9

Water Security in Sub-Saharan African Cities: City Blueprint Assessment of Abuja, Bangui, Harare, Libreville, Windhoek and Yaoundé

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Abstract

Water Security in African capital cities is extremely challenged by rapid growth and urbanisation, amplified by effects of climate change. In this chapter we describe the baseline assessment of Integrated Water Resources Management (IWRM) and governance capacity of six African capitals: Abuja, Bangui, Harare, Libreville, Windhoek, and Yaoundé. The assessment was done by local young professionals, as part of the internship and/or consultancy at UNESCO field units in these capitals, using the City Blueprint Approach (CBA). The young professionals were trained to collect data, interview important stakeholders and interpret the results. The CBA assesses external trends and pressures, performance of IWRM, and the governance capacity in a city. Furthermore, the project led to the development of an unofficial network of young professionals that empowered them through peer-to-peer learning of best practices in the different cities. After the assessment, the young professionals presented the outcome at workshops with city stakeholders to identify and prioritise the most pressing challenges in the cities. Common issues found in the six cities were: 1) challenging water supply and lack of wastewater treatment, 2) lack of adequate solid waste handling, 3) high burden of disease and flood risk, 4) economic pressure and political instability, 5) lack of data and monitoring constrains the capacity of these cities to address water-related challenges.

Keywords

Integrated Water Resources Management, Water Governance, City Blueprint Assessment, Young Water Professionals, Capacity Development, Urban Water Management

01

Water Management in an Urbanising World

The world is experiencing unprecedented population growth and urbanisation. The global population is expected to increase by 2 billion people, from 7.8 billion in 2020 to a total of 9.8 billion by 2050 (United Nations, 2018). Almost half (46%) of the global growth will take place in sub-Saharan Africa (sSA). Whilst the rural population is still growing, an exponential increase is predicted for cities in sSA reaching an urban population of around 1 billion people by 2050. Figure 9-1 shows the total, rural and urban population projections in sSA. For comparison, the global demographics are shown too.

As cities grow, water demand will grow proportionally and increase the water abstraction from primary water resources. Often, water demand grows even faster than proportional to the population growth, due to rapid economic development in cities. In many cases, local water resources become exhausted and cities have to import their water from other water basins (Richter *et al.* 2013). Therefore, urban growth can have significant regional effects on water resources, which can impact food production as well.

> *“As cities grow, water demand will grow proportionally and increase the water abstraction from primary water resources”*

Forget *et al.* (2021) have used mapping and satellite earth observation techniques to characterize urban expansion in sSA. Their data analysis shows that urbanisation does not occur uniformly in sSA. Smaller urban areas are growing faster than larger ones with growth rates varying from an average of 3.2% in large urban areas to 5.4% in smaller ones between 1995 and 2015.

Urban growth in sSA, which is mainly determined by rural-urban migration and natural population growth, takes place without proportional economic growth (Castells-Quintana and Wenban-Smith, 2020). The main factors for the absence of economic growth are: 1) ‘push conditions’ for migration (such as deteriorating agricultural conditions worsened by climate change, natural disasters or violent conflict); 2) slow development of the urban infrastructure that is lagging behind the urbanisation rate; 3) high urban densities. Castells-Quintana and Wenban-Smith (2020) conclude that there is a fundamental importance of investing in urban infrastructure in the context of rapid urban expansion and demographic transformation to ease pressures of population growth. This is confirmed by work of Visagie and Turok (2020) who conclude that 78% of the residential areas in sSA that were developed between 1990 and 2014 are informal and unplanned. They suggest an upwards rebuilding of these areas, instead of growing outwards, can create space for municipal services and economic activities. However, this requires collaboration between the government and the communities to support, as well as decentralized finance and simplified regulations, to enable pragmatic and tailored approaches.

Chitonge (2020) concludes that water scarcity in Africa is

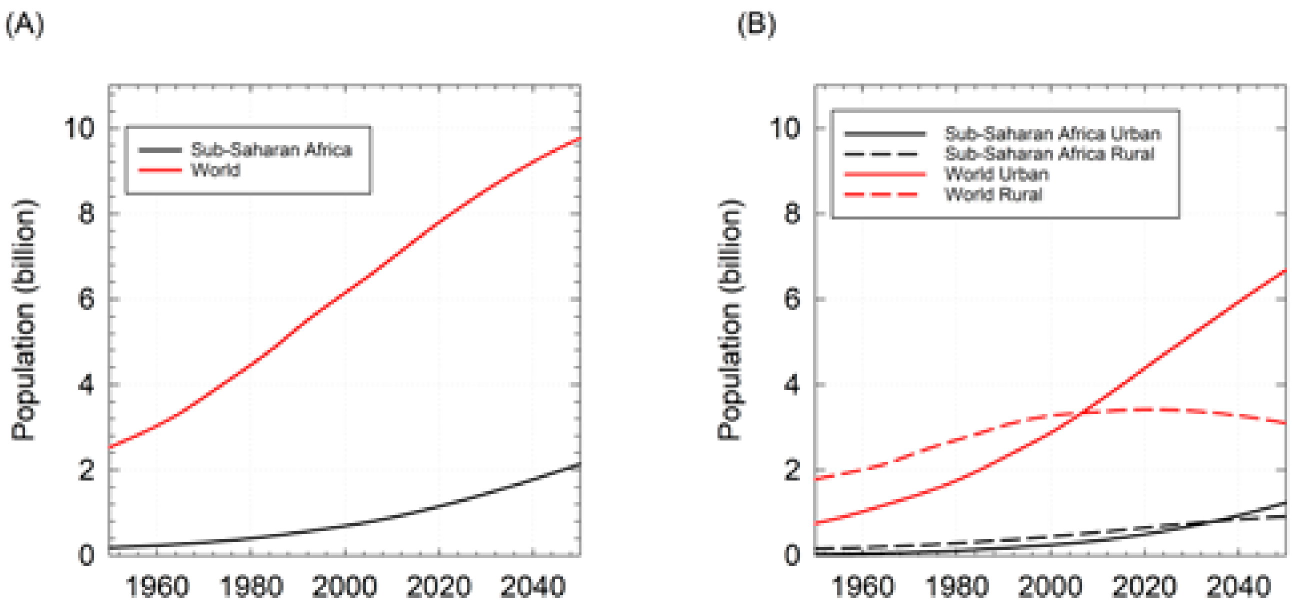


Figure 9-1 *Population growth in sub-Saharan Africa and the world. (A) Total, (B) Rural and Urban individually. (United Nations, 2018)*

broader than only the physical mismatch between supply and demand and goes beyond the availability of sufficient water resources in the natural environment.
Human-induced scarcity factors (racial, spatial, gender, age, nationality, or ethnic inequality, poor governance, weak institutions, unequal power relations) are equally important. The author observes that a push to urbanisation exists because of the inability of the rural economy to provide adequate employment.

