Young professionals identify water management priorities using the City Blueprint Approach

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Report

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The extensive work, experiences and feedback of young professionals in each of the six African cities formed the backbone of this effort to test, improve and upscale the City Blueprint Approach, with the ambition that based on these experiences all African Capital cities will be supported with strategic decision-making to address challenges of water, waste and climate change.

Hence, our deepest gratitude goes to:

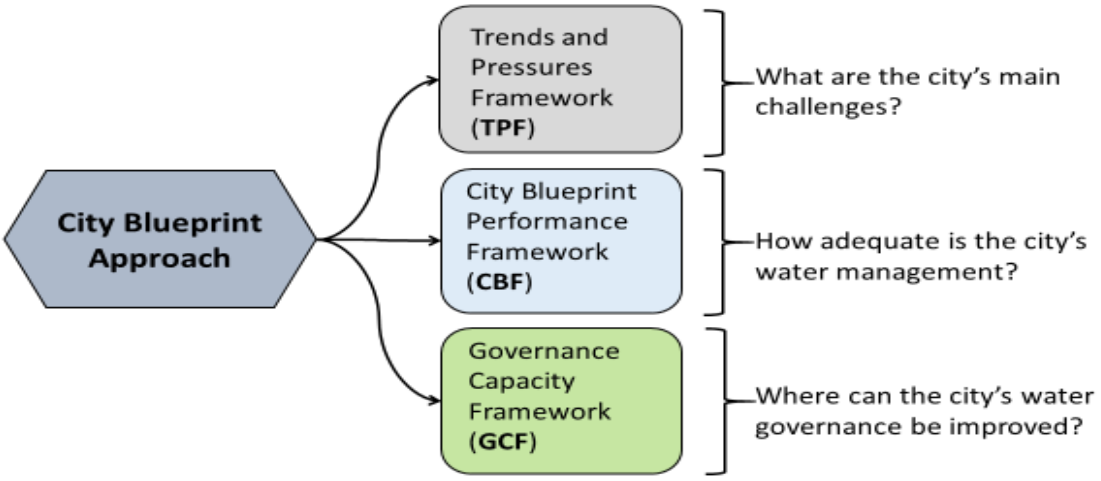
Humphrey Ozoani	lead investigator in Abuja (Nigeria)
Vanessa Grekonzy	lead investigator in Bangui (CAR)
Tariro Marekwa & Georgina Mukwirimba	lead investigators in Harare (Zimbabwe)
Glwadis Ovenga & Fritz Jaax	lead investigators in Libreville (Gabon)
Flavia Olivieri	lead investigator in Windhoek (Namibia)
Ibrahima Abdoulahi	lead investor in Yaoundé (Cameroon)

English executive summary

Cities in developing countries are facing unprecedented challenges caused by rapidly progressing urbanisation and effects of climate change. The latter causing recurrent weather events of increasing intensity, including floods and droughts, which hamper the provision of basic services. It is estimated that by 2050, 87% of the population will live in cities while at the same time the supply of water will be 40% less than demand, whilst risks for life and property increase. Cities are therefore obliged to adapt their water management to avoid falling prey to inaction and growing social inequalities. But how can a city quickly understand which elements of its water cycle are already sustainable and which ones need to be adapted?

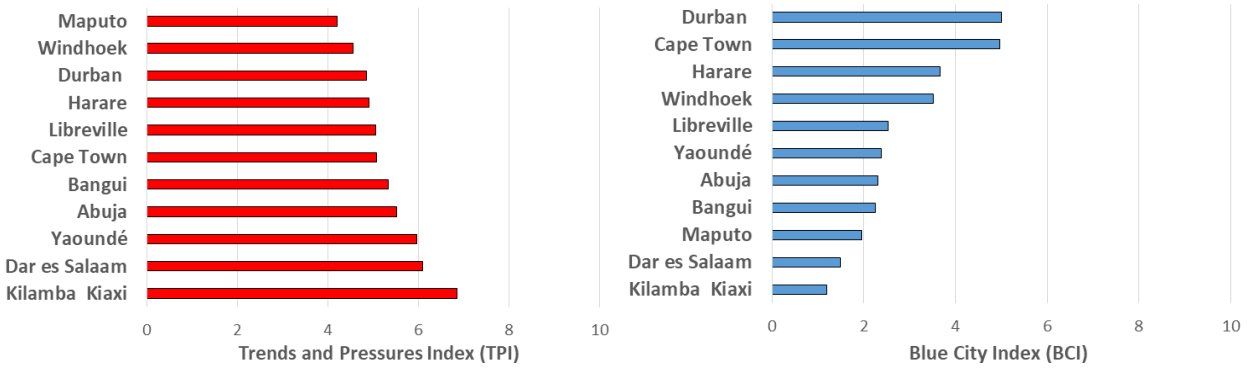
The City Blueprint Approach (CBA) is both a multi-stakeholder process and a practical assessment tool that can help cities on their journey to becoming water-wise cities, i.e. in their decision-making to address their challenges in terms of water, waste and climate change.

In this report, we have identified priorities for addressing integrated water challenges in six African cities: Abuja, Bangui, Harare, Libreville, Yaoundé and Windhoek. The CBA has been applied. It consists of three indicator assessments: (1) the Trends and Pressures Framework (TPF), (2) the City Blueprint Framework (CBF) and (3) the Water Governance Capacity Framework (GCF) as shown below.



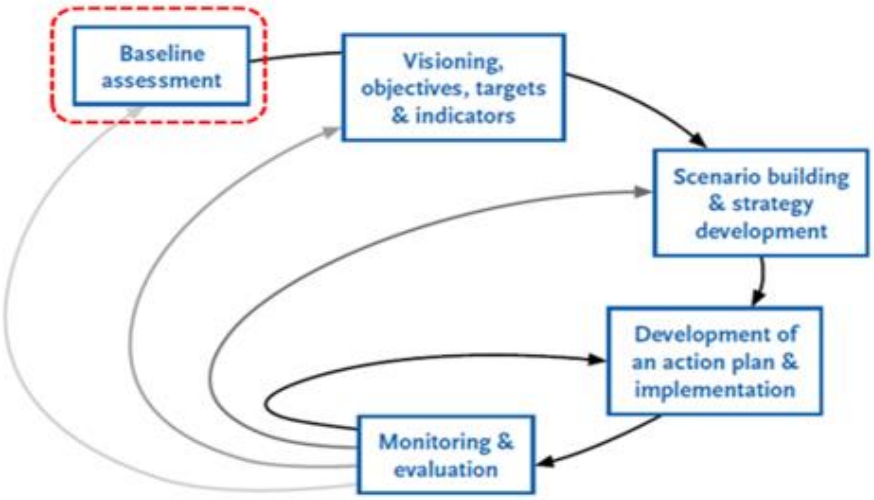
The TPF summarizes the key social, environmental, financial and governance pressures that can hinder water management. The CBF provides an integrated overview of water management performance. Finally, the GCF provides a framework for identifying the main obstacles and opportunities for developing governance capacity. The GCF has only been applied in Libreville and Yaoundé. The work was carried out by local young water professionals, coordinated by UNESCO, KWR Water Research Institute and the University of Bath in an interactive manner and result have been discussed at a workshop in Kampala, except Windhoek, which was added later.

Based on these results of the TPF analysis, we conclude that urbanization, burden of disease, tertiary education, economic pressure, air pollution in some cities, and governance arrangements affect African city-dwellers in general and the water sector in African cities, in particular. The CBF analysis shows that access to drinking water and drinking water quality are among the challenges. Wastewater treatment and solid waste collection and treatment in African cities also need to improve for lowering the burden of disease and as step towards creating a circular economy of water. The results for the Trends and Pressure Index (TPI) and the Blue City Index (BCI) – both aggregated scores of the TPF and CBF analysis – for all African cities assessed so far are shown in the figure below, Please note that a higher Trends and Pressures Index (TPI) score reflect higher social, environmental, financial and governance pressures that may affect water management performance which is being measured in the Blue City Index (BCI).



In comparison with cities in developed countries, the results show that African cities face more challenges. In fact, the highest TPI of the more than 125 cities that have been assessed with the CBA has been observed for Kilamba Kiaxi and the lowest TPI (1.6) for Stockholm. The lowest BCI value of all cities assessed so far has been observed for

Kilamba Kiaxi as well. For Stockholm and Amsterdam the BCI values are relatively high, i.e., 7.3 and 8.3, respectively. The low BCI scores for African cities indicate that there are currently major challenges in water management. It can be expected that the high population growth rates and urbanization rates in Africa will create further issues in cities if no adequate capacity building, water action programmes, and investments are realized in the very near future. As such, both frameworks form a baseline assessment that can further support adequate decision-making process as depicted in the figure below.



From the assessment of water management in African cities, using the CBA approach, the following conclusions are drawn:

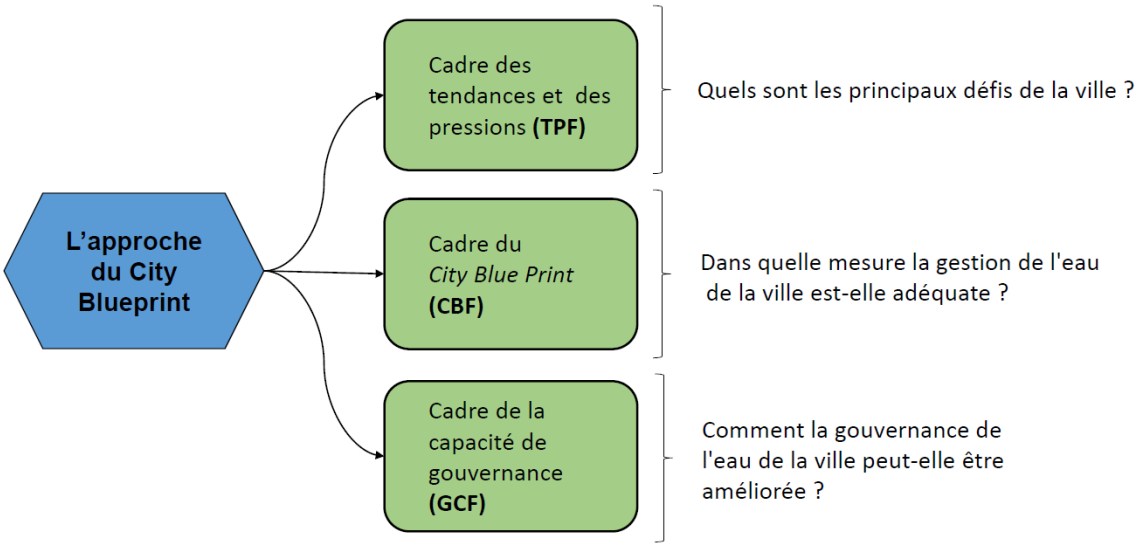
1. The CBA has been successfully applied by local young water professionals who identified priorities for addressing integrated water challenges in African cities: Abuja, Bangui, Harare, Libreville and Yaoundé. The results have been communicated to the local authorities for further information and action.
2. Wastewater treatment can be improved. This is often only limited to primary and secondary treatment, leading to large-scale surface water pollution. Also, solid waste collection and processing are great challenges in African cities.
3. The CBA provides good training on integrated water resources management, water management, water governance and how to approach stakeholders to assist in bridging data gaps.
4. If this work on five cities in Africa is regarded as a feasibility study, the successful results show that upscaling is a necessary next step. This can be organized in collaboration with UNESCO, the University of Bath and KWR.
5. After diagnosis, cure may be necessary. This means that the results have to be presented at higher policy or political levels, to discuss the results, discuss the options and decide on investment decisions, if needed. Further steps are needed with relevant stakeholders to accelerate actions to make African cities water-wise.

French executive summary

Les villes des pays en développement sont confrontées à des défis sans précédent causés par l'urbanisation galopante et les effets du changement climatique. Ces derniers provoquent des phénomènes météorologiques récurrents d'une intensité croissante, notamment des inondations et des sécheresses, qui entravent la fourniture de services de base. On estime que d'ici 2050, 87 % de la population vivra dans des villes alors que, dans le même temps, l'approvisionnement en eau sera inférieur de 40 % à la demande, tandis que les risques pour la vie et les biens augmenteront. Les villes sont donc obligées d'adapter leur gestion de l'eau pour éviter de devenir la proie de l'inaction et des inégalités sociales croissantes. Mais comment une ville peut-elle comprendre rapidement quels éléments de son cycle de l'eau sont déjà durables et lesquels doivent être adaptés ?

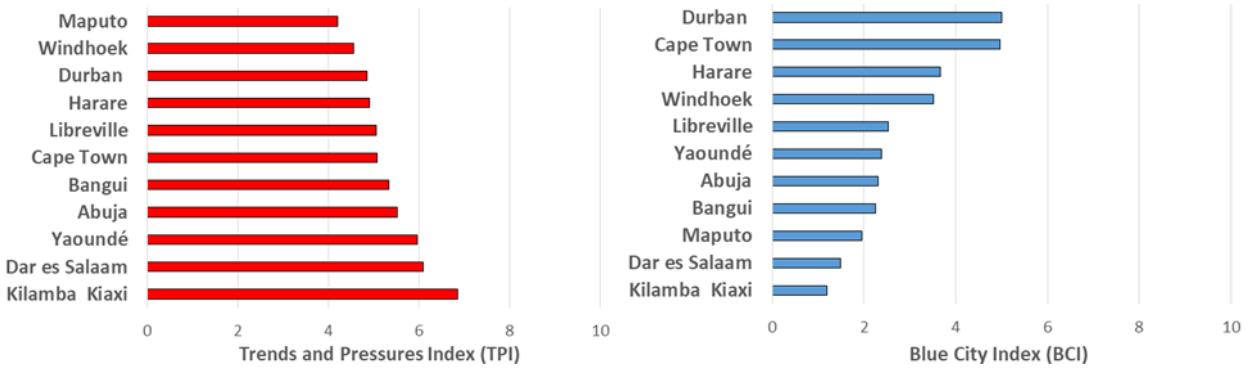
L'approche du plan directeur pour la ville (City Blueprint Approach - CBA) est à la fois un processus multipartite et un outil d'évaluation pratique qui peut aider les villes à devenir économes en eau, c'est-à-dire dans leur prise de décision pour relever leurs défis en termes d'eau, de déchets et de changement climatique.

Dans ce rapport, nous avons identifié des priorités pour relever les défis intégrés de l'eau dans cinq villes africaines : Abuja, Bangui, Harare, Libreville et Yaoundé. L'approche par le CBA a été appliquée. Elle se compose de trois cadres d'évaluations: (1) le cadre des tendances et des pressions (TPF), (2) le cadre du plan directeur de la ville (CBF) et (3) le cadre de la capacité de gouvernance de l'eau (GCF) comme indiqué ci-dessous.



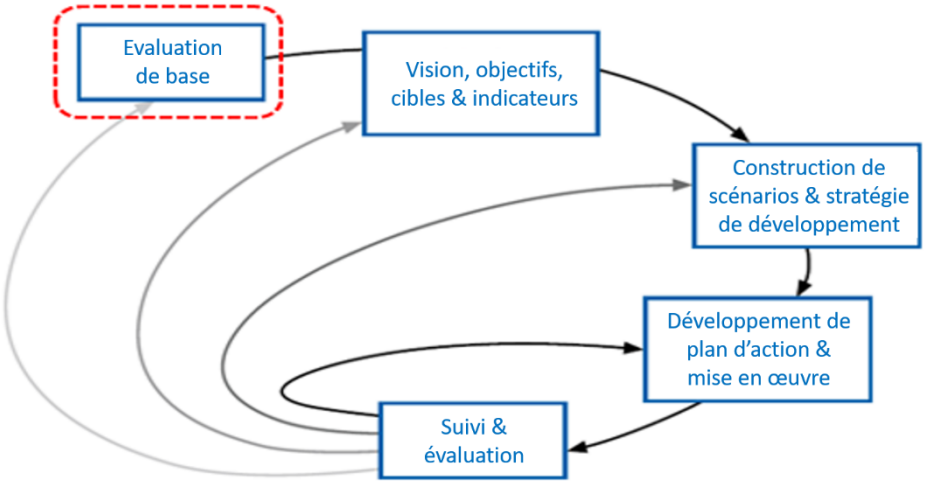
Le TPF résume les principales pressions sociales, environnementales, financières et de gouvernance qui peuvent entraver la gestion de l'eau. Le CBF fournit un aperçu intégré des performances de la gestion de l'eau. Enfin, le GCF offre un cadre permettant d'identifier les principaux obstacles et opportunités pour le développement des capacités de gouvernance. Le CGF n'a été appliqué qu'à Libreville et Yaoundé. Le travail a été réalisé par de jeunes professionnels exerçant dans le domaine de l'eau, coordonné par l'UNESCO, l'Institut de recherche sur l'eau KWR et l'Université de Bath de manière interactive et les résultats ont été discutés lors d'un atelier à Kampala, sauf pour le cas de Windhoek qui a été ajouté à l'étude dans un second temps:

Sur la base des résultats de l'analyse TPF, nous concluons que l'urbanisation, la charge de morbidité, l'enseignement supérieur, la pression économique, la pollution de l'air dans certaines villes et les dispositions en matière de gouvernance affectent les citadins africains en général et le secteur de l'eau dans les villes africaines en particulier. L'analyse du CBF montre que l'accès à l'eau potable et la qualité de l'eau potable font partie des défis à relever. Le traitement des eaux usées et la collecte et le traitement des déchets solides dans les villes africaines doivent également être améliorés pour réduire la charge de morbidité et pour créer une économie circulaire de l'eau. Les résultats de l'indice des tendances et des pressions (TPI) et de l'indice des villes bleues (BCI) - tous deux des scores agrégés de l'analyse TPF et CBF - pour toutes les villes africaines évaluées jusqu'à présent sont présentés ci-dessous. Il s'agit de noter qu'un indice des tendances et des pressions (TPI) plus élevé reflète des pressions sociales, environnementales, financières et de gouvernance plus fortes qui peuvent affecter la performance de la gestion de l'eau qui est mesurée dans l'indice Blue City (BCI).



