 km^2 [3].

(a) Country: Brazil

(b) State: São Paulo

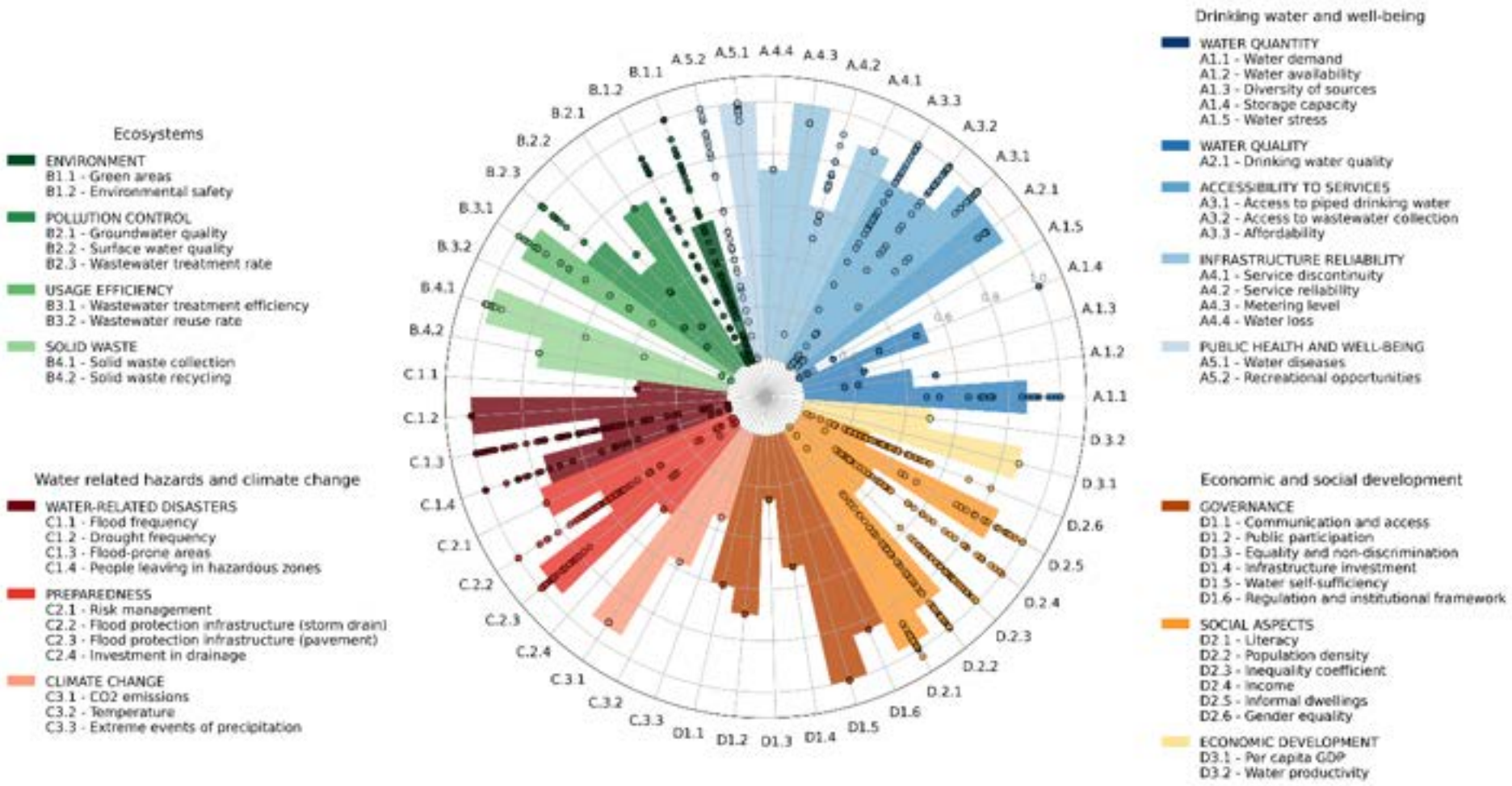
(c) City: Campinas

[3] IBGE - Instituto Brasileiro de Geograa e Estatistica. IBGE - cidades e estados.