From the above, it may be clear that it is important to act and develop plans for Integrated Water Resources Management (IWRM) and governance to enable long-term water security in sSA.

In this chapter, we describe our initiative to utilise the City Blueprint Approach for baseline assessment of IWRM and governance in sSA capital cities and to develop a bottom-up approach for capacity development with local young water professionals. The project also created the foundation for a city-to-city learning network. We describe the results for six cities which were assessed in 2019 and 2020: Abuja, Bangui, Harare, Libreville, Windhoek, and Yaoundé.
Four more cities are being assessed (Fall, 2021): Abidjan, Nairobi, Lagos and Lusaka, but their assessment results could not be included in this chapter.

02

City Blueprint Approach

The City Blueprint Approach (CBA) is a methodology for baseline assessment of the sustainability of IWRM in cities and urban areas. Since its initial conceptualization over 10 years ago, the CBA has evolved in a mature and easy to understand method (Koop *et al.,* 2017; Koop and Van Leeuwen 2015a; 2015b; Van Leeuwen and Chandy, 2013; Van Leeuwen *et al.,* 2012; Van Leeuwen *et al.,* 2016). Important reviews of the methodology took place in 2015 and in 2017 when the method was expanded to include the assessment of trends and pressures and water governance capacity respectively. Finally, in 2019, some simplifications were introduced. By mid-2021, 135 cities have been assessed in 57 countries from which a large dataset has been developed that can act as a benchmark for comparing water management performances and governance capacities of cities (KWR, 2021).

The current CBA comprises three complementary frameworks that each come with their own set of indicators (See Figure 9-2).

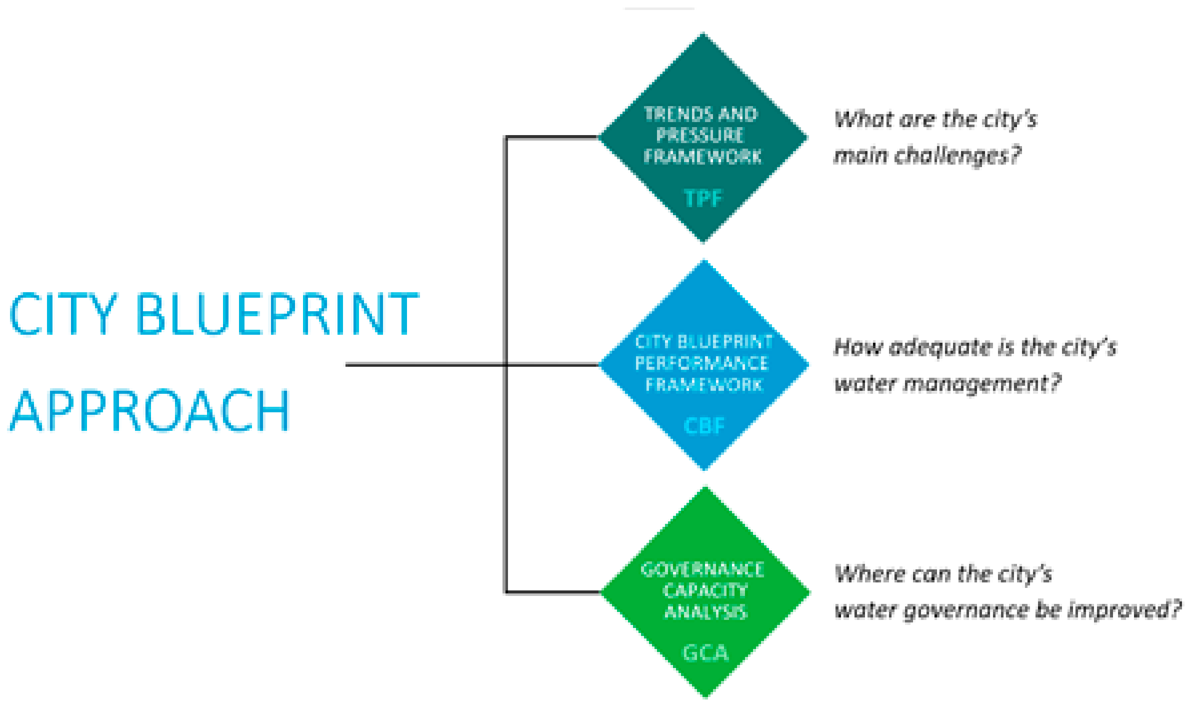


Figure 9-2 Three complementary diagnostic assessment frameworks of the City Blueprint Approach (Koop and Van Leeuwen 2015a; 2015b; 2017)

2.1. Trends and Pressures Framework

The Trends and Pressures Framework (TPF) (Koop and Van Leeuwen, 2021c) assesses the main external pressures that are beyond the sphere of influence of city planners and water managers. It comprises in total 24 indicators in four categories: social, environmental, financial pressures, and governance, i.e., the World Bank governance indicators. An overview of all indicators is given in Table 9-1. Table 9-2 introduces the scoring interpretation of the TPF indicators. The TPF can be aggregated into a Trends and Pressures Index (TPI) by calculating the average of all 24 indicators.

The 24 TPF indicators are standardised to a scale of 0–10 and divided into ordinal classes expressed as a 'degree of concern' and shown in Table 9-2.