En comparaison avec les villes des pays développés, les résultats montrent que les villes africaines sont confrontées à davantage de défis. En fait, le TPI le plus élevé des plus de 120 villes qui ont été évaluées avec l'approche du CBA a été observé pour Kilamba Kiaxi et le TPI le plus bas (1,6) pour Stockholm. La valeur la plus basse du BCI de toutes les

villes évaluées jusqu'à présent a également été observée pour Kilamba Kiaxi. Pour Stockholm et Amsterdam, les valeurs du BCI sont relativement élevées, à savoir 7,3 et 8,3 respectivement. Les faibles scores BCI des villes africaines indiquent qu'il existe actuellement des défis majeurs en matière de gestion de l'eau. On peut s'attendre à ce que les taux élevés de croissance démographique et d'urbanisation en Afrique créent d'autres problèmes dans les villes si aucun renforcement des capacités, aucun programme d'action pour l'eau et aucun investissement adéquat n'est réalisé dans un avenir très proche. En tant que tels, les deux cadres forment une évaluation de base qui peut ensuite soutenir un processus décisionnel adéquat, comme le montre la figure ci-dessous.



Les conclusions suivantes sont tirées de l'évaluation de la gestion de l'eau dans les villes africaines, en utilisant l'approche du CBA :

1. Le CBA a été appliqué avec succès par de jeunes professionnels locaux de l'eau qui ont identifié des priorités pour relever les défis intégrés de l'eau dans les villes africaines : Abuja, Bangui, Harare, Libreville et Yaoundé. Les résultats ont été communiqués aux autorités locales pour plus d'informations et d'actions complémentaires.
2. Le traitement des eaux usées peut être amélioré. Il se limite souvent au traitement primaire et secondaire, ce qui entraîne une pollution des eaux de surface à grande échelle. En outre, la collecte et le traitement des déchets solides constituent de grands défis dans les villes africaines.
3. Le CBA offre une bonne formation sur la gestion intégrée des ressources en eau, la gestion de l'eau, la gouvernance de l'eau et la manière d'approcher les parties prenantes pour aider à combler les lacunes en matière de données.
4. En considérant ce travail sur cinq villes d'Afrique comme une étude de faisabilité, les résultats positifs montrent qu'une transposition à plus grande échelle est une prochaine étape nécessaire. Ce travail peut être organisé en collaboration avec l'UNESCO, l'Université de Bath et KWR.
5. Après le diagnostic, un remède est nécessaire. Cela signifie que les résultats doivent être présentés à des niveaux politiques ou de politique plus élevés, afin de discuter des résultats, d'examiner les options et de prendre des décisions d'investissement, le cas échéant. D'autres mesures sont nécessaires avec les parties prenantes concernées pour accélérer les actions visant à rendre les villes africaines plus économes en eau.

Table of Content

1 Introduction

1.1 Water security challenges in urban Africa

In 2050, 87% of the population in developed countries will be living in cities. At about that time, water supply will fall short of demand by 40%. Africa is very much at risk as it is the fastest growing continent in the world. The challenges of water, waste and climate change have been addressed by UN Habitat (2018) as well as in a review by Koop and van Leeuwen (2017).

The consequences of climate change and urban growth leave cities no choice: they are forced to adapt their water management because the cost of inaction is projected to be high. But how can a city quickly grasp which elements of its water management are already sustainable and which need to be adapted? This can be done by following the planning cycle as introduced in the SWITCH project as shown in Figure 1. The planning cycle starts with a baseline assessment (red box in Figure 1) for which the City Blueprint Approach is used. The City Blueprint Approach (CBA) is a practical communicative tool that can help cities on their path to be become sustainable water-wise cities.

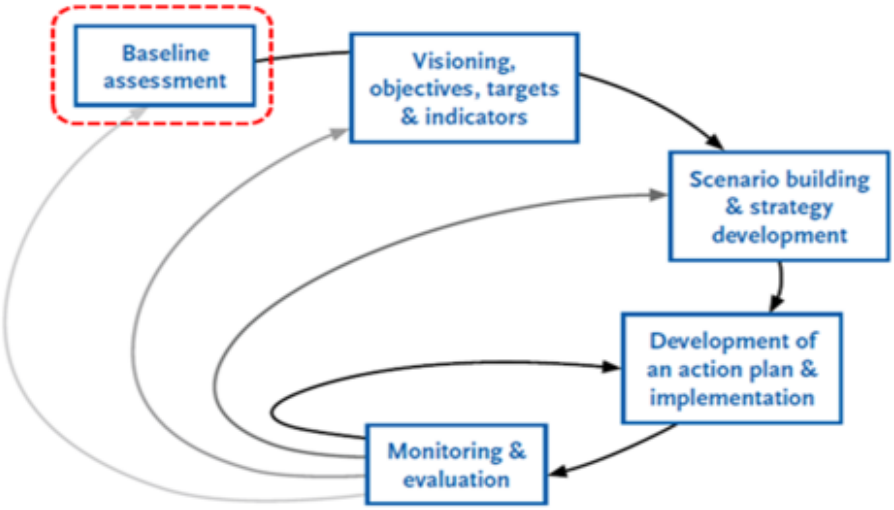


Figure 1 The role of the City Blueprint Approach in the planning process of municipalities and regions.

The City Blueprint Approach (CBA) is a diagnosis tool and consists of three complementary frameworks namely the Trends and Pressures Framework (TPF), the City Blueprint Framework (CBF) and the Governance Capacity Framework (GCF).

The TPF is used to assess the main challenges faced by the cities while the CBF assesses the integrated water management performance of a cities. TPF and CBF data are available for over 120 cities in more than 50 countries. The GCF is a new framework which assesses governance capacity of cities and has been applied in more than 15 cities, including Amsterdam, Quito (Ecuador), Melbourne, New York City, Seoul, Cape Town, Bandung (Indonesia) and Ahmedabad (India). This information published in open access papers can be found on the City Blueprint website and Governance Capacity website of Watershare.

1.2 Project Ambition

The main objective of the activity is to assess the sustainability of Integrated Water Resources Management (IWRM) in municipalities in the regions focusing on the five identified African cities. The activity will act as a baseline assessment (diagnosis) and a first step in the strategic planning process (Figure 2).

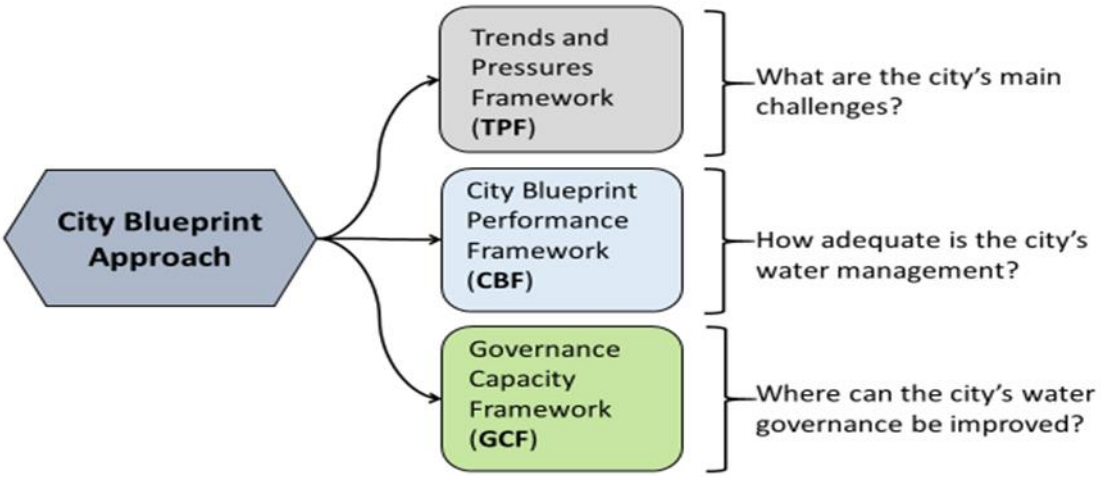


Figure 2 The City Blueprint Approach is a diagnosis framework comprised of three different frameworks.

The specific objectives of the African project are to:

1. develop training material,
2. identify one or two young experts in Europe (Utrecht University) and provide training on the CBF,
3. train the identified young experts in Africa, initially via a webinar and consequently in a face-to-face session, scheduled for February 2020, in Kampala, Uganda,
4. provide technical backstopping during the assessment period for all experts,
5. perform a Quality Assurance / Quality Control (QA/QC) exercise for the collected information,
6. help in the development of the charts,
7. propose a revised approach (if needed and based on the practical experience of the assessments) that will be better suitable to the context observed during the evaluation of the project.

In this way we demonstrate that young professionals can build-up a database in African cities in order to identify water management priorities, learning opportunities and select the most viable solutions. In the process, political awareness can be created and young professionals are empowered through network building and education.

1.3 Report outline

This report summarizes work done in a period of one year. In collaboration with UNESCO, cities have been approached to participate in an assessment according to the City Blueprint Methodology. The methods is a structured approach based on data collection, followed by the preparation of spider diagram's to summarize the results and to discuss the way forward in order to manage the challenges of water, waste and climate change in African cities. Here we provide only the results of the training, application, review and presentations, review, discussion, and follow-up activities on e.g. the assessment of the governance capacities in Libreville (Gabon) and Yaoundé (Central African Republic; CAR).

The most important aspect of the experience will not be reported in detail: the energizing process, the hard work and fantastic collaboration with UNESCO, the young professionals, and all other colleagues involved.

This report consists of a main report and three Annexes including more in-depth results of the governance capacity analysis of Libreville (Annex 1). Annex 2 provides a manuscript for the International Conference on Water, Megacities and Global Change reporting the results and key conclusions and recommentations of three Central African cities: Bangui (Central African Republic), Libreville (Gabon) and Yaoundé (Cameroon). Finally, annex 3 provides a detaled workshop report in Yaoundé. A detailed report of the city scores can be found here.

The main report follows a normal sequence of a scientific report. Section 2 provides a methodological outline of the City Blueprint Approach that has been applied in five cities (Section 3). Next, in section 4 we have provided additional information on how the methodological can be tailored for African cities. That is to say, based on the extensive experiences of the young professionals in each of the face cities, we provide suggestions for additional indicators and alternative scoring methods. We have added a section on the Helpdesk (Section 5), a guideline for upscaling (Section 6). Next, section 7 provides an outlines of viable next steps. We end with the main conclusion in section 8.

NB. After the Kampala workshop, we have updated all questionnaires and recalculated all the scores for the more than 120 cities in more than 50 countries. This explains why the scores in the present report may differ from the scores of the young professionals involved in the assessment process.

2 Methods

2.1 City Blueprint Approach

The City Blueprint Approach is a method to assess the sustainability of Integrated Water Resources Management (IWRM) in municipalities and regions. It is a baseline assessment and a first step in the strategic planning process in cities as described in Figures 1 and 2. The City Blueprint Approach has been developed in a learning-by-doing fashion. The first version of the City Blueprint Framework (CBF) was published in 2012. A first review and update led to two separate frameworks, i.e. the Trends and Pressures Framework (TPF) and the first revision of the CBF (Koop and Van Leeuwen, 2015a). In 2017 Koop et al. (2017) developed the Governance Capacity Framework (GCF). In 2019 further discussions about the need to include the World Bank Governance indicators and Air pollution in the TPF led to a revision and simplification of TPF. As a consequence, a minor revision was introduced in the CBF. The key publications of the CBA are listed below.

- Van Leeuwen, C.J., Frijns, J., Van Wezel, A., Van de Ven, F.H.M., 2012. *City Blueprints: 24 indicators to assess the sustainability of the urban water cycle.* Water Resources Management 26:2177–2197 (open access)
- Koop, S.H.A. and Van Leeuwen, C.J., 2015a. *Assessment of the Sustainability of Water Resources Management: A Critical Review of the City Blueprint Approach.* Water Resources Management 29:5649–5670 (open access)
- Koop, S.H.A. and Van Leeuwen, C.J., 2015b. *Application of the Improved City Blueprint Framework in 45 municipalities and regions.* Water Resources Management 29:4629-4647 (open access)
- Koop, S.H.A. and Van Leeuwen, C.J., 2016. *The challenges of water, waste and climate change in cities.* Environment, Development and Sustainability 19:385-418 (open access)
- Koop, S.H.A., Koetsier, L., Doornhof, A., Reinstra, O., Van Leeuwen, C.J., Brouwer, S., Dieperink, C., Driessen, P.P.J., 2017. *Assessing the Governance Capacity of Cities to Address Challenges of Water, Waste, and Climate Change.* Water Resources Management 31:3427-3443 (open access)

2.1.1. Trends and Pressures Framework (TPF)

The TPF consists of a total of 24 indicators (including the sub-indicators) and are divided over the following broad categories: social, environmental and financial pressures and include a 4th category, i.e. the World Bank governance indicators (Table 1).

Table 1 Overview of the TPF categories and indicators.

Category	Indicators	
I SOCIAL	1 Urbanization rate	
	2 Burden of disease	
	3 Education rate	
	4 Female participation	
II ENVIRONMENTAL	Flood risk	5 Urban drainage flood
		6 Sea level rise
		7 River peak discharges
		8 Land subsidence
	Water scarcity	9 Freshwater scarcity
		10 Groundwater scarcity
		11 Sea water intrusion
	Water quality	12 Biodiversity
	Heat risk	13 Heat island
	Air quality	14 PM2.5/10
III FINANCIAL	15 Economic pressure	
	16 Unemployment rate	
	17 Poverty rate	
	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	

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

Table 2 Scoring of the TPF indicators as 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

2.1.2. City Blueprint Framework (CBF)

The CBF framework 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 robustness and VII plans and actions. An overview of the CBF indicators is presented in Table 3 below. In the application of the CBF, 24 indicators are standardized according to a scale of 0-10 in which 10 points implies an excellent score and 0 points indicates a high improvement potential. This is done by comparing the values from an international range, using natural boundaries of 0 and 100% or by using ordinal classes. Often the min-max method is applied:

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

The seven steps in the process to be followed are:

1. Municipalities and regions are contacted to perform a City Blueprint analysis of their municipality or region
2. If a decision has been taken, an independent leading researcher is appointed who is responsible for the information collection. This leading researcher also contacts relevant stakeholders to verify and obtain the necessary information to score the indicators
3. The leading researcher completes the City Blueprint Framework (CBF) questionnaire for 25 indicators. The questionnaire (or an identical word file) is then used to collect the information, step by step (indicator by indicator)
4. For each indicator scoring information is gathered. The information, the sources (websites, documents or publications) and if necessary the page number(s) are provided and included in the CBF questionnaire word file
5. For each indicator, the scores are calculated as explained in Section 4 of this document
6. After the completion of this questionnaire a radar chart of all 25 indicators (the City Blueprint) and the Blue City Index (BCI) can be provided. These indicators and the BCI vary from 0 (high improvement potential) to 10 (excellent score). The City Blueprint spider diagram and the calculation of the BCI can be obtained by introducing the scores for the 24 indicators in the excel file for the calculation of the BCI

Table 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 WWT
	5 Tertiary WWT
	6 Groundwater quality
III Wastewater treatment	7 Nutrient recovery
	8 Energy recovery
	9 Sewage sludge recycling
	10 WWT energy efficiency
IV Water infrastructure	11 Stormwater separation
	12 Average age sewer
	13 Water system leakages
	14 Operation cost recovery
V Solid waste	15 MSW collected
	16 MSW recycled
	17 MSW energy recovered
VI Climate adaptation	18 Green space
	19 Climate adaptation
	20 Climate-robust buildings
VII Plans and actions	21 Management & action plans
	22 Water efficiency measures
	23 Drinking water consumption
	24 Attractiveness

2.1.3. Governance Capacity analysis Framework (GCF)

The GCF is a framework to assess the governance capacity to address water-related challenges and consists of three dimensions, nine key conditions and 27 indicators. An overview is presented in Table 4.

Table 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 internalization
	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

The GCF assesses how well different stakeholders work together to govern a common water challenge. As such the GCF can be applied to assess any type of water-related or environmental challenge that requires a joint effort of different stakeholders to address a common challenge. The framework has most often assessed five water-related governance challenges: Water scarcity, flood risk, wastewater treatment, solid waste treatment and urban heat islands. These challenges are the most reoccurring water-related challenges that will steadily increase in importance and frequency due to climate change and urbanization. The GCF has also been applied for assessing the governance capacity for water reuse (Steflova et al., 2018) or circular economy challenges (Ddiba et al., 2020). These 'governance challenges' tend to have fragmented scopes, viewpoints and responsibilities. As there are many causes leading to complexity, uncertainty and disagreement, there often is no single best approach to solve these governance challenges. It rather is an iterative process that requires governance capacity to find long-term solutions that are

supported with flexible intermittent targets to anticipate on emerging barriers and changing situations (Koop et al., 2019).

The 27 indicators all have a specific pre-defined question that the researcher needs to answer to for each of the five governance challenges using documents, reports and in-depth interviews. The answers provide the basis for the indicator score based on a Likert-type method which is specific for each of indicator. Here we provide these pre-defined questions and Likert-type scoring method for each of the 27 indicators. To perform the GCF assessment, a triangular method is applied:

(i) An analyses of policy documents and reports provide preliminary scores of the 27 indicators.

(ii) 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 and specifically asked with regards to the the governance challenges. The questions are open, non-technical, with follow-up questions to either target specific elements or for further clarification.

(iii) After the interviews the participants receive the predefined questions with the preliminary indicator scores 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.