Urban Water Security Assessment Framework

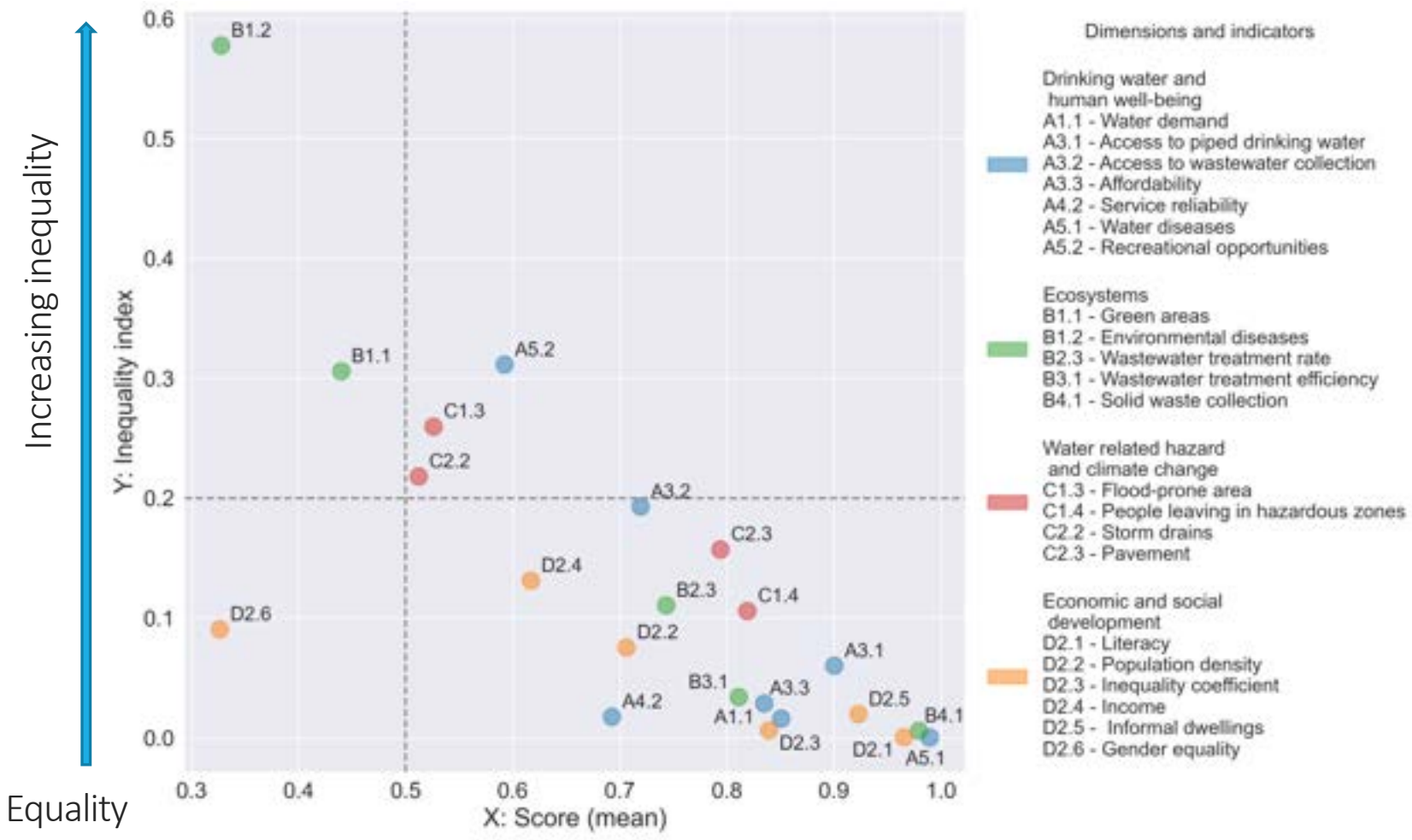
City | Region | Basin | Catchment area | Health coverage | Territorial unit | Survey sector

Multi-level assessment outcome: overview



Urban water security assessment resulting scores for city (bars) and sectors (round markers)

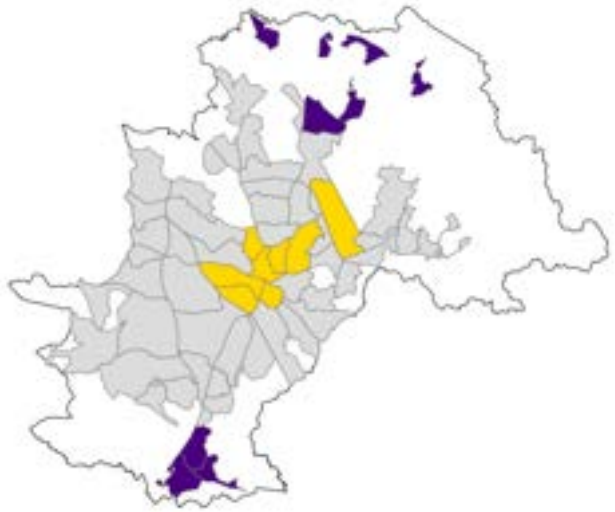
Mapping critical areas: inequality and spatial analysis



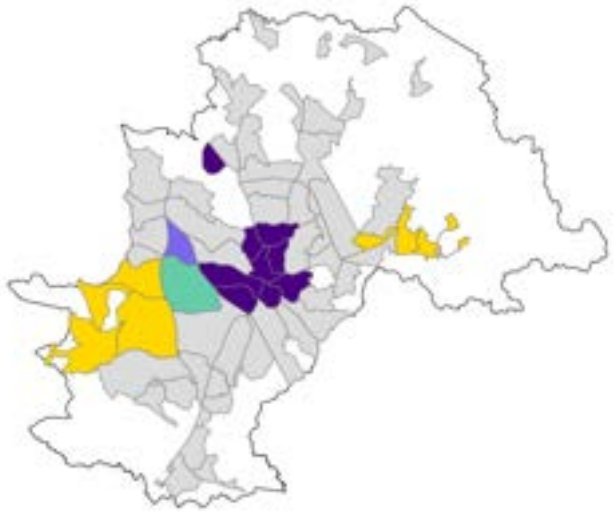
Inequality

Theil index

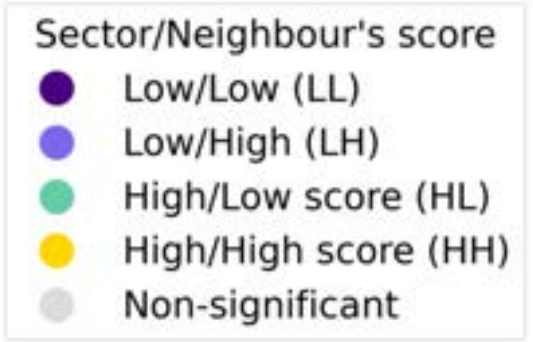
Spatial analysis



Wastewater collection



Green areas



Conclusion

- Holistic and more detailed vision of the city
- Support to communicate water security needs
- Guidance to infrastructure planning
- Development of local initiatives
- Improvement of water security at community/neighbourhood level

Water Security and SDG6

Water Innovation & Research Centre

UNIVERSITY OF BATH