Table 9-2 Scoring of the TPF indicators as a degree of concern

TPF indicator score	Degree of concern
0 – 2	no concern
2 – 4	little concern
4 – 6	medium concern
6 – 8	concern
8 - 10	great concern

$$TPI = \frac{1}{24} \sum_{i=1}^{24} TPFi$$

Table 9-1 Overview of the TPF categories and indicators

Category	Indicators	
I Social	1 Urbanisation rate	
	2 Burden of disease	
	3 Education rate	
	4 Female participation	
II Environmental	Flood risk	5 Urban drainage flooding
		6 Sea level rise
		7 River peak discharges
		8 Land subsidence
	Water scarcity	9 Freshwater scarcity
		10 Groundwater scarcity
		11 Seawater intrusion
	Water quality	12 Biodiversity
	Heat risk	13 Heat island
	Air quality	14 Particulate Matter2.5/10
III Financial	15 Economic pressure	
	16 Unemployment rate	
	17 Poverty rates	
	18 Investment freedom	
IV Governance	19 Voice and accountability	
	20 Political stability	
	21 Government effectiveness	
	22 Regulatory quality	
	23 Rule of law	
	24 Control of corruption	

2.2. City Blueprint Framework

The City Blueprint Framework (CBF) framework (Koop and Van Leeuwen, 2021a) consists of 24 indicators divided over seven main categories: I basic water services, II water quality, III wastewater treatment, IV water infrastructure, V solid waste, VI climate adaptation, and VII plans and actions. An overview of the CBF indicators is presented in Table 9-3 below. In the application of the CBF, 24 indicators are standardised according to the scale of zero to ten in which ten points implies an excellent score and zero points indicates a high improvement potential.
This is done by comparing the values from an international range using natural boundaries of zero and 100%, or by using ordinal classes; often the Min-Max method is applied:

$$\textit{Indicator score} = 10\ X\ \frac{\textit{value - minumum value}}{\textit{maximum value - minimum value}}$$

The CBF can be aggregated into a Blue City Index (BCI) by calculating the geometric mean of the indicators.

$$BCI = 10\ X\ \sqrt{(a_1+1)\ X\ (a_2+1)\dots\ (a_1+1)} - 1$$

Table 9-3 The CBF categories and indicators

Category	Indicator
I Basic water services	1 Access to drinking water
	2 Access to sanitation
	3 Drinking water quality
II Water quality	4 Secondary wastewater treatment
	5 Tertiary wastewater treatment
	6 Groundwater quality
III Wastewater treatment	7 Nutrient recovery
	8 Energy recovery
	9 Sewage sludge recycling
	10 Wastewater treatment energy efficiency
IV Water infrastructure	11 Stormwater separation
	12 Average age sewers
	13 Water system leakages
	14 Operation cost recovery
V Solid waste	15 Municipal solid waste collected
	16 Municipal solid waste recycled
	17 Municipal solid waste energy recovered
VI Climate adaptation	18 Greenspace
	19 Climate adaptation
	20 Climate robust buildings
VII Plans and actions	21 Management and action plans
	22 Water efficiency measures
	23 Drinking water consumption
	24 Attractiveness

2.3. Governance Capacity Framework

The Governance Capacity Framework (GCF) (Koop and Van Leeuwen, 2021b) is a framework to assess the governance capacity to address water-related challenges and consists of three dimensions, nine key conditions, and 27 indicators (Koop, 2019; Koop *et al.,* 2017). The framework assesses how well stakeholders collaborate to govern a water challenge. The water challenges addressed can differ from location to location, but the most often assessed challenges are water scarcity, flood risk, wastewater treatment, solid waste handling and urban heat islands.
These are frequently recurring challenges of growing importance due to progressing climate change and urbanisation. Other challenges that have been addressed are water reuse (Šteflová *et al.,* 2018), water desalinization, and circular economy challenges (Ddiba *et al.,* 2020).

The 27 indicators all have a specific pre-defined question that an independent researcher needs to answer based on standardised requirements and procedures (Table 9-4).
The answers provide the basis for the indicator score based on a Likert-type scale (– – to ++) which is specific for each indicator. To perform the GCF assessment, a three-step method is applied:

1. An analysis of policy documents and reports provide preliminary scores of the 27 indicators.

2. At least 10-15 interviewees need to be selected that represent the stakeholders involved.
The most relevant stakeholders are identified, their interdependencies are plotted, and key persons from different levels of decision-making are selected.
There are 27 predefined questions that the research needs to answer, one for each indicator. Interviewees are asked specifically about the governance challenges.
The questions are open, non-technical, with follow-up questions to either target specific elements or for further clarification.

3. After the interviews, the participants receive the preliminary indicator score substantiations for each of the predefined questions and are asked to provide constructive feedback and additional information that can be included in the final scoring. Once this feedback is incorporated, the assessment is completed.

Table 9-4 Dimensions, conditions and indicators of the Governance Capacity Framework

Dimensions	Condition	Indicators
Knowing	1 Awareness	1.1 Community knowledge 1.2 Local sense of urgency 1.3 Behavioural internationalisation
	2 Useful knowledge	2.1 Information availability 2.2 Information transparency 2.3 Knowledge cohesion
	3 Continuous learning	3.1 Smart monitoring 3.2 Evaluation 3.3 Cross-stakeholder learning
Wanting	4 Stakeholder engagement process	4.1 Stakeholder inclusiveness 4.2 Protection of core values 4.3 Progress and variety of options
	5 Management ambition	5.1 Ambitious and realistic management 5.2 Discourse embedding 5.3 Management cohesion
	6 Agents of change	6.1 Entrepreneurial agents 6.2 Collaborative agents 6.3 Visionary agents
Enabling	7 Multi-level network potential	7.1 Room to manoeuvre 7.2 Clear division of responsibilities 7.3 Authority
	8 Financial viability	8.1 Affordability 8.2 Consumer willingness to pay 8.3 Financial continuation
	9 Implementing capacity	9.1 Policy instruments 9.2 Statutory compliance 9.3 Preparedness

03
City Blueprint assessment in African capitals

3.1. Aims and Objectives

The project aimed to assess Integrated Water Resources Management (IWRM) in sub-Saharan African capital cities. The assessment provides a baseline diagnosis and a first step in the strategic planning process to improve water management and governance. As an additional objective, young African experts were trained in utilizing the CBA and use its results to initiate a strategic planning process with stakeholders in the city. In this way, we demonstrated that young professionals can build up a CBA database on African cities to identify water management priorities, learning opportunities, and select the most viable solutions. The process creates political awareness and empowers young professionals through network-building and education.

3.2. Cities

The cities included in this project were Abuja (Nigeria), Bangui (Central African Republic), Harare (Zimbabwe), Libreville (Gabon), Windhoek (Namibia), and Yaoundé (Cameroon). All cities were capitals and were selected based on availability of young professionals to conduct the research locally as part of their internship or consultancy and the presence of support from the UNESCO Programme Specialists who facilitated the process. A full description of the cities can be found in Appendix.

Figure 9-3 *Cities assessed in this study*

> *“Young professionals can build up a database to identify water management priorities, learning opportunities, and select the most viable solutions.”*

3.3. Approach

The CBA assessments in Abuja, Bangui, Harare, Libreville, and Yaoundé were completed by young professionals that are well-acquainted with the city of assessment. They were contracted by UNESCO field units and have a background in water or environmental sciences. The assessments have been completed by either one or two young professionals, each with a local supervisor as well as support from UNESCO headquarters, field units and KWR Water Research Institute. The Windhoek assessment was undertaken by a young professional from the University of Bath, in collaboration with the local UNESCO Windhoek office. The local supervisors supported the work and particularly supported reaching out to local organizations and stakeholders for data collection and, at the later stage, constructive discussions of the initial results.