For each of the frameworks, detailed questionnaires / indicator descriptions are available that can be found in the KWR library:

- TPF- https://library.kwrwater.nl/publication/61396712/
- CBF- https://library.kwrwater.nl/publication/61397318/
- GCF- https://library.kwrwater.nl/publication/61397218/

2.2 Field work approach

The assessments were completed by young professionals that are well-acquainted with the city of assessment. These young professionals were contracted by UNESCO 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 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 in reaching out to local organisations and stakeholders for data collection and, at the later stage, constructive discussions of the 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 a questionnaire that specifies the indicator's rationale and scoring method, the following steps were taken:

1. Preparation period: Young professionals in each city first studied a set of reading materials on the City Blueprint Approach's rational, 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. By starting the assessment, the young professionals were also encouraged to prepare questions about the indicator scoring, rational, and reporting or data demands.
2. Kick-off webinar: An online webinar, one in English and one in French, was organised by UNESCO headquarters and KWR Water Research Institute. A presentation on the methodology was provided and detailed instructions on conducing the assessment were presented. Next, the questions of the young professionals were discussed. An online web-environment was created to store and share information of each city as well as general information.
3. Field work & individual feedback sessions: The young professionals completed the assessment through elaborate networking with local authorities, developing alternative methods or information sources to score particular indicators. Regular email contact with KWR and UNESCO supported in this process. In addition to the kick-of webinar, feedback sessions for each city were organised to go through every detail and discuss how to deal with methodological and practical barriers.
4. Quality assurance: The assessment reporting that included the indicators scores calculation, methodological reporting and substantiation as well as detailed referencing of consulted documentation, stakeholder visits and the like. KWR provided a 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 AfWA-Conference in Kampala: In preparation to this workshop, the young professionals have been asked to prepare a presentation of their findings but also present their key recommendations for local authorities. In this two-day session, young professionals from all the five cities set together to with two key objectives. First, how other young professionals can in the future empowered with the experiences of these young professionals in order to assess all African Capital cities. Second, in what way the key results can be translated into messages that can be taken up by local authorities.
6. City-workshops: In most cities, a workshop with local decision-makers was being held. Here the assessment results were presented, followed by a discussion on how the city can best improve their water management performances.

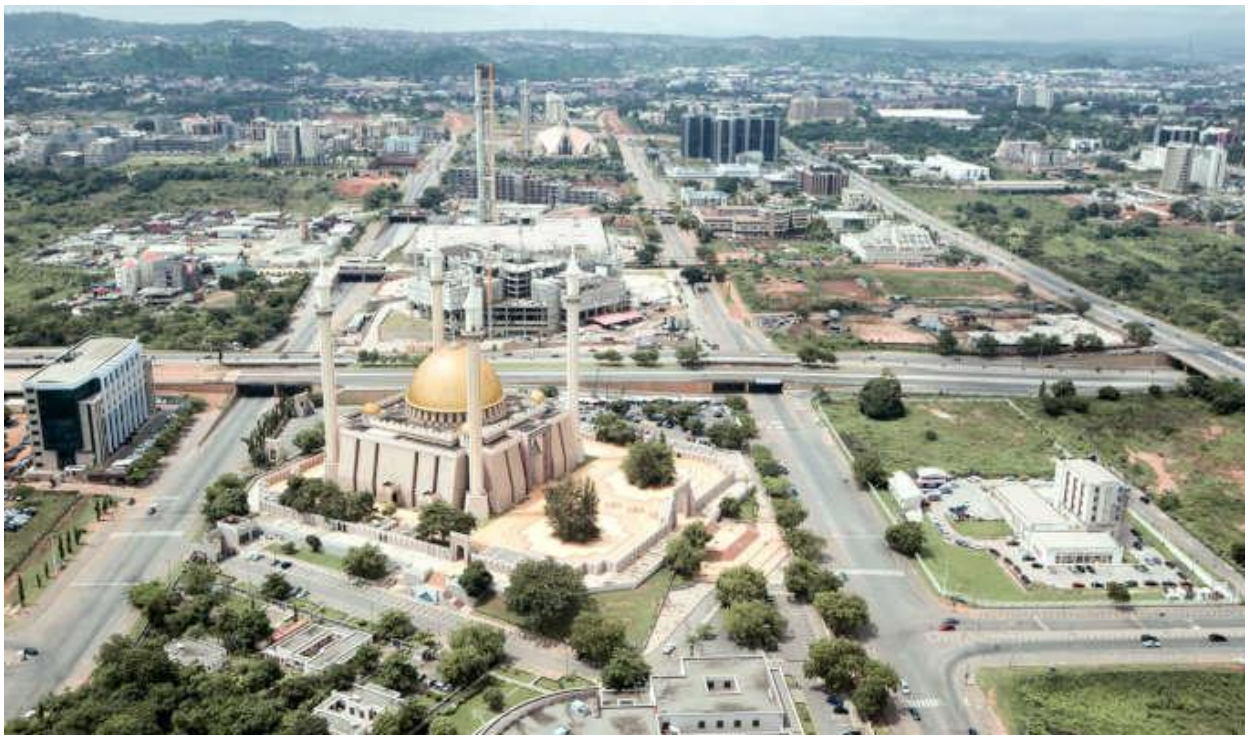
3 Results

Six African cities have been assessed: Abuja (Nigeria), Bangui (Central African Republic), Harare (Zimbabwe), Libreville (Gabon), Windhoek (Namibia) and Yaoundé (Cameroon). The key results are provided in this chapter.

3.1 Abuja

3.1.1 Introduction

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 built mainly in the 1980s. It officially became Nigeria's Capital on 12 December 1991, replacing Lagos, though Lagos remains the country's most populous city.



Source: https://www.villaafrika.com/fct-abuja-city-profile/

Abuja city lies on 477m above sea level and falls within latitude 745' and 739', and the climate here is basically tropical. The summers have a good deal of rainfall, while the winters have very little. The average annual temperature in Abuja is 25.7 °C. One beautiful feature about Abuja which it drives from its central location is that it shares the savannah grass with the North. And the overall effect of this is that Abuja has rich soil for Agriculture and enjoys an equable climate that is neither too hot nor too cold all year round. The federal capital territory experiences two distinct weather conditions in the year. Those are the rainy season which begins around March and runs through October. The dry season (usually characterized by bright sunshine) begins from October and ends in March.

At the 2006 census, the city of Abuja had a population of 776,298 making it then the eight most populous city in Nigeria. United Nations figures showed that Abuja grew by 139.7% between 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 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 in order to further cater for the growing population of the city. Currently, there are two new plants and each has the capacity to process 240 million liters of water a day. Raw water for the new plants is sourced from the lower Usuma dam (LUD) reservoir, which also supplies water to the phase 1 and 2 plants, and the new Gurara dam reservoir (https://www.watertechnology.net). Groundwater abstraction especially from boreholes is another growing source of drinking water supply to residents of the federal capital territory.

3.1.2 Trends and pressures hampering water management

The results of the TPF analysis for Abuja are shown in Table 5 and Figure 3. Taking into consideration the explanation of the TPF scores in Table 5, the conclusion is that Abuja faces many concerns that may hamper water management both now, as well as in the future as 7 of the TPF indicators score as a great concerns. These high TPF scores are in bold. The Trends and Pressures Index (TPI), the arithmetic mean of the 24 indicators of the TPF of Abuja, is 5.5.

Table 5 Overview of the Trends and Pressures Framework (TPF) categories and indicators of Abuja. Great concerns are depicted in bold.

Category	Indicators		Score
I SOCIAL	1 Urbanization rate		**9.3**
	2 Burden of disease		**10.0**
	3 Education rate		**9.4**
	4 Female participation		5.2
II ENVIRONMENTAL	Flood risk	5 Urban drainage flood	5.4
		6 Sea level rise	0.0
		7 River peak discharges	0.0
		8 Land subsidence	0.0
	Water scarcity	9 Freshwater scarcity	1.0
		10 Groundwater scarcity	2.5
		11 Sea water intrusion	0.0
	Water quality	12 Biodiversity	3.8
	Heat risk	13 Heat island	5.0
	Air quality	14 PM2.5/10	**10.0**
III FINANCIAL	15 Economic pressure		**9.8**
	16 Unemployment rate		4.0
	17 Poverty rate		**8.9**
	18 Investment freedom		5.5
IV GOVERNANCE	19 Voice and accountability		5.8
	20 Political stability		**9.4**
	21 Government effectiveness		7.0
	22 Regulatory quality		6.8
	23 Rule of law		6.8
	24 Control of corruption		7.1

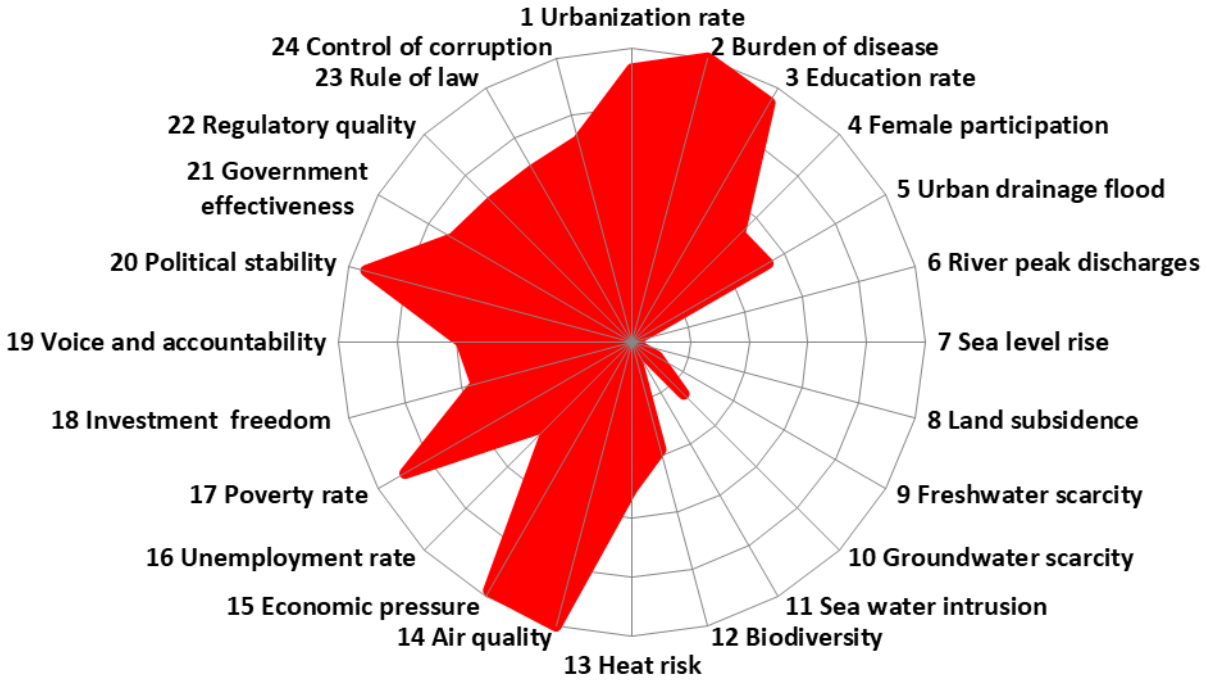


Figure 3 Trends and Pressures Framework (TPF) results of Abuja, Nigeria. The redder, the more pressures the city faces that may hamper water manager. The Trends and Pressures Index is 5.5.

Indicators 21 (Government effectiveness); 22 (Regulatory quality); 23 (Rule of law) and 24 (Control of corruption) all show indicator values whose levels of concern can be best described as concern. Thus, requiring prompt interventions from relevant bodies in the Nigerian water sector in order to address the situation and gradually erode its hampering effects in the overall management of the federal capital territories water management.

3.1.3 City Blueprint water management performance

Public data or data provided by the (waste) water utilities in the city was based on questionnaires, structured oral interviews and interactions with the various water sector stakeholders during field/facility visits. The relevant stakeholders visited included: The FCT Water Board; The Abuja Municipal Area Council; The Abuja Environmental Protection Board; The Nigeria Integrated Water Resources Management Commission; The Federal Capital Territory Administration; The Federal Capital Development Authority; NGOS etc. The process adopted was basically interactive with all stakeholders involved early on in the process (Letters to Local Authorities in the City of Abuja was provided by UNESCO and distributed to the relevant bodies by the CBF intern to enhance synergy and collaboration).

The results of the CBF for Abuja are provided in Table 6 and Figure 4. Indicators 8, 9, 15, 16 and 17 were more difficult to obtain due to lack of records on most of the adjoining parameters. The remaining indicators were generally available or at least inferable.

Indicators 2, 9, 11 and 23 show very high performance scores. Indicator 12 shows an average score of 6 and all other CBF indicators score ≤ 5. This is also reflected in the spider diagram in Figure 4.

Table 6 City Blueprint Framework's scores of Abuja, Nigeria.

Category	Indicator	Score
I Basic water services	1 Access to drinking water	4.0
	2 Access to sanitation	9.7
	3 Drinking water quality	9.5
II Water quality	4 Secondary WWT	2.1
	5 Tertiary WWT	0.3
	6 Groundwater quality	2.9
III Wastewater treatment	7 Nutrient recovery	0.0
	8 Energy recovery	0.0
	9 Sewage sludge recycling	9.7
	10 WWT energy efficiency	0.0
IV Water infrastructure	11 Stormwater separation	10.0
	12 Average age sewer	6.0
	13 Water system leakages	0.3
	14 Operation cost recovery	2.7
V Solid waste	15 Solid waste collected	1.9
	16 Solid waste recycled	0.0
	17 Solid waste energy recovered	0.0
VI Climate adaptation	18 Green space	4.4
	19 Climate adaptation	4.0
	20 Climate-robust buildings	0.0
VII Plans and actions	21 Management and action plans	2.0
	22 Water efficiency measures	5.0
	23 Drinking water consumption	10.0
	24 Attractiveness	4.0

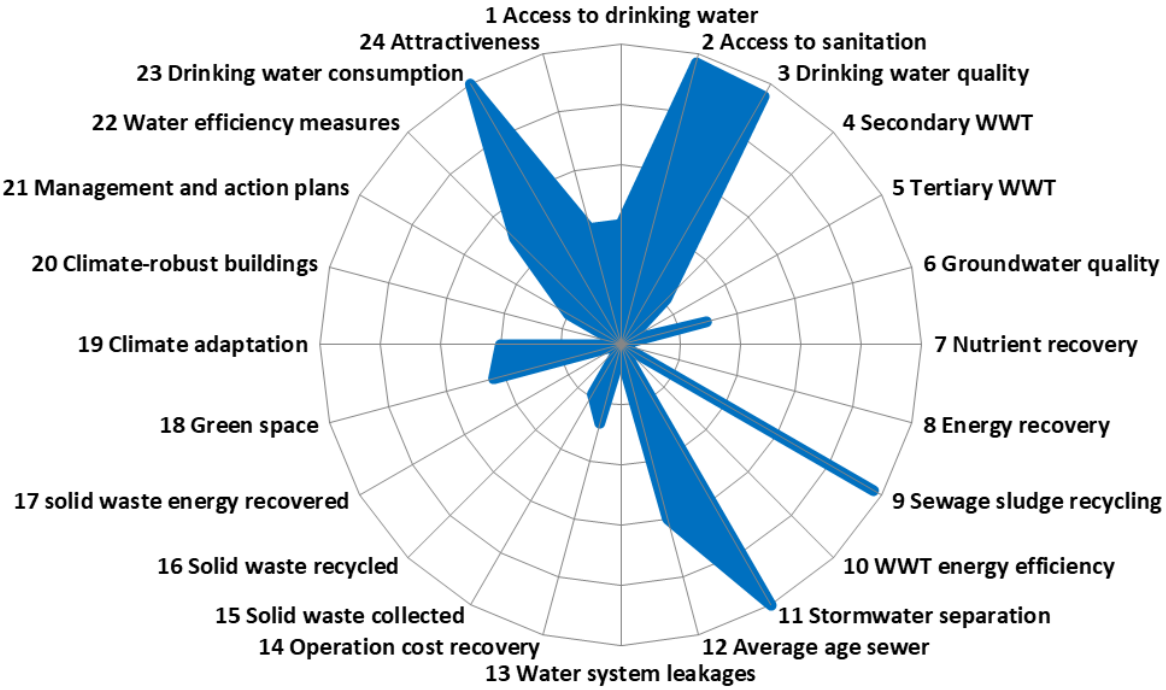


Figure 4 Spider diagram of the City Blueprint Framework's scores of Abuja, Nigeria. The bluer, the better the water management performance. The Blue City Index is 2.3.

3.1.4 Most viable solutions & recommendations

Comparing Abuja to other cities assessed and following the explanations of the scores explained in the methodology section, the scoring can be summarized as follows:

What was good?

- Indicator 23: Drinking water consumption (10.0 points)
- Indicator 12: Average age sewer (6.0 points)
- Indicator 11: Storm water separation (10.0 points)
- Indicator 9: Sewage sludge recycling (9.7 points)
- Indicator 3: Drinking water quality (9.5 points)
- Indicator 2: Access to sanitation (9.7 points)

What can be improved?

- Indicator 20: Climate robust buildings (0.0 point)
- Indicator 17: Solid waste energy recovered (0.0 point)
- Indicator 16: Solid waste recycled (0 point)
- Indicator 15: Solid waste collected (1.9 points)
- Indicator 13: Water system leakages (0.3 point)
- Indicator 8: Energy recovery (0.0 point)
- Indicator 7: Nutrient recovery (0.3 point)
- Indicator 5: Tertiary WWT (0.3 point)
- Indicator 4: Secondary WWT (2.1 points)

All CBF indicators with scores of 0 (zero) to 4 (four) should be improved upon via new initiatives in terms of increased funding by Government for manpower training and capacity building in order to devise more creative means of sustainable urban water management and record keeping, in line with global best practices.

Provision of informed options to further improve the IWRM situation in the federal capital territory, multi-agency and multi-disciplinary collaborations as well as effective information sharing of knowledge acquired from research opportunities like the CBF, TPF, GCF, and allied studies, should encouraged and sustained. Young experts in other

cities who will engage in similar research efforts should primarily see the entire assessment as an opportunity to learn and improve their competencies, while also contributing to knowledge and service to humanity. Training, workshops and seminars based on research findings of the City Blueprint Approach (i.e. TPF, CBF and GCF) must be encouraged and sustained by all environmental and water resources management stakeholders globally. This will enhance proactive policies, actions and interventions to areas of weaknesses and vulnerabilities.