The young professionals started their fieldwork in September 2019 and completed their work in March 2020. Windhoek was assessed between June and September 2020.

Based on standardised questionnaires for the three assessment frameworks (TPF, CBF and Governance Capacity Assessment (GCA)) which specify the indicator's rationale and scoring method (Koop and Van Leeuwen, 2021a; 2021b; 2021c), the following steps were taken (Koop *et al.,* 2020):

> *"To clearly delineate the different communities' boundaries and identify their members, a consensus on the list of water users needed to be established"*

1. **Preparation period**: Young professionals in each city first studied a set of reading materials on the City Blueprint Approach's rationale, methodology and applications. Simultaneously they already started the indicator assessment as specified by the questionnaire. Through consulting public reports, websites, policy documents or scientific studies they already provided preliminary scores of the indicators for which information was publicly available. The young professionals were also encouraged to prepare questions about the indicator scoring, rationale, and reporting or data demands for validation of the data with stakeholders.

2. **Kick-off webinar**: Online webinars, one in English and one in French, were organized by UNESCO headquarters and KWR Water Research Institute. A presentation on the methodology was provided and detailed instructions on conducting the assessment were presented. Next, the questions of the young professionals were discussed. An online web environment was created to store and share information about each city as well as general information.

3. **Fieldwork and individual feedback sessions**: The young professionals completed the assessment through elaborate networking with local authorities, facilitated by UNESCO, developing alternative methods or information sources to score particular indicators. Regular email contact with KWR and UNESCO supported this process. In addition to the kick-off webinar, feedback sessions for each city were organized to go through every detail and discuss how to deal with methodological and practical barriers.

4. **Quality assurance**: The assessment reporting included the indicators scores' calculation, methodological reporting and substantiation, as well as detailed referencing of consulted documentation, stakeholder visits and the like. KWR provided detailed quality assurance and for some indicators requested some clarifications, additional information or guidance. A second revised version of the indicator scores was then provided in preparation for step 5.

5. **Workshop at the African Water Association Conference in Kampala** (February 2020): In preparation for this workshop, the young professionals were asked to prepare a presentation of their findings and also to present their key recommendations for local authorities. In this two-day session, young professionals from all the five cities sat together to answer two key questions. Firstly, how can other young professionals in the future be empowered with the experiences of these young professionals to assess all African Capital cities? Secondly, in what way can the key results be translated into messages that can be taken up by local authorities and decision-makers?

6. **City workshops**: In most cities, a workshop with local decision-makers was held. Here the assessment results were presented, followed by a discussion on how the city can best improve its water management performances.

04

Results and Discussion

4.1. Trends and Pressures

The Trends and Pressures Indices (TPIs), of the six cities are shown in Table 9-5, where they are compared to other cities in Africa that were previously assessed. The detailed TPF results are shown in Table 9-6, giving a full overview of all indicators. The results show remarkable similarities and indicate that for all cities strong pressures exist, leading to TPI values that are indicating a medium concern. In all cities, high scores were found for the indicators 2 – Burden of disease, 3 – Education rate, and 15 – Economic pressure, indicating pressures for citizens and the water sector in these cities. In all cities except Windhoek, the Governance indicators of the TPF also show high scores, indicating that strong governance challenges exist in these cities.

“There are significant social, environmental, financial and governance concerns that both complicate and emphasize the need for improved water management”

The results mean that there are significant social, environmental, financial and governance concerns that both complicate and emphasize the need for improved water management in the six cities. There is an urgent need for improving the water governance structures to develop effective management strategies to improve IWRM.

Table 9-5 Trends and Pressure Indices for some African urban areas.

City	TPI
Dar es Salaam	6.1
Kilamba Kiaxi	7.0
Maputo	4.3
Cape Town	5.2
Durban	5.0
Abuja	5.5
Bangui	5.3
Harare	4.9
Libreville	5.1
Windhoek	4.6
Yaoundé	6.0

4.1.1 Abuja

The TPF scores of Abuja show that the city is facing many challenges in its water management. Seven indicators have values that qualify as ‘great concern’, including most of the social indicators, economic pressure, and political stability. Also, air pollution is a great concern.
In addition, the governance indicators are at a level that that qualifies as ‘concern’. The indicators show that adequate interventions are required by the relevant institutions and stakeholders to develop effective water management and leadership which can gradually tackle the pressures.

4.1.2. Bangui

The city of Bangui shows a similar scoring as in Abuja.
Again, here the social indicators, financial pressures and governance factors are scoring to indicate ‘concern’ or ‘great concern’. Also, air quality is of great concern.

4.1.3. Harare

Similarly, Harare faces trends and pressures that will form a barrier to realising effective water management. There are substantial social pressures from disease and low education rates, financial pressures and, again, governance challenges.

4.1.4. Libreville

Trends and pressures in Libreville show great concerns for education and unemployment, but also many of the other parameters are at a concerning level, including the burden of disease, economic pressure, and regulatory quality.

4.1.5. Windhoek

The city of Windhoek shows a TPF scoring profile that deviates from the other cities, with better scores on governance, albeit with medium concern scores in this area. Some indicators are also showing great concern, mainly in the area of economics and unemployment. Also, some social indicators are showing values of great concern.

4.1.6. Yaoundé

Yaoundé has nine indicators that are at a great concern level, again including social issues, but also some of the environmental pressures, including flood risks and land subsidence, are at a high level. Also, air pollution is included in this list. As in the other sSA cities, there are economic pressures and governance issues, in particular political stability. These pressures hamper adequate water management.

Table 9-6 Trends and Pressure Indices for some African urban areas (for colour coding see Table 9-2)

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**

4.2. Integrated Water Resources Management

The effectiveness of water management practices in the six cities was assessed using the City Blueprint Framework. The results are shown in Figure 9-4 and the corresponding aggregated Blue City Indices or BCIs are shown in Table 9-7. The spider diagrams give an immediate graphical overview of the assessment results. In the CBF, a high score means better IWRM performance. For the spider web this means 'the bluer the better'.

The spider diagrams of the six assessed cities indicate that all cities have different characteristic performances for the different aspects. Abuja, Bangui, and Libreville have only limited access to drinking water; Harare and Yaoundé have moderate access, whilst Windhoek has relatively good access to drinking water. The drinking water quality delivered is challenging in most cases. Secondary and tertiary wastewater treatment systems are often not present in the cities. An exception for wastewater treatment is observed in Windhoek and, to some extent, in Harare.