Incineration is a cost-effective municipal waste disposal option which is seldom applied in Nigeria, especially in hospitals where medical wastes are incinerated at a minimal scale. However, the cheapest and simplest method of waste disposal is landfill. The resulting environmental impact of landfills is enormous but could be mitigated provided sanitary precautions are undertaken and waste reduction advocated. These two municipal waste management techniques are hereby, recommended for adoption in Nigerian and other African city centres.

3.2 Bangui

3.2.1 City Introduction

According to the World Bank, the Central African Republic is a landlocked country with a population of close to 4.9 million, 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. Bangui is the capital and largest city of the Central African Republic.

Source: https://www.reuters.com/article/centrafrique-combats-idFRKBN13I2LO

Source: https://news.un.org/en/story/2018/05/1008762

As of 2012, the city had an estimated population of 734,350. 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. Vegetation is Guinean forest type. The rainy season lasts from May to November and the dry season December to April. Rainfall is about 1500mm a year (Climatedata.eu). It has a tropical savanna climate (Köppen) with dry winters. The city is bordered by thick tropical rainforests along the river banks. The soil consists of clay and silt. The source of drinking water is the Oubangui River SODECA, boreholes. Population growth is 2.14%/year, based on the 2019 population. This is also reflected in the median average age of people in the Central African Republic which is 17.6 years.

3.2.2 Trends and pressures hampering water management

The Trends and Pressures Framework indicators for Bangui have been calculated and reviewed and are provided in Table 7 and Figure 5. The TPI (Trends and Pressures Index) for Bangui is 5.1. It means that Bangui faces relatively many social, environmental, financial and governance pressures that may affect its local water management.

Table 7 Trends and Pressures Framework's scores for Bangui, Central African Republic. Great concerns are depicted in bold.

Category	Indicators		Score
I SOCIAL	1 Urbanization rate		5.5
	2 Burden of disease		**10.0**
	3 Education rate		**9.7**
	4 Female participation		3.4
II ENVIRONMENTAL	Flood risk	5 Urban drainage flood	6.9
		6 Sea level rise	0.0
		7 River peak discharges	0.0
		8 Land subsidence	0.0
	Water scarcity	9 Freshwater scarcity	0.0
		10 Groundwater scarcity	0.0
		11 Sea water intrusion	0.0
	Water quality	12 Biodiversity	3.0
	Heat risk	13 Heat island	4.8
	Air quality	14 PM2.5/10	**8.9**
III FINANCIAL	15 Economic pressure		**10.0**
	16 Unemployment rate		1.4
	17 Poverty rate		**10.0**
	18 Investment freedom		5.5
IV GOVERNANCE	19 Voice and accountability		7.4
	20 Political stability		**9.6**
	21 Government effectiveness		**8.4**
	22 Regulatory quality		7.7
	23 Rule of law		**8.4**
	24 Control of corruption		7.5

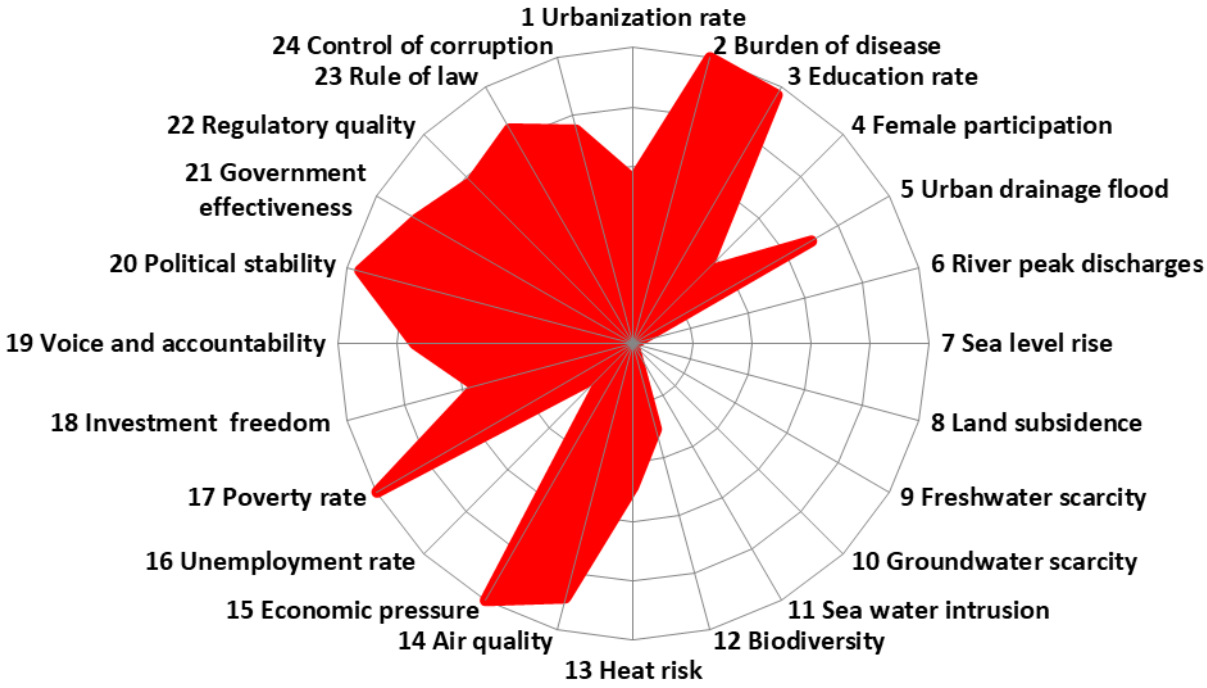


Figure 5 Trends and Pressures Framework's spider diagram of Bangui, CAR. The redder, the more pressures the city faces that may hamper water manager. Trends and Pressures Index is 5.1.

The results of the TPF analysis for Bangui show that Bangui faces high concerns (indicator scores 8-10) in the areas of burden of disease, education, air quality, economic pressure, poverty, political stability, government effectiveness and rule of law.

City Blueprint: water management performances

The CBF for Bangui have been provided, scores have been calculated and reviewed and are provided in Table 8 and Figure 6. The Blue City Index, the geometric mean of the 24 CBF indicators of Bangui is 5.3

Table 8 City Blueprint Framework of Bangui, CAR. Great concerns are depicted in bold.

Category	Indicator	Score
I Basic water services	1 Access to drinking water	3.0
	2 Access to sanitation	2.8
	3 Drinking water quality	9.3
II Water quality	4 Secondary WWT	4.6
	5 Tertiary WWT	0.0
	6 Groundwater quality	2.0
III Wastewater treatment	7 Nutrient recovery	0.0
	8 Energy recovery	0.0
	9 Sewage sludge recycling	0.0
	10 WWT energy efficiency	2.0
IV Water infrastructure	11 Stormwater separation	0.0
	12 Average age sewer	9.6
	13 Water system leakages	8.0
	14 Operation cost recovery	6.0
V Solid waste	15 MSW collected	10.0
	16 MSW recycled	0.0
	17 MSW energy recovered	0.0
VI Climate adaptation	18 Green space	10.0*
	19 Climate adaptation	5.0
	20 Climate-robust buildings	0.0
VII Plans and actions	21 Management & action plans	4.0
	22 Water efficiency measures	4.0
	23 Drinking water consumption	10.0
	24 Attractiveness	1.0

*Using the satellite map of Bangui, blue-green space is estimated to be more than 50% leading to an indicator score of 10.

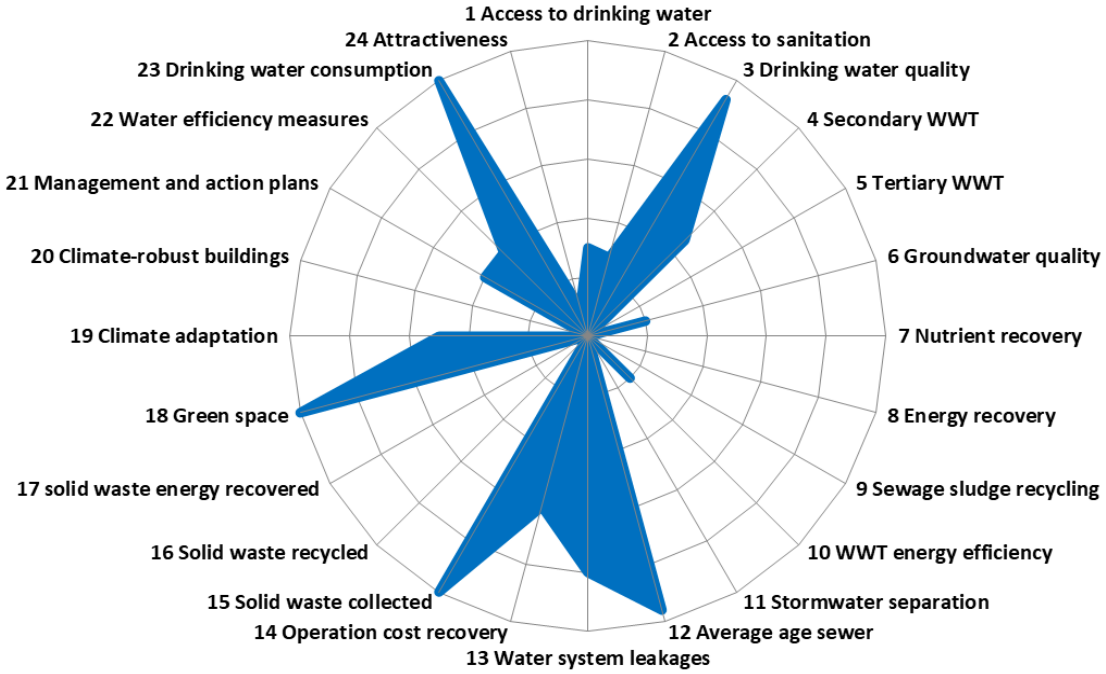


Figure 6 The City Blueprint Framework's spider diagram of Bangui, CAR. The bluer, the better the water management performance. Blue City Index is 2.3.

The spider diagram of Bangui shows that there are excellent scores for drinking water quality, average age of the sewer, water system leakages, solid waste collected, green space and drinking water consumption. On the other hand, there are great challenges in the areas of access to drinking water, wastewater treatment and solid waste collection and treatment.

3.2.3 Most viable solutions & recommendations

The authors who assessed Bangui have provided a lot of comments in the final report of Bangui and thank UNESCO for having undertaken this approach. Some difficulties have been encountered due to a lack of indicators in the database of the authorities in charge of water resource management in the country. The detailed report is a description of the various consultations carried out with stakeholders in the water and sanitation sector in the Central African Republic. The results of the TPF analysis for Bangui show that Bangui faces high concerns (indicator scores 8-10) in the areas of burden of disease, education, air quality, economic pressure, poverty, political stability, government effectiveness, and rule of law. The spider diagram or City Blueprint of Bangui shows that there are excellent scores for drinking water quality, age of the sewer, water system leakages, solid waste collected, green space and drinking water consumption. On the other hand there are great challenges in the areas of access to drinking water, waste water treatment and solid waste collection and treatment.

The results obtained in this work pave the way for new perspectives that will be developed in the second phase of the pit project. Anyhow, the results as described above clearly provide a series of opportunities for improvement and will now enable the Central African Republic to capitalise on the data and make it available for studies at the sub-regional level.

The author, Vanessa Grekonzy has provided the following recommendations:

- Reinforcement of the production capacity of the drinking water treatment plant
- Setting up public waste bins

- Ensure waste separation at the household level
- Construct improved latrines at the level of educational and training institutions
- Setting up a water sector regulatory agency
- Perform an on-site chlorination in order to guarantee the quality of the water supplied
- Building sewage treatment plants in major hospitals and some boroughs
- Implementing Tertiary Wastewater Treatment
- Install a protective perimeter and to develop traditional wells and sources
- Recycle sewage sludge and heat treat it for use in agriculture
- Redeveloping old collectors

This can be done, amongst other things by: raising public awareness; field trips, continue the work on identification of the most relevant indicators.

3.3 Harare

3.3.1 City Introduction

Zimbabwe currently has a population of nearly 15 million. The population density in Zimbabwe is 38 per Km^2 .The total land area is 386,850 Km^2. 38.4 % of the population is urban (5,700,460 people in 2020) and the median age in Zimbabwe is 18.7 years.

Harare is the capital and most populous city of Zimbabwe. The city has an area of 960.6 km^2. 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 is the most populous city in Zimbabwe having an average population of 1.53 million people (excluding the satellite towns) in 2020 and estimated growth rate of 0.59% from 2019. Situated in north-eastern Zimbabwe in the country's Mashonaland region, Harare is a metropolitan province, which also incorporates the municipalities of Chitungwiza and Epworth.

Harare lies at an elevation of 1,483 metres and has a subtropical highland climate, temperate climate. The average annual temperature is 17.95ºC, rather low for tropics. This is due to its high altitude position and the prevalence of a cool south-easterly airflow. However, with climate change we have seen 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 temperatures ranges are about 7-22ºC in July (coldest month) and about 16-26ºC in January (mid-summer). The average annual rainfall is about 825mm in the southwest, rising to 855mm on the higher land of the northeast. On average there are 73 days per year with more than 0.1 mm of precipitation or 6.1 days with a quantity of rain, sleet, snow etc. per month. 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.

Source: Samwise Gamgee (https://en.wikipedia.org/wiki/File:Harare_Skyline.jpg)

Harare was founded in 1890 by the Pioneer Column, a small military force of the British South Africa Company, and named Fort Salisbury after the United Kingdom's Prime Minister Lord Salisbury. Company administrators demarcated the city and ran it until Southern Rhodesia achieved responsible government in 1923. Salisbury was thereafter the seat of the Southern Rhodesian (later Rhodesian) government and was the capital of the Central African Federation in the period of 1953–1963. It retained the name Salisbury until 1982, when it was renamed Harare on the second anniversary of Zimbabwean independence from the United Kingdom.

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 is done. The population has grown to about 4.5 million (which includes the satellite towns), and the water supply systems are have severe under-capacity and cannot meet the demand. Harare is has a mandate to supply water to its satellite towns even though it has been failing to supply water to its own suburbs.

The Harare raw water has been depreciating in its quality due to domestic, agricultural and industrial activities. Sewage works in these local authorities are dysfunctional resulting in raw sewage flows into the dams since they are located downstream of the settlements this has seen an increasing demand for chemicals to make the water potable. The city now uses 8 chemicals to effectively deal with impurities and is incurring an expenditure of US $3 million per month.

Besides the costs, there is a reduced productivity as filters at the works are frequently chocked and have to be backwashed. The current backwashing frequency is now every 8 hours resulting in water losses of 105 million litres a day instead of backwashing once In 48 hours which would lose only 17.5 million litres a day.

3.3.2 Trends and pressures hampering water management

The Trends and Pressures Framework for Harare have been provided, scores have been calculated and reviewed and are provided in Table 9 and Figure 7. The TPI (Trends and Pressures Index) for Harare is 4.9. It means that Harare face substantial social, environmental, financial and governance pressues that may form barriers for adequate local water management.

Table 9 Trends and Pressures Framework's scores for Bangui. Great concern scores are depicted in bold (TPI = 4.9).

Category	Indicators		Score
I SOCIAL	1 Urbanization rate		4.8
	2 Burden of disease		**9.0**
	3 Education rate		**9.7**
	4 Female participation		2.1
II ENVIRONMENTAL	Flood risk	5 Urban drainage flood	5.3
		6 Sea level rise	0.0
		7 River peak discharges	0.0
		8 Land subsidence	0.0
	Water scarcity	9 Freshwater scarcity	4.0
		10 Groundwater scarcity	2.5
		11 Sea water intrusion	0.0
	Water quality	12 Biodiversity	3.2
	Heat risk	13 Heat island	5.0
	Air quality	14 PM2.5/10	2.9
III FINANCIAL	15 Economic pressure		**9.8**
	16 Unemployment rate		2.1
	17 Poverty rate		5.7
	18 Investment freedom		7.5
IV GOVERNANCE	19 Voice and accountability		7.3
	20 Political stability		6.4
	21 Government effectiveness		7.4
	22 Regulatory quality		**8.2**
	23 Rule of law		7.5
	24 Control of corruption		7.4

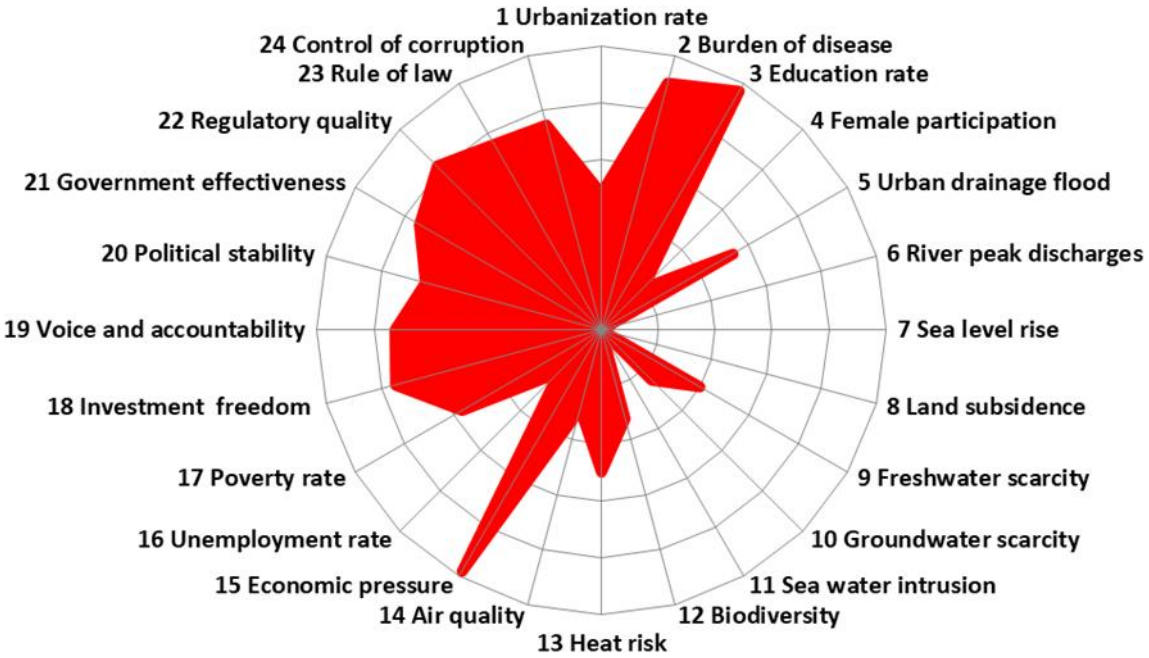


Figure 7 City Blueprint Framework's spider diagram of Harare, Zimbabwe. The redder, the more pressures the city faces that may hamper water manager. Trends and Pressures Index is 4.9.