Solid waste is an important issue in most cities. In some cities, solid waste is collected, but recycling and energy recovery from solid waste are absent in all cities.

In terms of climate change and climate-robust buildings, the scores are low to moderate.

Table 9-7 *Blue City Indices for African urban areas including the six cities assessed in this study*

City	BCI
Abuja	3.3
Bangui	3.3
Cape Town	5.0
Dar es Salaam	1.5
Durban	5.0
Harare	4.7
Kilamba Kiaxi	1.2
Libreville	3.5
Maputo	2.0
Windhoek	3.5
Yaoundé	3.7

4.2.1. Abuja

The data for the CBF assessment were from public sources or provided by regional authorities such as the water utilities in the city. Nevertheless, for some indicators, it was difficult to obtain data, including energy and nutrient recovery from wastewater (indicators 8, 9) and solid waste handling (indicators 15 to 17).

A few indicators score high, such as access to sanitation, drinking water quality and consumption, sewage sludge recycling, and stormwater separation, but most indicators show low scores of around or below 4 points.
This indicates that many water management areas require significant improvement.

4.2.2. Bangui

Bangui shows excellent scores for drinking water supply: water quality is good, water system leakages and drinking water consumption all have high scores. Nevertheless, access to drinking water has a very challenging low score.
Also, there were high scores for sewer assets age, meaning that the existing infrastructure is rather obsolete.
In addition, access to sanitation is poor. Solid waste collection and green spaces show very promising high scores.
Major challenges in Bangui are exerted from the absence of wastewater treatment and solid waste processing, as well as a lack of climate-robust buildings.

4.2.3. Harare

From the CBF in Harare, it can be concluded that the city has major challenges around access to drinking water and sanitation. On the other hand, the system provides high-quality drinking water, for which use efficacy measures are in place. Also, wastewater treatment is available to some extent, including energy recovery. Operation cost recovery scores well, which is an important advantage to enable further improvements.

4.2.4. Libreville

Libreville scores very well on issues such as drinking water quality and groundwater quality due to limited use of groundwater resources and little monitoring.
Operation cost recovery, solid waste collected, green space, climate adaptation and drinking water consumption score rather high as well. Hence, the city has an opportunity to develop in a more flood-proof city by preventing blocking of water ways by solid waste and improving urban drainage.
Access to sanitation, wastewater treatment, water network infrastructure, and solid waste handling are however major challenges for the city.

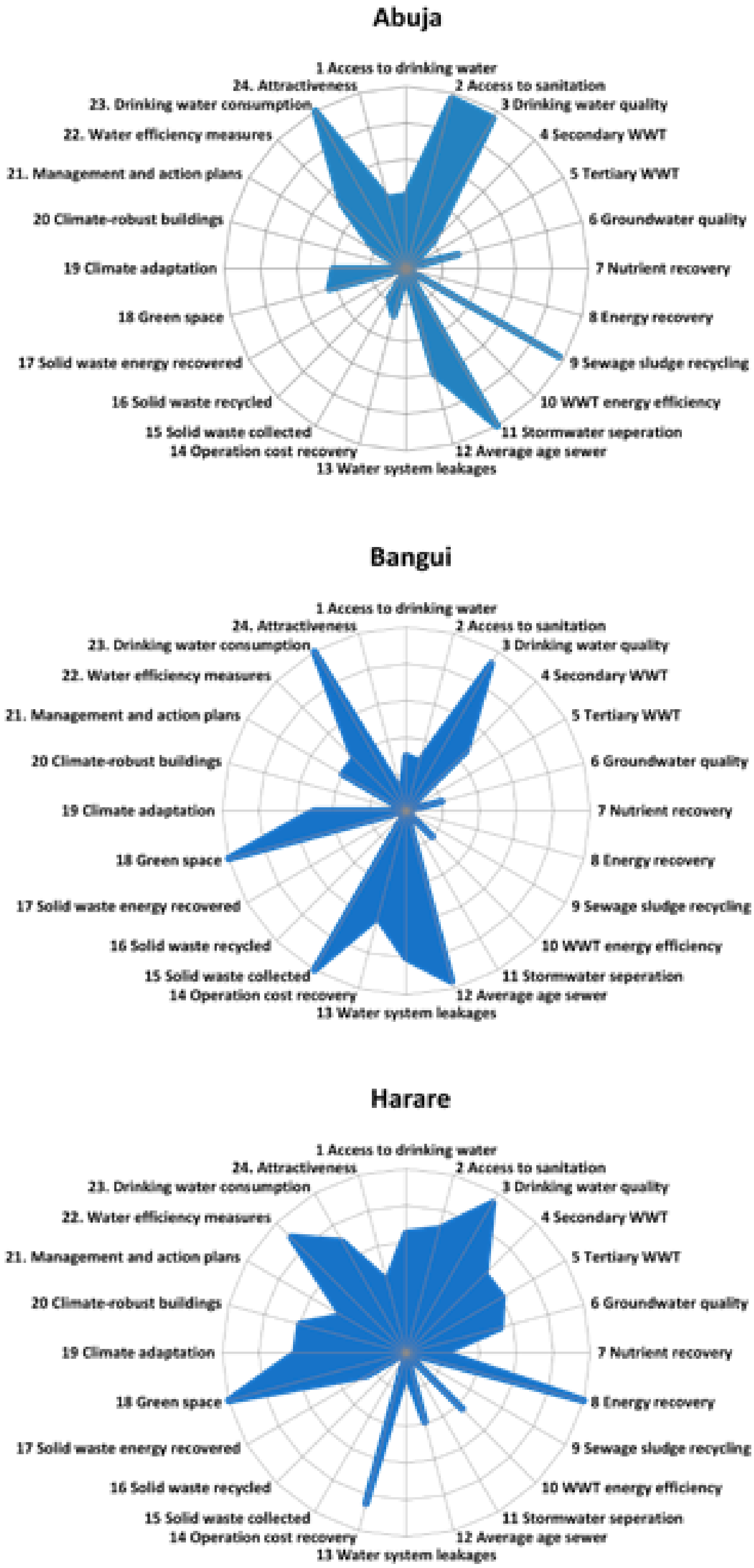
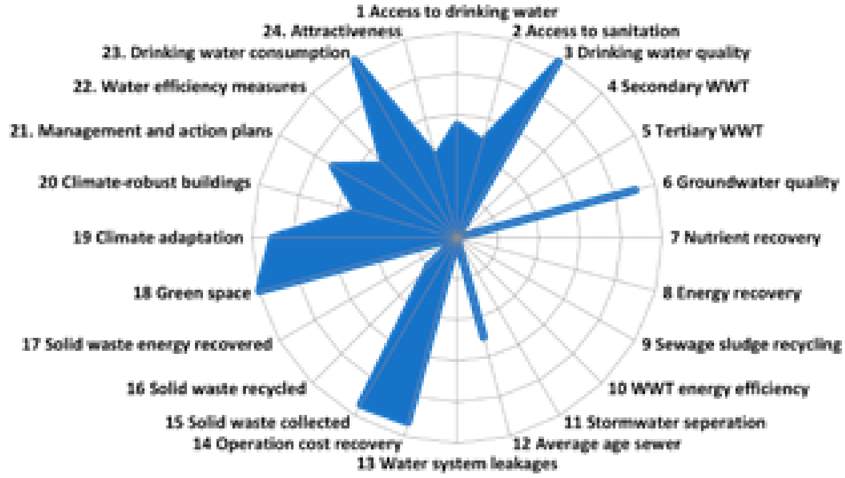
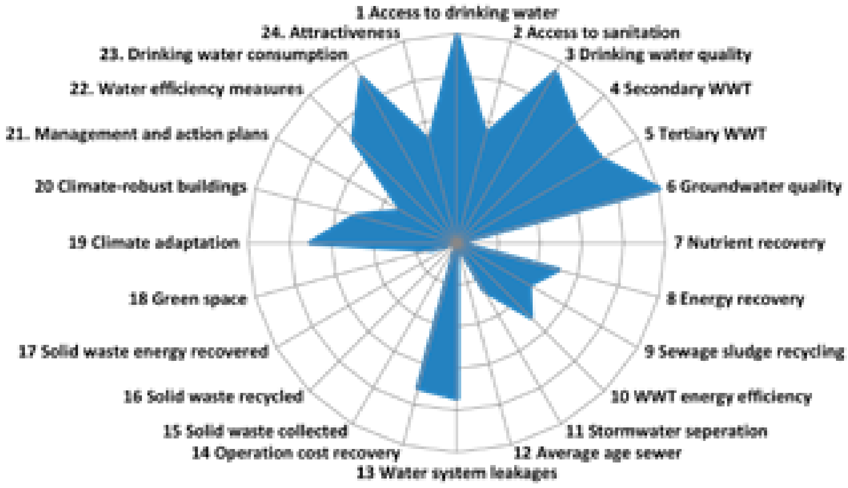