The results of the TPF analysis for Harare show that Harare faces some great concerns (indicator scores 8-10) in the areas of burden of disease, education, economic pressure and regulatory quality. Many of the other World Bank governance indicators also show to be of high concern.

3.3.3 City Blueprint water management performances

The research first began with a desktop analysis. This is where we searched for the data for each indicator online, through research articles and reports. We were trying to find out which data can be obtained online without having to meet the stakeholders. This first process was difficult as you hardly find data online especially from organizations in Zimbabwe and the only information we could find was from years back. Data from international organizations would only be for the country not specific to cities especially in Africa. We mainly engaged with the Harare city council, department of water. They provided us with most of the data from their 2018 service level benchmarking and they had expertise in most of the indicators. Our main contact person was Engineer Chinyanya. We also engaged the Environmental Management Agency, the Ministry which incorporates the department of water and the Zimbabwe National Statistics.

The CBF for Harare have been provided, scores have been calculated and reviewed and are provided in Table 10 and Figure 8. The Blue City Index, the geometric mean of the 24 CBF indicators of Harare is 3.7.

Table 10 Results of the City Blueprint Framework of the city of Harare, Zimbabwe.

Category	Indicator	Score
I Basic water services	1 Access to drinking water	6.5
	2 Access to sanitation	7.0
	3 Drinking water quality	9.4
II Water quality	4 Secondary WWT	6.0
	5 Tertiary WWT	6.0
	6 Groundwater quality	5.3
III Wastewater treatment	7 Nutrient recovery	2.0
	8 Energy recovery	10.0
	9 Sewage sludge recycling	10.0
	10 WWT energy efficiency	4.3
IV Water infrastructure	11 Stormwater separation	0.0
	12 Average age sewer	3.9
	13 Water system leakages	1.0
	14 Operation cost recovery	8.5
V Solid waste	15 MSW collected	0.0
	16 MSW recycled	0.0
	17 MSW energy recovered	2.5
VI Climate adaptation	18 Green space	10.0
	19 Climate adaptation	6.0
	20 Climate-robust buildings	6.0
VII Plans and actions	21 Management & action plans	4.0
	22 Water efficiency measures	8.9
	23 Drinking water consumption	7.0
	24 Attractiveness	4.0

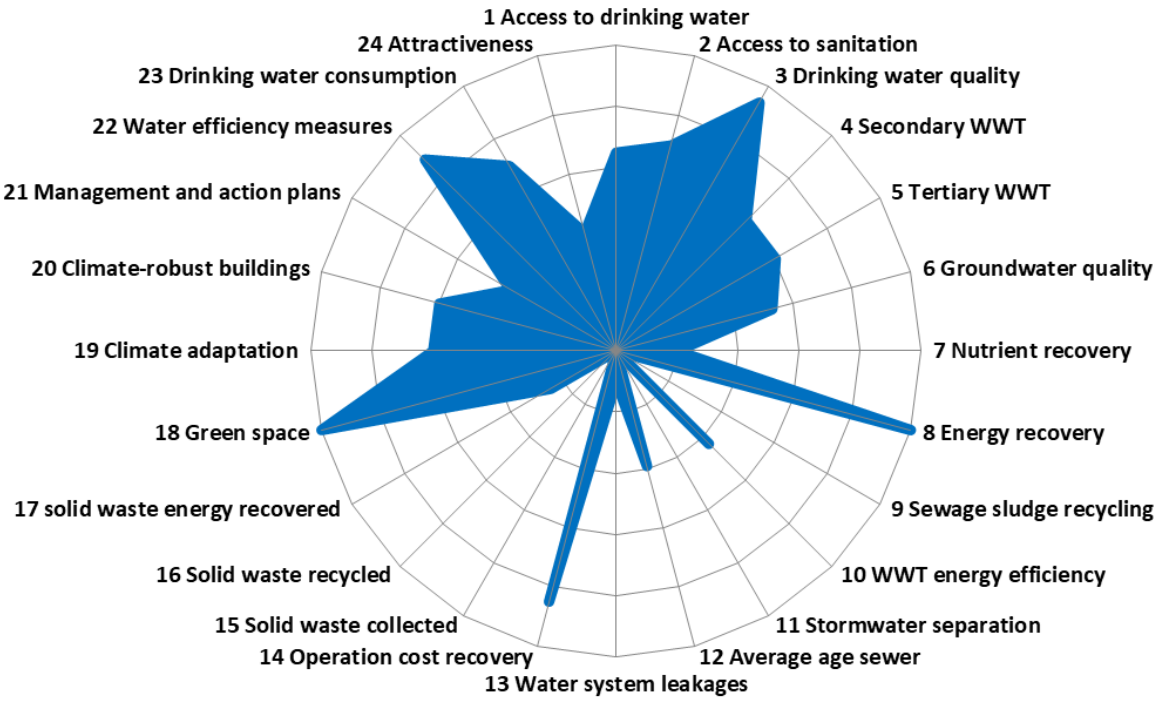


Figure 8 City Blueprint Framework's spider diagram of Harare, Zimbabwe. The bluer, the better the water management performance. Blue City Index is 3.7.

The spider diagram of Harare shows that there are excellent scores for drinking water quality, energy recovery, operation cost recovery, green space and water efficiency measures. On the other hand, there are great challenges in the areas of access to drinking water and sanitation, waste water treatment and solid waste collection and treatment.

3.3.4 Most viable solutions & recommendations

Georgina Mukwirimba and Tariro Marekwa (UNESCO Regional Office for Southern Africa) have drawn the following conclusions and provide the following recommendations:

The local municipality with support from government and perhaps donors must take the initiative to introduce energy recovery forms (technology) in the country. This will not only provide a clean source of energy at the treatment plants but will also create employment for the people in Zimbabwe especially the youth and will be very economical.

There is need to decentralise the water authority from Harare to satellite towns like Chitungwiza, Epworth so that they become water authorities and supply water from their local dams. This needs funding to set up the treatment plants and the distribution systems and a lot of involvement from a lot of stakeholders (council, government, NGOs, intergovernmental organisations, community & donors).

The infrastructure for wastewater collection and distribution of water is very old and requires replacement and even expansion (council, donors, NGOs, community).

A dialogue between the Harare city council, government ministries (finance, water, health etc.), president and political members, community representatives, UN agencies and other related NGOs must take place, to look at the problem on the ground and identify the role of each party to solve them holistically.

We could contribute to facilitating the process of creating a dialogue between the above stakeholders and following up on the action points discussed in the dialogue. Hopefully contribute to mobilising funds from donors (grant

proposals) to compliment the funds from the municipality and government. Contribute in capacity building of the relevant stakeholders, be it skills, knowledge and other resources. If projects kick in, our civil engineering knowledge can be relevant in the design and construction part of the projects for easy collaboration among the different actors.

The first advice would be to involve as many stakeholders both in the public and private sector. This will ensure the information obtained is the most accurate and up to date. The other advice would be to spend less time in desktop analysis. Especially for African Countries, the information is mostly within the relevant stakeholders so the most time must be spent engaging these stakeholders and conducting interviews.

3.4 Libreville

3.4.1 City Introduction

Gabon, officially the Gabonese Republic (French: République gabonaise), is a country on the west coast of Central Africa. 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 (100,000 sq. mi) and its population is estimated at 2.1 million people. Its capital and largest city is Libreville. The official language is French.

Libreville is the capital and largest city of Gabon. 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.

City: Le grand Libreville

Commune: Akanda, Libreville, Owendo and Ntoum

Area: 1058 Km2

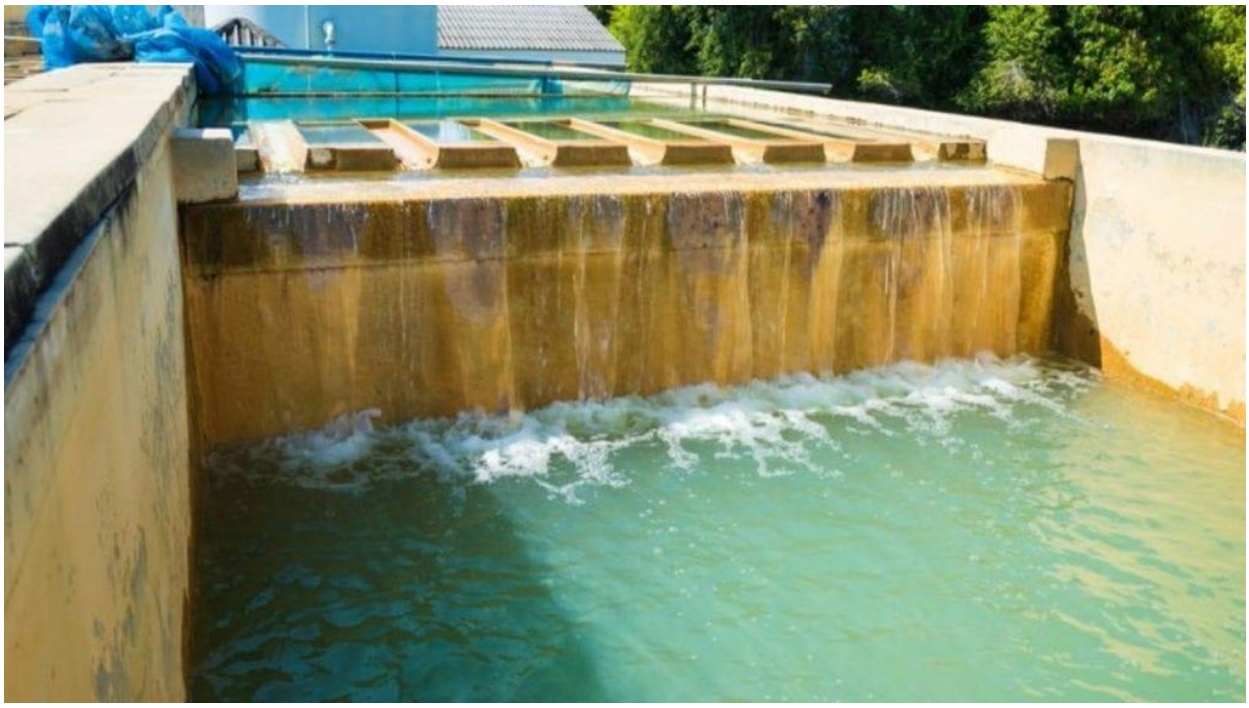
Population: 920,000 inhabitants

Climate: equatorial, hot and humid, characterised by very high rainfall (2000 to 3800 mm) and a large number of rainy days ranging from 170 to 200.

Temperatures: high all year round 24°C between 21° and 28°C.

Hydrographic network: Very dense, 1 river every 600m

Source: https://wwwnc.cdc.gov/travel/destinations/traveler/none/gabon



Source: https://africaincmag.com/2020/09/08/gabons-utility-company-seeg-launches-new-projects-to-enhance-access-to-water-and-electricity/

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

3.4.2 Trends and pressures hampering water management

The Trends and Pressures Framework's data for Libreville have been provided, scores have been calculated and reviewed and are provided in Table 11 and Figure 9. The TPI (Trends and Pressures Index) for Libreville is 5.1. It means that the arithmetic average of the 24 TPF indicators (TPI) of Libreville is relatively high.

Table 11 Trends and Pressures Framework's scores for Libreville, Gabon. Great concern scores are depicted in bold. Trends and Pressures Index is 5.1.

Category	Indicators		Score
I SOCIAL	1 Urbanization rate		5.7
	2 Burden of disease		7.0
	3 Education rate		**9.9**
	4 Female participation		5.4
II ENVIRONMENTAL	Flood risk	5 Urban drainage flood	7.5
		6 Sea level rise	0.0
		7 River peak discharges	0.0
		8 Land subsidence	0.0
	Water scarcity	9 Freshwater scarcity	0.0
		10 Groundwater scarcity	0.0
		11 Sea water intrusion	7.5
	Water quality	12 Biodiversity	2.9
	Heat risk	13 Heat island	5.0
	Air quality	14 PM2.5/10	6.6
III FINANCIAL	15 Economic pressure		7.6
	16 Unemployment rate		**10.0**
	17 Poverty rate		0.6
	18 Investment freedom		4.0
IV GOVERNANCE	19 Voice and accountability		6.9
	20 Political stability		5.5
	21 Government effectiveness		6.6
	22 Regulatory quality		6.8
	23 Rule of law		6.4
	24 Control of corruption		6.7

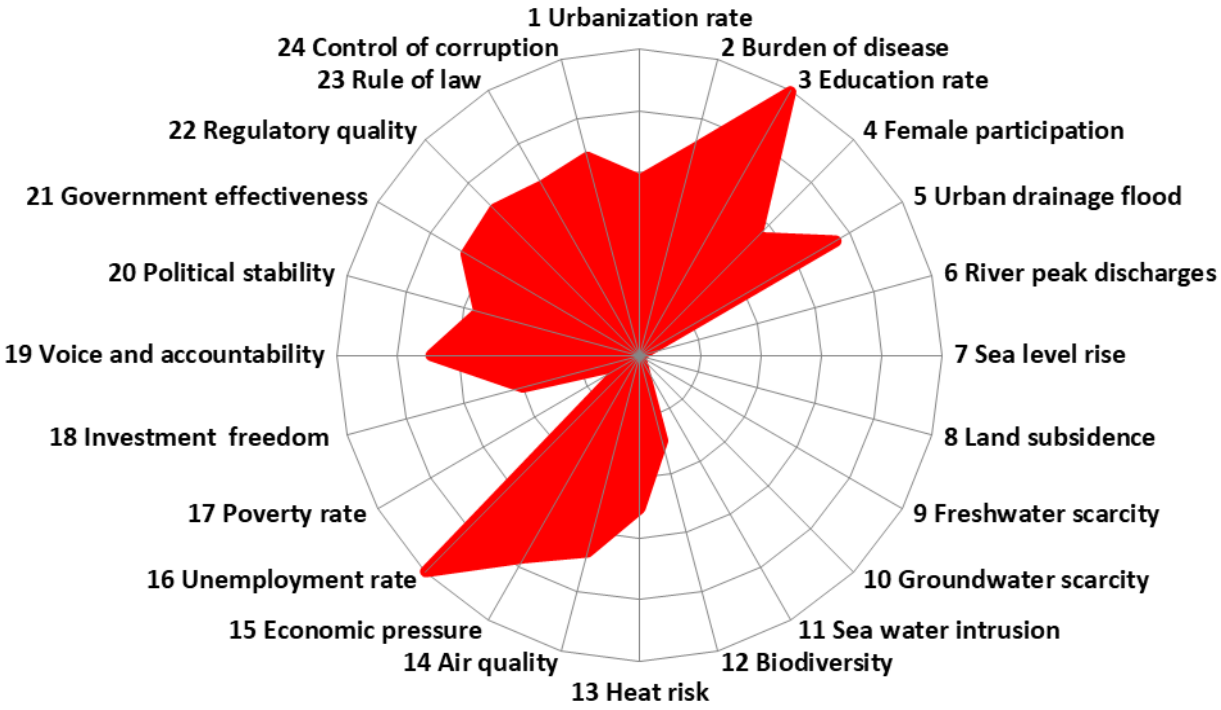


Figure 9 Trends and Pressures Framework's spider diagram Libreville, Gabon. The redder, the more pressures the city faces that may hamper water manager. Trends and Pressures Index is 5.2.

The results of the TPF analysis for Libreville show that Libreville faces two great concerns (indicator scores 8-10) in the areas of education and unemployment. The World Bank governance indicators (Indicators 19-24) burden of disease, education, economic pressure and regulatory quality score as concerning.

3.4.3 City Blueprint water management performances

Public data or data provided by the (waste) water utilities in the city was based on questionnaires, structured oral interviews and interactions with the various water sector stakeholders during field/facility visits. The following stakeholders were consulted and involved in the data collection and interviews:

- Directorate General for Water
- Sanitation Directorate
- Institute of Hygiene and Public Health
- Central Town Hall
- SEEG
- National Climate Council
- AVERDA (waste collection companies)

The results of the CBF for Libreville are provided in Table 12 and Figure 10. The Blue City Index of Libreville is 2.5. Indicators 2, 9, 11 and 23 show very high performance scores. Indicator 12 shows an average score of 5.0 and all other CBF indicators score ≤ 5. This is also reflected in the spider diagram in Figure 10.

Table 12 City Blueprint Framework's scores of Libreville, Gabon.

Category	Indicator	Score
I Basic water services	1 Access to drinking water	5.5
	2 Access to sanitation	4.8
	3 Drinking water quality	9.9
II Water Quality	4 Secondary WWT	0.0
	5 Tertiary WWT	0.0
	6 Groundwater quality	9.0
III Wastewater treatment	7 Nutrient recovery	0.0
	8 Energy recovery	0.0
	9 Sewage sludge recycling	0.0
	10 WWT energy efficiency	0.0
IV Water infrastructure	11 Stormwater separation	0.0
	12 Average age sewer	5.0
	13 Water system leakages	0.1
	14 Operation cost recovery	9.3
V Solid waste	15 Solid waste collected	9.4
	16 Solid waste recycled	2.0
	17 Solid waste energy recovered	0.0
VI Climate adaptation	18 Green space	10.0
	19 Climate adaptation	9.0
	20 Climate-robust buildings	5.0
VII Plans and actions	21 Management and action plans	7.0
	22 Water efficiency measures	5.0
	23 Drinking water consumption	10.0
	24 Attractiveness	4.0

Libreville scores very well on issues such as drinking water quality, groundwater quality, operation cost recovery, solid waste collected, green space, climate adaptation and drinking water consumption. But it is obvious from Table 12 and Figure 10 that access to sanitation, waste water treatment and solid waste handling are major challenges for the city.

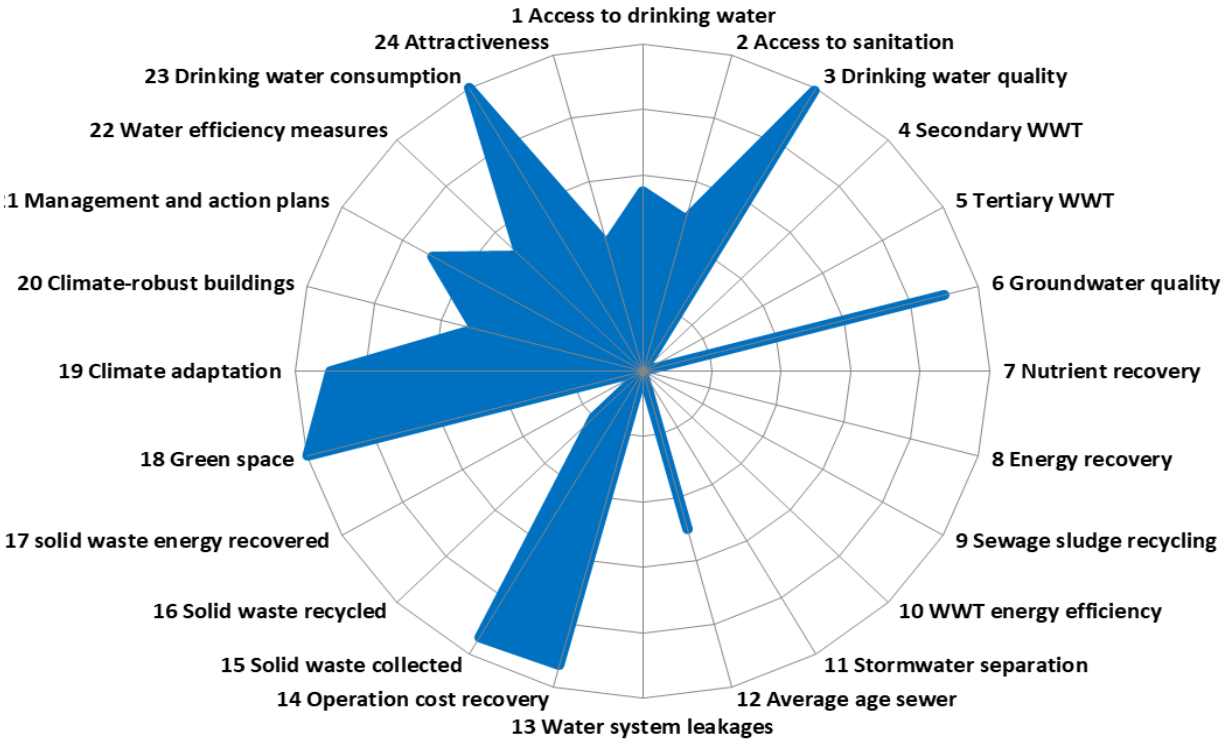


Figure 10 City Blueprint Framework's spider diagram of Libreville, Gabon. The bluer, the better the water management performance. Blue City Index is 2.5.

3.4.4 Governance Capacity analysis

Considering the importance of adequate water governance when attempting to tackle various water-related issues, indicators measuring the governance capacity of a city or region are necessary. There are numerous broader indicators on governance such as the 'Voice and Accountability Indicator', the 'Government Effectiveness Indicator', or the 'Control of Corruption Indicator' amongst others as applied by the World Bank and incorporated in the TPF framework. In the case of Libreville, the Governance Capacity Framework (GCF) is applied, as it provides a reliable overview of governance conditions related to specific water-related issues by examining the state of knowledge on an issue, stakeholder participation and institutional capacity (Koop et al., 2017).

The GCF, measuring urban water governance, adequately assesses governance conditions, in an integrated problem-oriented manner. In order to improve IWRM the governance capacity of a city must be adequate and in order to ameliorate this governance capacity the conditions of the GCF provide important clues of what the priorities are for capacity development to address specific water-related challenges. By applying this framework to cities, one may find out which governance conditions fare well or which fare less well in specific cities and one may even compare different cities with each other to learn how one city responds to a specific issue.

Originally the three issues of water pollution, flooding and water scarcity were to be assessed using the GCF. However, due to Covid-19 outbreak only the in-situ field study in Libreville was interrupted at an early stage and was subsequently continued via long-distance telecommunication. As a consequence, it was decided to focus on a more in-depth analysis of water pollution challenge rather than assessing multiple challenges in less detail. For this analysis, 10 semi-structured interviews with officials from various institutions, as well as with academics and NGO workers were held through online Skype interviews. The predefined questions along with follow-up questions were asked for each indicator. The score substantiations serve to discuss why which score was chosen.

In the context of climate change and urban growth, water pollution issues are likely to play a more decisive role in Libreville's near future social and economic development. The issues hampering the capacity of stakeholders and authorities to together govern water pollution challenges are highly inter-related. A summary of the results is provided in Figure 11. For a more detailed reporting of the assessments results, we refer to annex 1.

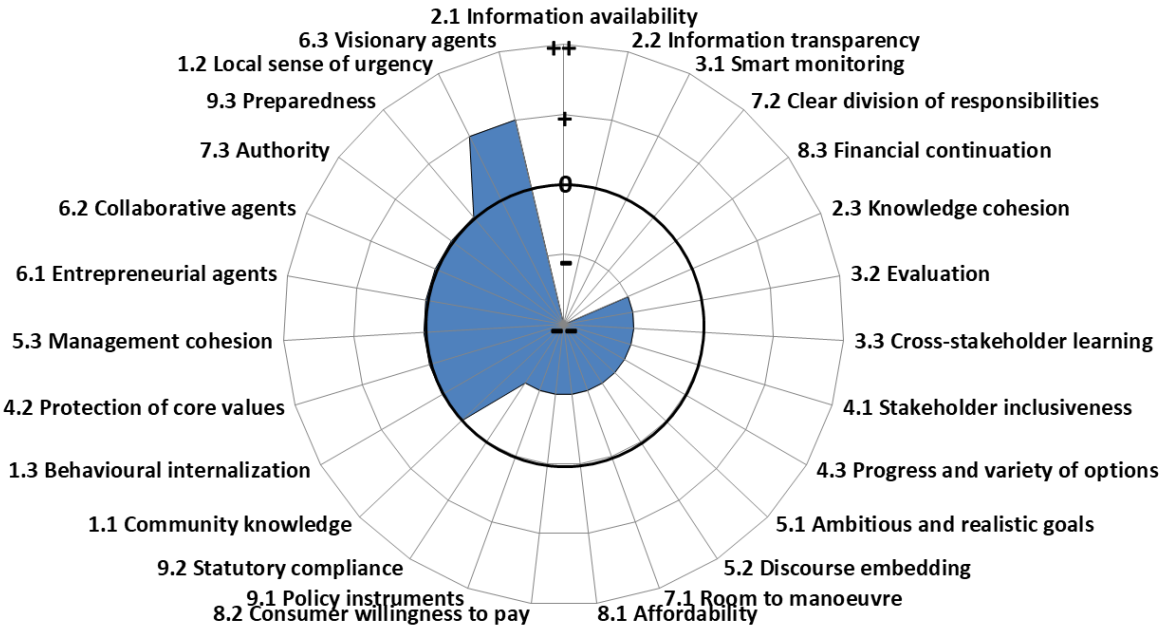


Figure 11 Governance Capacity Framework's spider diagram of the city of Libreville, Gabon.

Without a consistent water quality monitoring system (indicator 3.1) in place throughout the city, it is challenging to know what is going on the system, to determine where most pollution sources originate and test what can be done to stem these. Because there is a lack of data and information on water pollution (indicator 2.1) as well as no monitoring system in place (indicator 3.1), it is also difficult for the relevant institutions to know which policies have to be implemented where (condition 5), which policy instruments have to be applied (indicator 9.1) and how to evaluate if they work or not (indicator 3.2). Also, how may one prepare action plans for sudden pollution incidents or gradual increases in water pollution (indicator 9.3), or determine who complies or does not (indicator 9.2). Hence, insufficient monitoring of water pollution - both domestic and industrial – directly inhibits statutory compliance (indicator 9.2) and evaluation and improvement (indicators 3.2 and 3.3) of existing policies instruments (indicator 9.1).

A lack of financial arrangements (indicator 8.3) and human capacities are also a major barrier at mitigating water pollution in the city. Not only could more financial arrangements help secure an efficient smart water quality monitoring system (indicator 3.1), but are also necessary for the construction of a separate sewage network and wastewater treatment facilities. The continuation of financial arrangements (8.3) might also help secure the completion of projects aiming at reducing water pollution.

In addition to this, the fragmented policies (indicator 5.1) on wastewater treatment, sanitation and water pollution hamper a clear division of responsibilities (indicator 7.2) as to who must do what in practice in regard to these issues. The ministry of water and energy, the ministry of the environment, the ministry of health and the ministry of public works all work on the issues of water pollution, more explicitly sanitation, yet some seem to have similar functions as others. For example, both the ministry of the environment and the ministry of public health check water quality and may sanction. However, the ministry of water and energy, which also may control water quality and is involved

in sanitation efforts, cannot ensure compliance with pollution regulation. Thus, an unclear division of responsibilities also makes sanctioning (indicator 7.3) more difficult and facilities statuary incompliance (indicator 9.2).

A water code, in which competencies as well as the concepts of sanitation and wastewater treatment would be clearly defined, could help resolve issues of overlapping function and unclear division of responsibilities (indicator 7.2) as well as clarify authority to sanction (indicator 7.3). Next to this, an independent regulatory organisation could check the work of these institutions and organise regular meetings between officials of these institutions or create a communication platform between them. In this way, information between the relevant institutions could be shared improving cross-stakeholder capacity building (indicator 3.3) and make information accessible to the public enhancing information availability (indicator 2.1).

However, in order to address water pollution issues in Libreville the first most beneficial step is the implementation of a smart water quality monitoring system (indicator 3.1). Consequently, a monitoring system and a larger amount of available information (indicator 2.1) on water quality would make foreign investment into addressing these issues more attractive as a return on investments would be secure. Hence, this would strengthen financial continuation (indicator 8.3) for projects aiming at addressing water quality and investment in hard infrastructure as well as the education of professionals in the field. Secondly, a water code with new laws and short-term policy goals would be beneficial at guiding the work of institutions in charge of addressing water pollution by clearly identifying their responsibilities (indicator 7.2) and authority (indicator 7.3). Third, a regulatory organisation could help improve communication between ministries and evaluate their efforts as well as new policies in place. Fourth, regular meetings organised between this regulatory body, the relevant institutions, municipalities, NGOs and the private sector may serve to improve stakeholder inclusiveness and protection of core values (indicator 4.1; 4.3) as well as even alter the behaviour of stakeholders (indicator 1.3).

3.4.5 Most viable solutions & recommendations

The analysis of Libreville shows that there are many issues that can be improved. The most important ones according to Gwladis Ovenga are:

- Redesigning the distribution network and the frequency of water withdrawal for treatment
- Knowledge tools and capacity building
- Strengthening initiatives on the effects of climate change at the coastal level
- Solid waste collection and handling can be added too

The challenges will probably needs much time and effort to be addressed and involvement is crucial from

- The Government
- The drinking water production and distribution company
- Raising awareness and sensitizing the population on water-related challenges

Many of the observations as provided in the governance capacity assessment carried out by Fritz Jaax (Utrecht University) after the initial assessment of Libreville need to be addressed as well. These will be reported in a separate report (master thesis).

3.5 Windhoek

3.5.1 City Introduction

The protection of groundwater sources is critical for human survival and economic development, especially in drought-prone areas where the average rainfall is less than 1,000 mm per year and inter annual rainfall variability is high. This is the case for Namibia, an arid country flanked by the Namib Desert in the west and Kalahari Desert in the east. Over 80% of its 842,000 square kilometres is desert, arid or semi-arid (Lahnsteiner & Lempert, 2007). Windhoek, its capital, receives around 370 mm of annual rainfall, with a surface water evaporation rate of 3,200-3,400 mm/y. Added to this, temperatures in Namibia have been steadily increasing since the 1970s: the number of days where temperatures exceed 35°C have 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., 2010). The infrequency and variability of rainfall combined with the high evaporation rate result in a 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 disincentivised water conservation measures (Lahnsteiner & 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 (https://worldpopulationreview.com/world-cities/windhoek-population) 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 of time 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/y (or 150 l/cap/d) is expected to increase, which will add pressure to an already limited resource (Van der Merwe, 2000). All of this is occurring in the context of a water sector that is lacking funding, technical expertise, shows poor collaboration and communication between stakeholders, weak regulation, and enforcement (Lewis et al., 2019).

Windhoek's water management

Windhoek started protecting its limited water resource decades ago. This is because in the 1960s, the city approached the limits of groundwater and surface water availability, which compelled it to diversify its water sources. As a result, in 1968 it pioneered a direct water reclamation system from domestic sewage to supplement potable water to its citizens. Follow-up studies highlighted its success, due to the quality of the water and the positive financial benefits compared to other water supply alternatives (Haarhoff & Van der Merwe, 1996). In 1993, the city installed a dual pipe system to ensure that all municipal parks, gardens, and sports fields could be irrigated with treated sewage effluent, replacing around six percent of potable water demand (Lewis et al., 2019). Despite these efforts, in 1995 the city began falling short of drinkable water once again due to a rising urban population and resulting increase in water demand (Haarhoff & Van der Merwe, 1996). Around that time, the city began emulating international practice: Windhoek's council approved an Integrated Water Resource Management (IWRM) plan, adopted across global communities to maintain a high quality and availability of water resources. This aims to reduce consumption and improve water use efficiency by considering the water cycle in a holistic manner, including policy and legislative considerations, technical and financial measures, and education (Van der Merwe, 1996). The block tariffs on water consumption were one of the most successful way to control water consumption, leading to a residential water use decrease from 201 to 130l/cap/day between 1994-1999, or 40% per capita reduction. Over time this decrease reached a plateau, despite water rates increasing almost annually. This suggested that block tariffs would need to be combined with other measures (Lewis et al., 2019), which led to a penalty tariff for households consuming over 50m^3 per month (the threshold was later lowered to 40m^3 per month) and a basic water tariff increase of 10% (Haidula, 2015).

In addition, the option of recharging the aquifer artificially with potable water was considered in 1997, to offset the depletion of the valuable groundwater resource. The recharge water would be comprised of 75% surface water and 25% reclaimed wastewater, treated to drinking water quality standards, to prevent groundwater deterioration and minimise clogging of recharge boreholes (Lewis et al., 2019). Underground storage reduces water loss to 5% over a 10-year period, compared with dam storage, which can reach up to 50% losses over 10-year period. The aquifer's useful storage capacity is around 90 Mm^3, or around three times the city's current water demand, however a full recharge has been constrained by limited finances (Lewis et al., 2019). In the meantime, the city is considering other augmentation ideas, for instance transfer of water from the Okavango River (Lewis et al., 2019), however the river is on a shared border which makes extracting water from there a political issue. Other alternatives such as desalination involve time, costs and environmental hazards that need to be thoroughly assessed prior to implementation. For example, using desalinated water would entail long travelling distances, which may not be financially nor technically viable. This suggests that careful monitoring and consideration needs to be conducted prior to implementing new drinking water sources, to ensure their sustainability and feasibility.

The water demand management in Windhoek is seen as a success story, however a low budget allocation and inconsistency in implementing the IWRM plan affected it negatively. This is because implementation is only maintained during drought periods (Lewis et al., 2019). This suggests that decision-makers, water managers and water users need to embed long term planning and accelerate the IWRM plan effort. Alongside the IWRM, the government also reformed the institutions that had been inherited from the apartheid regime. This included separating roles and responsibilities between institutions and governance levels. As a result, the Ministry of Agriculture, Water and Land Reform (MAWLR) became responsible for water resource management, NamWater became the state-owned bulk water supplier across the country, selling to local municipalities, who became accountable for distributing and re-selling water to citizens (Lewis et al., 2019).

Water supply

Windhoek features three main sources of water supply (Figure 1). The main sources are the Grootfontein-Omatako Eastern National water Carrier and three large, interlinked reservoirs (Omatako, Von Bach and Swakoppoort dams), supplied with surface water from ephemeral rivers and groundwater transferred from aquifers around 450km north of the city (Lewis et al., 2019). The network can supply up to 95% of the required water, however erratic inflow and chronic water shortages led the city to pilot reclaimed municipal wastewater usage (section 2.2.1), which covers around 25% of the water supply: the capacity of the water recovery stands at 7.5 million m^3/year, with the city currently using around 5.5 million m^3/year, or around 160 l/cap/day (Van der Merwe, 2000). Since the beginning of reclaimed wastewater, there has been no outbreak of waterborne diseases or negative health effects, suggesting that this provides a sound drinking water resource in Namibia. These combined features highlight the value of wastewater reclamation as a sustainable, long-term water source.