Figure 9-4 *City Blueprint Framework (CBF) spider diagrams for Abuja, Bangui, Harare, Libreville, Windhoek, and Yaoundé. Scores run from 0 (center) to 10 (outer circle), with higher scores for higher performance (more blue indicates higher scores)*

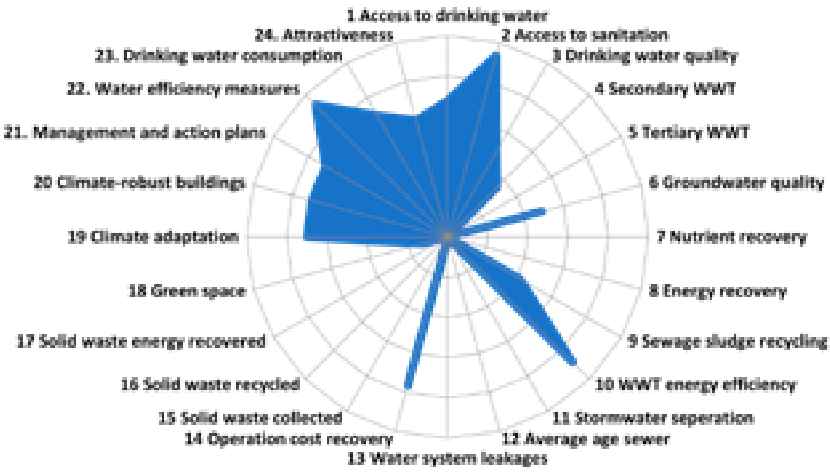
Libreville



Windhoek



Yaoundé



4.25. Windhoek

The City of Windhoek has good access to drinking water, which has a good quality rating and is used efficiently, driven by drought episodes over the last few decades.
Also, wastewater treatment in Windhoek scores well, although access to sanitation is lagging with a lower score. Also, aspects such as nutrient and energy recovery could be improved given the high scores for wastewater handling.

4.2.6. Yaoundé

Yaoundé scores relatively well in drinking water consumption, although drinking water quality is poor.
Moderate scores are found for water efficiency as well as climate actions. Wastewater treatment is absent and no nutrients or energy recovery from wastewater occurs. Green spaces in the city also score extremely low.
In addition, many people live in flood prone areas and sewers are regularly clogged by solid waste. Hence, Yaoundé is a rather flood-prone city.

4.3. Governance Capacity Assessment

The Governance Capacity Assessment (GCA) was conducted in three cities: Libreville, Windhoek, and Yaoundé. Unfortunately, due to the COVID-19 pandemic, the GCA could not be executed to the full extent and much of the data collection and stakeholder interviews had to be done remotely with digital communication tools.
Nevertheless, the GCA delivered interesting and important results (See Figure 9-5).

4.3.1. Libreville

The city of Libreville faces three key water-related challenges: i. water pollution, ii. flooding and iii. water scarcity.
Due to the restriction caused by the pandemic, only water pollution could be fully assessed by the GCA. Particularly water pollution issues are playing a key role in social and economic development in the city.
The GCA assessment however shows that the availability of information and monitoring is very limiting. Effects of policies or implementation of new policy instruments are limited, which also inhibits statutory compliance, and policy evaluation and management improvements. Moreover, limited financial resources and human capacities form a major barrier to tackling pollution issues in Libreville. Particularly, investments in strengthening professional expertise such as policymaking, monitoring, and water management optimisation seems a promising way forward in addressing water pollution issues in Libreville.

4.3.2. Windhoek

The GCA analysis of Windhoek identified several strengths: resourcefulness and the ability to provide a continued water supply, even in times of drought.
The good agreement among stakeholders leads to common themes and issues, which enables a collaborative approach for addressing them. Nevertheless, some governance shortcomings were identified. Implementation capacity for legislation, often in the context of a lack of financial continuation, technical expertise, and accountability, hinder further development of IWRM in Windhoek. A key issue here is that the current legislative frameworks are very Eurocentric, which does not always fit well in the Namibian context.
Also, collaboration and coordination of activities are often hindered by insufficient organisational structures in institutions of the key players of water management, which leads to low stakeholder engagement and short-term thinking.