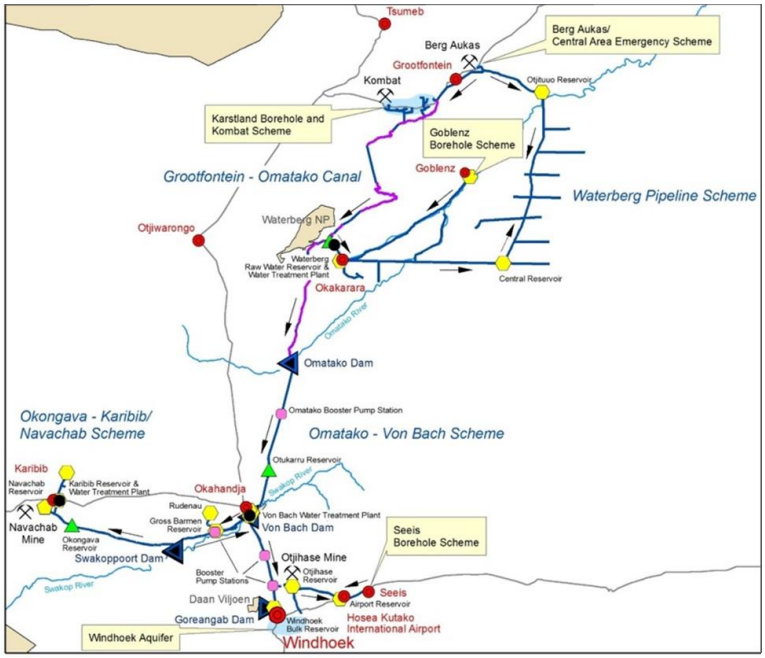


Figure 12 Central Area of Namibia water supply scheme. Source: Lund Consulting Engineers, Windhoek (IWA, 2020).

Actions

Added to water supply diversification and IWRM, Windhoek has taken other measures to offset water depletion. It established objectives to decrease the per capita consumption to 100 l/day, and imposed block tariffs to curb excessive water consumption with sharp penalties when this exceeds 200 l/day (Lahnsteiner & Lempert, 2007). A consumption related water pricing is also in place (Municipality of Windhoek, 2004), with higher consumption of water being charged more (in 2004, 0-0.2 m^3/day cost 0.58 €/m^3, while 1.8 m^3/day cost 1.8 /m^3). Windhoek also implemented technical measures such as leakage control, carried out with frequent leakage detection and water audits. This led to a systematic pipe replacement system that reduced water losses in Windhoek to only 13% (Ministry of Agriculture, Water and Forestry, 2006), which is a very low value even when compared to developed regions. There are also strict regulations against pollution threats: the city of Windhoek is compensated by anyone polluting the aquifer, and additionally the "polluter pays" principle is applied, whereby the polluter deals with the cost of repairing the damage. The regulations also provide for a new groundwater protection land zone, where no potentially polluting business, industry or enterprise can be built (Lewis et al., 2019). Lastly, Windhoek has established a public awareness campaign on reducing water use and overcoming psychological barriers to the wastewater reclamation plant (Lahnsteiner & Lempert, 2007): this has mainly included educational programmes in schools, radio, or television.

It is evident that 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). This means that Windhoek should strive to continuously apply its integrated approach to water management and aim for clear long-term visions marked by progressive milestones in order to be fully prepared to meet future demands and to respond to climate emergencies.

Challenges in the water sector

One of the major challenges facing water resource management globally is to meet water demand in the future. This vision is seemingly lacking, or still at its infancy, in Windhoek (section 2.2.3), since it requires a form of strategic

planning that is hindered by issues of economic, political and social nature (Lewis et al., 2019). Governance plays a key role in urban water management performance (Grindle, 2007). In Namibia, inadequate governance structures have failed to implement suitable plans and policies since independence in 1990 (Remmert, 2016), resulting in a weakened water sector. Windhoek's council features little staff with the skills and technical expertise that are required to navigate across the water sector. A lot of this experienced staff has moved to the private sector due to more attractive benefits, creating an imbalance of skills that hinders adequate water management (Remmert, 2017). It is of paramount importance that the private sectors be involved in mentoring, capacity building and maintenance of infrastructure to at least mitigate some of this imbalance. Even if the private sector were to be more involved, the top-down approaches used to manage the resource have resulted in limited stakeholder involvement, aggravated by the absence of platforms through which stakeholders and water experts can engage with the government: some solutions may exist, but they are not being communicated to the individuals that are responsible for enacting them (New Era, 2016). As a result, the current communication and coordination strategy needs to be revisited and alternative systems of cooperation must be established (Lewis et al., 2019).

Namibia's national budget has prioritised transport, military and public services over water and sanitation (Brown, 2016). Consequently, the water sector is constantly challenged with lack of finances for capital investments in new projects as well as the maintenance of existing structures. This means that urban water infrastructure has exceeded its design life in most areas, leading to high leakage rates in some houses up to 110l/day (Remmert, 2016). This needs to be offset, since the acceptable threshold of water leakage is of 20l/day. It is stated that the annual savings that could be achieved with proper maintenance of water infrastructure are up to N$5.8 million (Lewis et al., 2019), which suggest that the council needs to address maintenance as part of a sustainable water supply strategy but also as a means to retain more finances for future developments.

3.5.2 Trends and pressures hampering water management

The result of the trends and pressures analysis are presented in Figure 13 and Table 13.

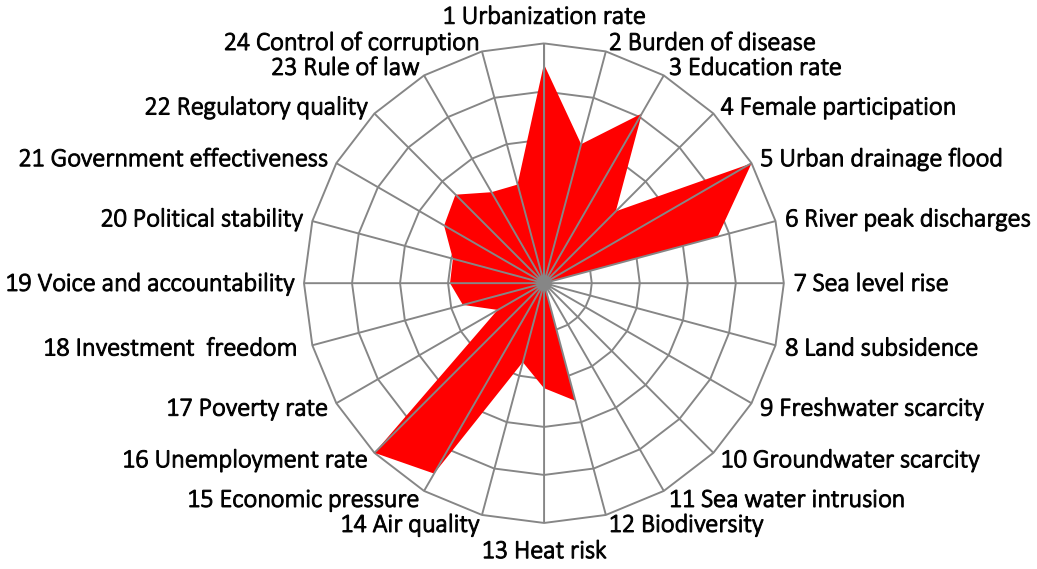


Figure 13 Trends and Pressures Framework's spider diagram Windhoek, Namibia. The redder, the more pressures the city faces that may hamper water management. Trends and Pressures Index is 4.6.

The Trends and Pressures Framework indicators consist of a total of 24 indicators (including the sub-indicators) and are divided over the following broad categories: social, environmental and financial pressures and include a 4th category, i.e. the World Bank governance indicators. The Trends and Pressures analysis followed the procedure as described by Koop and Van Leeuwen (2020a) and is explained in great detail there. Scores of 0-2 represent no concern, scores between 2 and 4 are of little concern, scores between 4 and 6 are of medium concern and scores between 6-8 and 8-10 are concerns and great concerns, respectiviely. From Figure 13 and Table 13 it is shown that Windhoek faces great concern scores (scores >8) for urbanization, education, urban drainage flooding, economic pressure and unemployment.

Table 13 Overview of the Trends and Pressures Framework (TPF) categories and indicators of Windhoek.

Category	Indicators		Score
I SOCIAL	1 Urbanization rate		9.1
	2 Burden of disease		6.0
	3 Education rate		8.2
	4 Female participation		4.2
II ENVIRONMENTAL	Flood risk	5 Urban drainage flood	10.0
		6 Sea level rise	7.5
		7 River peak discharges	0.0
		8 Land subsidence	0.0
	Water scarcity	9 Freshwater scarcity	0.0
		10 Groundwater scarcity	0.0
		11 Sea water intrusion	0.0
	Water quality	12 Biodiversity	5.1
	Heat risk	13 Heat island	4.4
	Air quality	14 PM2.5/10	3.4
III FINANCIAL	15 Economic pressure		9.2
	16 Unemployment rate		10.0
	17 Poverty rate		2.2
	18 Investment freedom		3.5
IV GOVERNANCE	19 Voice and accountability		3.9
	20 Political stability		3.9
	21 Government effectiveness		4.8
	22 Regulatory quality		5.2
	23 Rule of law		4.4
	24 Control of corruption		4.3

3.5.3 City Blueprint water management performances

The CBF analysis (Table 14 and Figure 14) was mainly carried out using online academic literature, government documents, open access studies. The limited volume of studies on water systems in Windhoek means that some data was also obtained by individuals working in the municipality of Windhoek. The overall City Blueprint Index (BCI) value for Windhoek is 5.0. The highest-ranking score was groundwater quality, which achieved a 10, closely followed by access to drinking water that scored 9.9. Multiple indicators gained a score of zero, which suggests that the water infrastructure needs to be updated in Windhoek.

Overall, the results from the CBF highlight a gap in the technical infrastructure that would be needed to support water systems. However, these same results also indicate that the municipality of Windhoek has excelled in providing

a vast majority of its citizens with potable water, despite finding itself in a water scarce context, which is a commendable outcome.

Table 14 City Blueprint Framework's scores of Windhoek, Namibia.

Category	Indicator	Score
I Basic water services	1 Access to drinking water	9.9
	2 Access to sanitation	5.3
	3 Drinking water quality	9.4
II Water Quality	4 Secondary WWT	8.0
	5 Tertiary WWT	8.0
	6 Groundwater quality	10.0
III Wastewater treatment	7 Nutrient recovery	0.0
	8 Energy recovery	5.0
	9 Sewage sludge recycling	0.0
	10 WWT energy efficiency	5.0
IV Water infrastructure	11 Stormwater separation	3.0
	12 Average age sewer	0.0
	13 Water system leakages	7.2
	14 Operation cost recovery	7.0
V Solid waste	15 Solid waste collected	0.0
	16 Solid waste recycled	1.0
	17 Solid waste energy recovered	0.0
VI Climate adaptation	18 Green space	0.0
	19 Climate adaptation	7.0
	20 Climate-robust buildings	5.0
VII Plans and actions	21 Management and action plans	3.0
	22 Water efficiency measures	7.0
	23 Drinking water consumption	9.0
	24 Attractiveness	5.0

Literature results occasionally disagreed with the findings in the present study: for example, the 2019 NamWater report claimed that 67% of its annual budget is spent on maintenance, but this was not reflected in the status of infrastructure nor in the stakeholder perception of it. In fact, the absence of adequate maintenance was highlighted as one of the key issues. Water systems require expensive capital investment and high maintenance costs (High Level Panel on Water, 2020), so it may be that the money allocated is simply not enough to maintain the entire urban water cycle. This is troubling considering the high percentage of the total budget that is spent on maintenance.

There are further discrepancies: "access to drinking water" was rated a high 9.9 based on data by Uhlendahl et al. (2010). According to Lewis and colleagues (2018) however, only 11% of residents in informal settlements live within one kilometre of safe drinking water. This is the minimum potable water access standard set by the World Health Organisation (WHO). A total of 67% households live between one and five kilometres away from a water tap, which sheds a different light on the high-ranking criteria. Access to drinking water can be interpreted in many ways, for example it may exclude a maximum travel distance, which suggests that the criteria requirement may need to integrate these international standards. This is compounded by Windhoek's ambiguous boundaries: informal settlements are formed *ad hoc* and are constantly evolving. This means that Windhoek's boundary probably has changed since Uhlendahl et al.'s paper (2010). The result is that the water supply infrastructure may need to be

constantly updated to reflect new migration. The present research project aims to encompass all of Windhoek and its surrounding informal settlements, so in person substantiation of this criteria may be required.

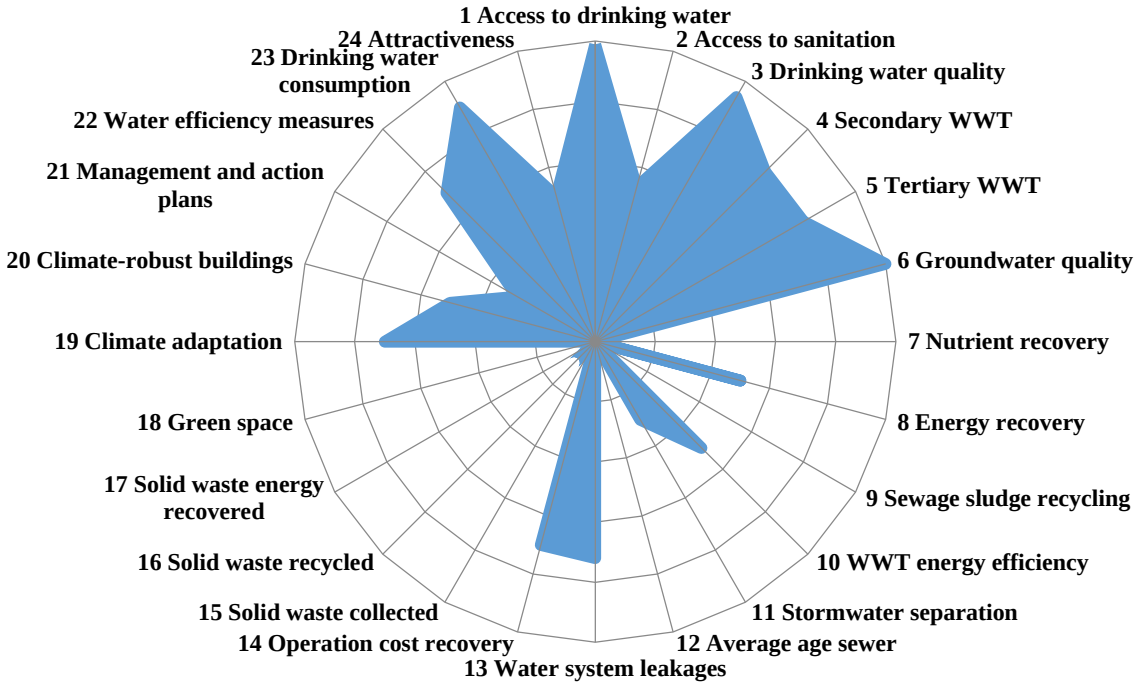


Figure 14 City Blueprint Framework's spider diagram of Windhoek, Namibia. The bluer, the better the water management performance. Blue City Index is 5.0.

Another high ranking criteria was "drinking water quality", however the results were found from a paper assessing groundwater quality from 15 grab samples of the Goreangab Dam (Weler Consulting Services, 2020), all of which met quality standards, and from NamWater's 2019 Technical Report, which included 2,620 bacteriological samples of which 5.61% did not meet water quality standards. Overall these findings should be reliable, but the absence of a data port that brings together all the information on water quality across the multiple water sources (groundwater, surface water and reclaimed wastewater) suggests that findings should be interpreted with caution and substantiated with clear studies across the water cycle. This same principle applies to the "groundwater quality" criterion: this also scored a 10, based on the same Weler study on the Goreangab dam. Additionally, according to some stakeholders, there is missing knowledge on what good quality, drinking water should be. This is true even within water-related businesses, which suggests that this information should be freely and openly available for everybody to ensure that a high degree of water quality follows international standards and not personal interpretation.

The "water system leakages" criterion is worth elaborating on: a positive 13% loss was identified in literature (Ministry of Agriculture, Water and Forestry, 2006), which is a good outcome even in developed countries: not only is this finding dated, but interviews for the GCF featured pervasive comments on domestic water losses and pipe leakages, which question the reliability of that value. Even research found leakage rates in households as high, due to inferior equipment and lack of maintenance, reaching an average of 88 l/day loss (Lewis et al., 2019).

The literature highlights the success story of Windhoek's solid waste management (Global Recycling, 2016), particularly since the municipality implemented a 2010 Solid Waste Management Policy, however the results from the CBF point to a different story: of the 985.5 kg/cap/year of solid waste collected, 7% is recycled and none is incinerated with energy recovery, all of which yielded low scores for the solid waste criteria (Sipa et al., 2018; African Clean Cities, 2020). Although residents separate their waste, 20% of this is sent to landfill whereas the rest is sent to

South Africa for recycling. Across SSA, Sipa and colleagues (2018) found that 69% of waste is openly dumped or incinerated. It may be worthwhile updating these results to see whether the 2010 Solid Waste Management Policy yielded any positive changes for solid waste management. Overall, it is clear that in-person studies and investigations need to follow-up this study, partly to validate the findings.

Interviews have substantiated some of the CBF results, and contrasted others. Multiple stakeholders mentioned the old age of existing infrastructure, and the lack of financing to support capital project as well as maintenance efforts. Findings from this study closely match those found by Lewis and colleagues (2019), who summarised urban water management challenges in Windhoek as relating to lack of funds and staff, limited expertise, poor communication between stakeholders, weak regulation and enforcement.