4.3.3. Yaoundé

The GCA in Yaoundé has been done with a focus on five water-related challenges. Governance of water scarcity and urban heat island effects is relatively well-developed.
For flood risks, wastewater treatment, and solid waste treatment, some of the GCA indicators show very limited or limited scores (Abdoulahi *et al.,* 2021). Important aspects limiting the development of IWRM that surfaced from the GCA were: 2.1 information availability, 3.1 smart monitoring, 3.2

Figure 9-5 *Governance capacity framework (GCA) spider diagrams for Libreville, Windhoek, and Yaoundé.*

evaluation, 3.3 cross- stakeholders learning, 5.2 discourse embedding, 6.2 collaborative agents, 7.2 clear division of responsibilities, 8.1 affordability, 8.3 financial continuity, and 9.2 compliance with laws, policy, and regulations.
A lack of knowledge prevents informed decision-making (Rowley 2007; van Rijswick *et al.,* 2014).

It is recommended to improve smart monitoring and evaluation of projects and cross-stakeholders learning efforts. For example, through workshops that involve different levels of management, stakeholders empower each other to continuously learn and together make the city's water management more effective.
Taking up monitoring will enable an analysis of the impact of different measures and policies that enables this type of social learning. Importantly, this approach will strengthen accountability and compliance with regulations.

4.4. Discussion

The assessment of urban water management in African capitals has shown that severe challenges exist.
In all six cities studied, access to the water supply is challenging and concerning, wastewater treatment is very limited (with the exception of the City of Windhoek), and solid waste handling is also a key issue in most places. Also, climate adaptation is a topic of (great) concern, whilst sufficient management plans are often not in place.
As a result, the burden of disease and flood risks are high for the six assessed cities. This pattern seems to apply for most cities in sub-Saharan Africa. Economic pressures and low political stability are discouraging the improvement of this situation, especially in the context of rapid urbanisation.

The three governance capacity analyses have shown that a lack of data and monitoring is hindering further development. Without data, steering and prioritising projects becomes extremely difficult or impossible and, above all, learning from previous mistakes is greatly inhibited.
Also, education rates and limited capacity development are a barrier for developing and implementing long-term sustainable policy instruments. Lack of good data hinders demonstration of compliance with standards and accountability of the responsible stakeholders.

In this project, we have chosen a bottom-up approach that supports young water professionals. The predominantly female young experts were empowered to research their cities, comprehend the challenges faced and develop a way forward.
Furthermore, they were able to link up and create an unofficial network that will further the work locally, regionally and internationally.

Identifying the data gaps that hinder science-based decisions and policymaking is one result of the research presented herein.
An analytical profile of the challenges for each of the cities where the CBA was applied is the second result of the work. These results were presented at citywide meetings and discussed with officials and concerned citizens.
Unfortunately, the latter exercise was not optimal as it coincided with the COVID-19 pandemic.
As a result, participation of local stakeholders was limited in some cities. Furthermore, due to financial limitations, not all of the six capitals were able to organise such sessions. The results were still very encouraging though, which led to assessing four more cities in a subsequent project (Fall, 2021).

The project has demonstrated that the CBA is ideally suited for the purpose of capacity development and information disclosure that can enable better informed local decision-making and strengthen the capacity of young local water professionals in the process.

The methodology is easy to learn, uses transparent, open and verifiable data, and its results are easy to understand by researchers, politicians and policymakers, and other relevant stakeholders.
Furthermore, the method is fast and, since its inception, a large database of city assessments has been built up. This database provides an opportunity for learning from best practices, which is an important outcome to support the young professional network.

> *“An important first step for improvement is to conduct a baseline assessment of the performance of IWRM”*

05 Conclusion

The African continent faces unprecedented urbanisation. Some of the capitals are amongst the fastest growing cities in the world. The rapid growth, exacerbated by the effects of climate change, results in great concerns for water security, due to strong impeding circumstances for Integrated Water Resources Management and water governance.
An important first step for improvement is to conduct a baseline assessment of the performance of IWRM.
In this project, we have used the City Blueprint Approach for this purpose. Six sub-Saharan African capitals, Abuja, Bangui, Harare, Libreville, Windhoek, and Yaoundé, have been assessed for external trends and pressures, performance of IWRM, and governance capacity. The assessment process was undertaken by local young professionals who were interning at UNESCO or hired as consultants. The young professionals collected data required for the assessment from public sources and by interviewing stakeholders. Experts from KWR Water Research Institute and the University of Bath were responsible for the required quality checks.

The approach formed the basis for the development of an unofficial network of young professionals and provided the opportunity to develop their leadership skills which empowered them to discuss the results with important stakeholders and policymakers in their cities.
Results have been presented in workshops that enabled identification and prioritisation of the most important challenges in the capitals.

The method showed that all cities have a different character and different issues prevail. Nevertheless, several common issues have been identified:

- Water supply and wastewater treatment are important and concerning challenges in all cities.
- Solid waste handling is limited, which is an important factor causing flooding and pollution.
- Due to the above there is a great burden of disease and high flood risk in the capital cities.
- Economic pressure and political instability are important aspects that hinder improvement.
- Lack of data and monitoring makes governance blind. Without reliable data, policy development and governance will not be successful in addressing urban water-related challenges.

Based on the success of this method, the ambition is to expand the analysis to all sSA capitals. At the time of writing, four more capitals are being assessed.

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Appendix: City Descriptions

Abuja

Abuja City has a land area of 8,000 square kilometres and is located in the centre of Nigeria within the Federal Capital Territory (FCT). Abuja is essentially a planned city and was mainly built in the 1980s. It officially became Nigeria's capital on 12 December 1991, replacing Lagos, though Lagos remains the country's most populous city.

Abuja city lies 477 metres above sea level and it has a tropical climate. Most rainfall is during summer, while winters are relatively dry: the rainy season begins around March and runs through October.

At the 2006 census, the city of Abuja had a population of 776,298. United Nations figures showed that Abuja grew by 139.7% between the years 2000 and 2010, making it the fastest-growing city in the world. It currently has an estimated population of around 3.3 million people.

Abuja receives part of its drinking water supply from the lower Usuma dam located in the Bwari area council of the federal capital territory. The capacity of the plant that treats surface water from the dam's reservoir was in the process of being increased in 2012 to further service the growing population of the city. At present, there are also two new plants each with a production capacity of 240 million litres of water a day. Raw water for the new plants is sourced from the lower Usuma dam reservoir, which also supplies water to the new Gurara dam reservoir.

However, water supply in the city is unreliable due to several challenges, including acute water scarcity, poor infrastructure, inefficient billing, low pressure, poor water quality and the rapid population growth due to in-migration (Abubakar 2016, 2018). This forces households to other strategies for water supply, including private boreholes and local wells or water sold at water trucks.

Bangui

Bangui is the capital and largest city of the Central African Republic. The country is landlocked and has a population of close to 4.9 million. It has embarked on a long recovery process, following a major security crisis in 2013 that unravelled its social fabric and displaced over 25% of its population.

As of 2021, the city had an estimated population of 812,400. Bangui is situated close to the Equator in the South of the country which has a slightly hotter and wetter climate than the country's northern regions. The rainy season lasts from May to November and the dry season from December to April. Rainfall is about 1500mm a year. It has a tropical savanna climate (Köppen climate characterisation) with dry winters. The soil consists of clay and silt. The sources of drinking water in Bangui are the public supply by the Société de Distribution d'Eau (SODECO) or from private boreholes. Population growth is 2.14%/year, based on the 2019 population statistics. The city has – like the rest of the country - a young population aged 17.6 years on average.

Harare

Zimbabwe currently has a population of nearly 15 million. The population density in Zimbabwe is 38 per square kilometre. The current urban population is 5,700,460 people (2020), just over 38% of the country's population. Zimbabwe's population is young with a median age of 18.7 years.

Harare is the capital and the most populous city. The population size of Harare increased from 1.87 million in 1997 to 2.24 million in 2014 growing at an average annual rate of 4.67%.

Harare lies at an elevation of 1,483 metres and has a subtropical highland temperate climate. The average annual temperature is 18°C which is rather low for the tropics. This is due to its high-altitude position and the prevalence of cool south-easterly airflow. However, with climate change, there has been a change in rainfall and temperature patterns. There are three main seasons: (i) a warm, wet season from November to March/April, (ii) a cool, dry season from May to August and (iii) a hot, dry season in September/October. Daily temperature ranges are about 7-22°C in July (the coldest month) and about 16-26°C in January (mid-summer). The average annual rainfall is about 825mm in the southwest, rising to 855mm on the higher land of the northeast. The driest weather is in July when an average of 1.8 mm of rainfall occurs. The wettest weather is in January when an average of 191.4 mm of rainfall occurs.

Harare obtains raw water from four impoundments on the Manyame River. These are Harava and Seke dams which supply Prince Edward treatment works, and Chivero and Manyame dams which supply Morton Jaffray treatment works. The water supply infrastructure was originally designed to supply 350,000 people. The infrastructure was upgraded progressively with the last phase commissioned in 1994 to supply 1.5 million people, which was the last upgrade that has been done. The population has grown to about 4.5 million (which includes the satellite towns), and the water supply systems have severe under-capacity. Harare has a mandate to supply water to its satellite towns as its suburbs that also lack access to piped drinking water.

The water sources have a depreciating quality due to domestic, agricultural and industrial activities. Sewage works in these local authorities are dysfunctional resulting in raw sewage flows into the reservoirs and, therefore, decreasing performance and increasing costs and chemicals demand for potable water treatment.

Libreville

Located on the equator, Gabon is bordered by Equatorial Guinea to the northwest, Cameroon to the north, the Republic of the Congo on the east and south, and the Gulf of Guinea to the west. It has an area of nearly 270,000 square kilometres and its population is estimated at 2.1 million people.

Libreville is the capital and largest city of Gabon. The official language is French. Occupying 65 square kilometres in the north western province of Estuaire, Libreville is a port on the Komo River, near the Gulf of Guinea. As of the 2013 census, its population was 703,904, currently 845,000 for the Libreville urban area.

Abundant petroleum and foreign private investment have helped make Gabon one of the most prosperous countries in sSA. However, because of inequality in income distribution, a significant proportion of the population remains poor.

Windhoek

Namibia is an arid country flanked by the Namib Desert in the west and the Kalahari Desert in the east. Over 80% of its 842,000 square kilometres is desert, arid or semi-arid (Lahnsteiner and Lempert 2007). Windhoek, its capital, receives around 370 mm of annual rainfall, with a surface water evaporation rate of 3,200-3,400 mm annually. Added to this, temperatures in Namibia have been steadily increasing since the 1970s: the number of days where temperatures exceed 35°C has increased, whereas the days with temperatures below 5°C have decreased. There has also been a later onset and earlier cessation of rains, with a statistically significant decrease in the number of wet days, including a 20% decrease in average rainfall in the central parts of Namibia where Windhoek is found (Turpie *et al.* 2018). The infrequency and variability of rainfall combined with the high evaporation rate result in frequent exposure to drought events in Windhoek and the rest of the country. To make matters worse, poor network maintenance historically caused losses in the distribution network, and low water prices disincentivized water conservation measures (Lahnsteiner and Lempert 2007). These combined impacts caused an increasing and unsustainable water consumption over the last years, which led to the depletion of all potable water resources within a 500 km radius of Windhoek.

The population of Windhoek (World Population Review 2021) grew from 19,000 in 1950 to 430,000 in 2020. The current growth rate is exceeding 3% per annum: this high urban influx across a short period is impacting the delivery of water resources, and satisfying demand has necessitated the construction of additional costly water projects (Lewis *et al.* 2019). The current water consumption of 21 million m^3 per year (or 150 litres/capita/day) is expected to increase, which will add pressure to an already limited resource (Van Der Merwe 2000).

Windhoek has actively adopted a series of measures to offset water depletion. Ultimately, the city provided its citizens with constant water access even during severe drought periods. Despite these positive steps, the onset of climate change and a growing population predicted to reach 790,000 in 2050 will increase the city's water demand while taxing an already aged infrastructure (Murray *et al.* 2018).

Yaoundé

Yaoundé is the capital of Cameroon and, with a population of more than 2.8 million, the second-largest city in the country after the port city Douala. It lies in the Centre Region of the nation at an elevation of about 760 metres above sea level. The climate is of an equatorial type with an average temperature of 23.5°C (16°C and 31°C). Rain is about 831.7 mm per year. The population of the greater metropolitan area is around four million and the urban area grows at a rate of 6%, based on data of 2006.
Most of Yaoundé's economy is centred on the administrative structure of the civil service and the diplomatic services. Owing to these high-profile central structures, Yaoundé has a higher standard of living and security than the rest of Cameroon.