3.5.4 Governance Capacity Analysis

Primary and secondary data, mainly of qualitative nature, was required for the GCA. A comprehensive desk study provided the first level of understanding of water management systems in Windhoek. There is a paucity of high-level studies on Windhoek's water systems, which means that the literature search needed to be substantiated with primary data. This involved structured interviews with individuals working or volunteering across Windhoek's water sector, whether it was academia, private enterprises, consulting engineers, para-statal organisations or governance structures. These individuals will hereby be referred to as stakeholders. A total of 35 stakeholders were sourced and contacted, online via email and by phone-call through local liaisons. From this, 17 interviews were arranged via online platforms, and one interview was conducted in writing. The data collection period ran from June to mid-August 2020. The global circumstances limited the amount of in-person contact, which may have impacted the volume of responses and slowed down the whole data collection process. Once an interview was confirmed, a detailed background research on the interviewee and her/his post allowed the selection of the most relevant criteria: for instance, governance figures were asked about policies, since they were expected to hold this knowledge more than engineers or consultants. In addition, the pre-defined GCF questions were rephrased so that they were more memorable during the interview and covered all the main points the criteria tried to answer (Appendix A). A total of 10 criteria were prepared for each stakeholder, however the interviewees were not constrained or timed: as a result, some gave very detailed answers for fewer criteria, whereas others concisely answered all criteria.

Interviews were conducted on online platforms including MS Teams or Skype and lasted an hour. All participants agreed to be recorded, which allowed for a detailed, individual interview transcript to be produced and sent back to each stakeholder. This gave them the opportunity to ensure that the paraphrased information was correct, and to add any more information where needed or relevant. Eight interviewees responded to this, of which five gave additional feedback.

This analysis interviews identified a series of recurring problems at governance level. In particular, the framework was applied to the water supply security issue. There were minor discrepancies amongst stakeholders. The spider web diagram in Figure 15 illustrates the scoring for individual indicators, while the average scores for nine categories are found in Figure 16. For privacy purposes, the stakeholders are referred to as "S-numbers 1-18".

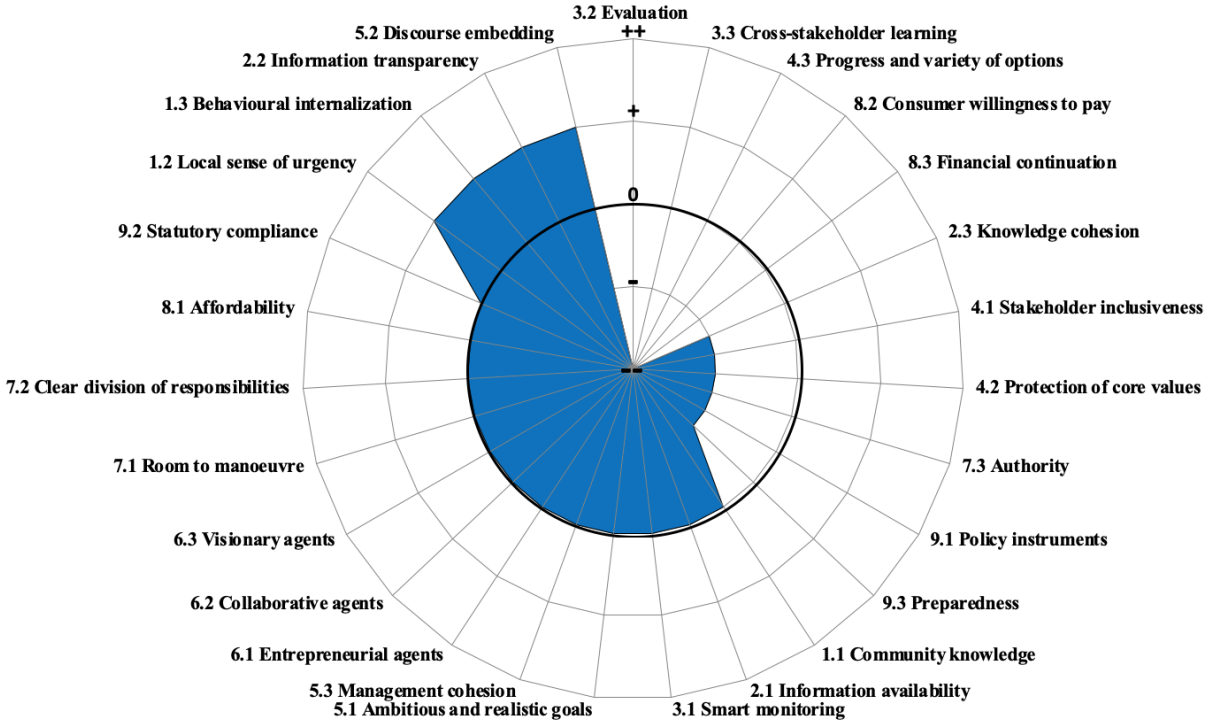


Figure 15 Governance Capacity Framework's spider diagram of the city of Windhoek, Namibia.

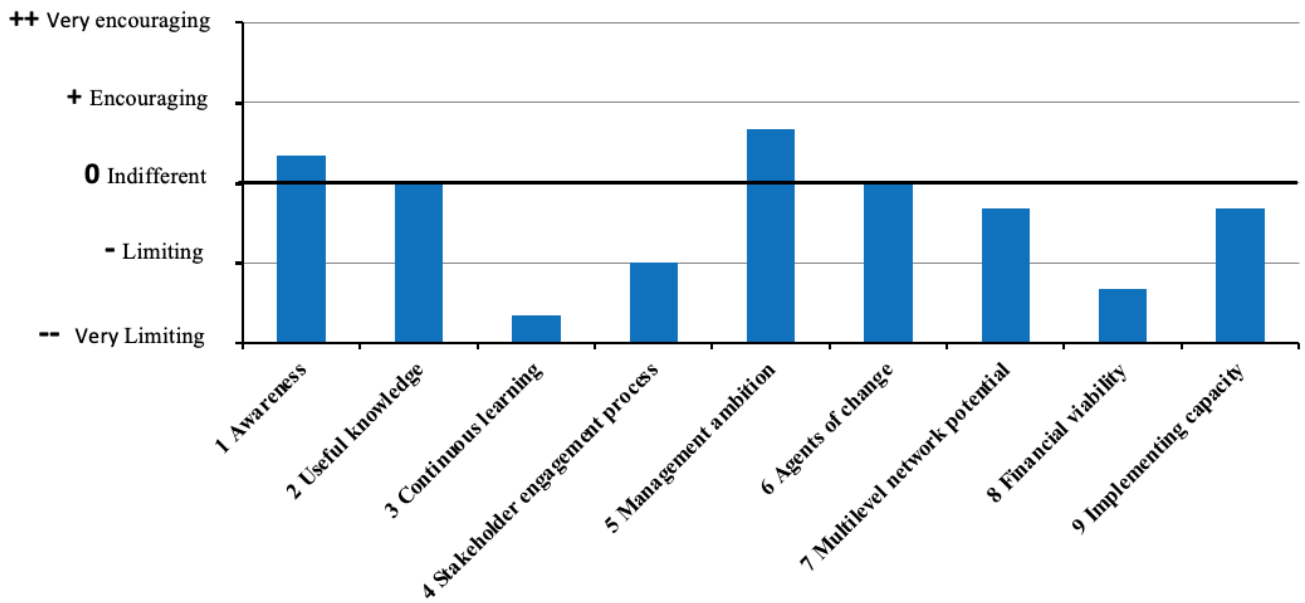


Figure 16 *Average scores of each category of the GCF. No category gained a "very encouraging" rating. Continuous learning was the lowest scoring category whereas management ambition was the highest scoring category.*

3.5.4.1 Knowing

This dimension encompasses information on the awareness of the security of water supply and provision within the community, the knowledge that is available and the degree of continuous learning and information-gathering efforts that occur around this challenge. The average score across the dimension was '0'.

Awareness

The average score for Awareness (criteria 1.1-1.3) was just above '0' (Figure 16). Windhoek's community is fully aware of the water security risks occurring because of frequent droughts, the arid nature of the country and climate change. Behavioural changes are encouraged via priming methods (S-06), weekly bulletins and monthly newsletters (S-02, S-18), and school interventions (S-18), however the degree of internalisation varies across the community (S-02). During drought periods, people are reported to talk of "Day Zero" and collaboratively work to reduce water consumption (S-02), however this attitude discontinued once drought periods are over (S-05). Beyond this awareness of water security risks, there is little understanding on which technologies and methods are best suited to produce clean water (S-03, S-08, S-09).
The awareness of the water security issue is not matched with appropriate municipal responses: for example, pipe bursts are not immediately dealt with (S-03, S-04), despite the community being very active in calling "hotlines" or communicating on Neighbourhood Watch groups (S-04, S-12).

Useful Knowledge
The average score for Useful Knowledge (criteria 2.1-2.3) was a '0' (Figure 16). A comprehensive set of academic literature looks at Windhoek's water resource, water systems and their challenges (Van Der Merwe, 2000), but data is lacking on the quality of water (Lapworth et al., 2017). Information mainly focuses on drought risks (S-03, S-17), although it is unclear whether it is matched with updated, reliable, and complete technical data. Research does not necessarily reflect the needs of the present, possibly due to insufficient finances (S-02, S-15, S-17). There needs to be a data bank where all the water-related knowledge can be placed, since this is only available for those who actively research information (S-10, S-15).

Continuous Learning
The average score for Continuous Learning (criteria 3.1-3.3) was the lowest across the entire questionnaire ('--') (Figure 16). Windhoek employs a range of monitoring methods, although this is not in real-time (S-03, S-10), and often may be based on estimates (Uhlendahl et al., 2010). Fully integrated and automatic systems measure water flows at stations along the water network (S-12), which helps identify major pipe bursts (S-12). Rain and drought period occur in regular and reliable cycles, which makes predicting drought events in advance a possibiity (S-16). Collaborations with neighbouring countries allow for flood predictions to be made to 2-weeks in advance in the case of the Zamib river (S-12). None of these advance warning systems are coupled with a risk management strategy (S-12), and monitoring mainly occurs *ad hoc* or in isolation, which also reflects the degree of stakeholder involvement: there is a closed attitude to this and interaction between stakeholders occurs on a case-by-case basis (S-07, S-10, S-12, S-14, S-15). The few efforts made to involve more stakeholders are either inconsequential (S-14, S-15) or inclusive of only certain stakeholders (S-05, S-07, S-12, S-14, S-15).

3.5.4.2 Wanting
This dimension includes information relative to the active participation of stakeholders, goals that are formulated at policy-level and the agents that can promote this. The average scoring for the nine criteria across this dimension was '0'. Management ambition was the highest scoring category throughout the analysis.

Stakeholder Engagement Process
Stakeholder engagement gained a '-'-score (Figure 4) across the three criteria of stakeholder inclusiveness, protection of core values, progress and variety of options. The water sector is monopolised: the Ministry of Agriculture, Water and Land Reform (MAWLR) protects the water resource, the para-statal NamWater distributes water in bulk to local authorities, such as Windhoek, which distribute it to its citizens (S-05, S-07, S-16). There is cooperation between these entities; beyond this, stakeholder participation is treated as a "checkbox" exercise (S-13, S-14, S-15). According to some, stakeholder mapping is conducted to ensure widespread involvement, however this does not resonate with what most interviewees said: civil engineers are involved in water-related projects as consultants, the private sector is consistently excluded, and it appears that no stakeholder actively sways decisions, since most of these are made top-down on the basis of contacts and friendships (S-06, S-07, S-08, S-10, S-14). Overall, decisions are insufficiently

guided by research (S-15). On a more positive note, the multitude of water sources indicate that some key decisions have been made from an informed position (S-15), a broad consultation process was carried out for the formulation of an Integrated Water Resource Management Plan (S-15, S-17), and there is an increased consideration on the importance of stakeholder involvement (S-12).

Management Ambition

The three criteria of ambitious and realistic goals, discourse embedding, and management cohesion gained an average score of '+'.

A salient policy is the Integrated Water Resource Management (IWRM) plan that includes policy matters, legislation, education, technical and financial measures, special measures for water reuse and saving, consumption-related water pricing and public awareness (Lahsteiner & Lempert, 2007). This includes long-term considerations as well as improved inclusiveness (S-06, S-11, S-14) since there is a clear need to comprehensively address to water challenge (S-05). Basin Management Committees (BMCs) have been established via the IWRM for dealing with drought risk and water supply in a comprehensive, decentralised, and collaborative way but they are largely inactive (S-14). Transboundary rivers are also managed with international committees; however, this cross-country collaboration does not always result in effective solutions (S-05, S-14). Ultimately, cross-sectoral planning is dysfunctional (S-14), particularly since the end of drought periods usually mark the end of continued collaborations (S-14, S-15, S-17).

Agents of Change

The criteria of entrepreneurial agents, collaborative agents and visionary agents gained an average score of '0' (Figure 16). Although there is a recognised need to continuously update and innovate (S-03, S-17), the limited knowledge, funding and acceptance of new ideas inhibit this (S-01, S-15). The monopoly of water-related affairs does not allow space for competition, which would drive innovation (S-08).

3.5.4.3 Enabling

This dimension encompasses considerations for authority figures and their roles, the financial viability and policy measures and considerations for creating a sustainable water supply. The average score across the nine criteria involved was a '-' (Figure 16).

Multilevel Network Potential

An average score of '0' was found across the criteria of room to manoeuvre, clear division of responsibility and authority (Figure 16). There are few government funds, which limit the availability of developing alternative approaches (S-01, S-11). A strong leadership needs to oversee collaborative action: this is currently lacking, and as a result most initiatives occur individually (S-01, S-15). Although responsibilities in the water sector are clearly formulated, there is no ministry of water: it floats around as a subsidiary of other departments (S-07). In addition, the president set up a technical committee dealing with water security, tasked with developing a master plan for water infrastructure, overlapping with the work done by MAWLR and suggesting that there is mistrust in the institution (S-05, S-14).

According to the aforementioned IWRM, new institutions are supposed to be established with clearly defined roles (S-15), however this is still to be implemented and as a result most responsibilities are allocated to the minister (S-12). Ministers are the highest authority figures, typically governing for five years or less: the result is that their policy ambition goes towards securing support rather than a steady, sustainable, long-term vision that is needed by the water sector (S-05).

Financial Viability

An average score of - was found across the criteria of affordability, consumer willingness to pay and financial continuation. Consumption related water pricing means that people living in informal settlements pay less for the same volume of water compared with people living in more affluent areas (S-18). In fact, according to some water is too cheap: political influence and widespread poverty prevents water from being sold at the correct price, which

impacts the funds available for project development (S-10, S-13). Additionally, funding for the ministry of water is side-lined in favour of infrastructure, education, and defence (S-02), which has affected the delivery of climate adaptation measures such as aquifer recharge (S-18). The little money that is available is not necessarily allocated to the right projects (S-09, S-11), the overall result of which is a reliance on external sources of funding (S-07, S-11).

Implementing Capacity

An average score of '0' was found across the criteria policy instruments, statutory compliance, and preparedness. Implementation of policy frameworks is a recurring issue. This partly occurs because many objectives have been modelled on European systems, where collaboration between stakeholders is easily achieved and water is readily available. These frameworks do not respond to the Namibian context (S-11): as a result, the comprehensive IWRM plan is still not 5% complete in 2020, despite being formulated a decade ago (S-18). Windhoek still operates on 1956 legislation from South African rule (S-06), and the existing systems holds no accountability, required expertise and clear governance structures that can fulfil objectives (S-05). For instance, a recent drought had been modelled in the years prior to it, but nobody was held accountable for failing to implement better measures to offset its impacts (S-14). Collaborations may emerge during crises, but these are short-lived, and in practice most situations are deal with as of and when required (S-04, S-05, S-14): in fact, there is a "fire brigade" office that responds to crises *ad hoc* (S-02). Added to this, there is a lot of room for not following the guidelines: lucrative businesses may not abide to legislation or find ways around meeting quality standards (S-08).

3.5.5 Discussion

The governance analysis overall identified several issues that will be elaborated upon below. There are strengths of the existing system that mainly relate to the resourcefulness and ability of Windhoek to provide its citizens with continued water supply, even in times of drought: this resilience is possibly a function of the diversified water source, of which one is reclaimed wastewater. This makes Windhoek a very interesting case study, since it shows the wider community that it is possible to reclaim wastewater and transform it into drinkable water. This reduces the wastage of water but also improves the water supply security. Another strength identified was the agreement between stakeholders: there were generally common themes, issues and concerns that emerged, which in itself is a positive indicator since it suggests that the people on the ground have identified recurring issues in water management systems, and are therefore better equipped to collaboratively address them.

Implementation Capacity

The reduced capacity to implement legislation was frequently quoted by stakeholders. This occurs due to multiple reasons, which include a Eurocentric vision combined with a lack of funding, technical expertise, and accountability. The IWRM plan was finalised around 2013-4 and approved by Parliament: this plan addresses the water security challenge in a comprehensive and holistic manner and defines the importance of the water resource to human well-being, socio-economic development, and the environment. Despite this, the regulations supporting the act have not been finalised. As a result, Windhoek today operates on the Water Act N.54 (Republic of Namibia) from 1956, which does not offer the inclusive and sustainable vision that is needed by the water sector.

Eurocentrism

The current and planned legislative frameworks do not speak to the Namibian context, and this is because they either belong to a period of apartheid, that speak to a white minority or because they are modelled on European systems. The latter feature stakeholder collaboration and widespread water availability that are not reflected in Windhoek's context. Consequently, the policies that are promoted assure success in Europe but not in Namibia, or as a stakeholder defined it "the policy is ahead of its times". The traditional laws that embed water saving principles are discarded in favour of modern legislation, which looks at the principles of city living including excessive water consumption. As a result, the legislative frameworks need to be re-formulated to better reflect the context in which they would be applied. This is expected to offset some of the implementation issues.

Accountability

A lack of accountability impacts the ability of policies to be implemented and monitored. When a water crisis occurs, it is blamed on climate change or an arid Namibian environment: although these are true, this generates a reduced sense of initiative over dealing with the challenge. There is a need for some individuals and institutions to take charge and responsibility, especially when these sit at governance level, and begin effectively managing the resource. Governing figures must be held accountable when they fail to deal with a crisis. The absence of this means that Windhoek is incapable of preparing in advance for crises, rather it deals with these when they arise. The changing conditions that continuous water depletion and climate change will bring will not be offset in this manner, compromising the long-term and sustainable water supply.

Technical expertise

The level of technical expertise that can support policy implementation is lacking, especially at governance level. There was a recent turnaround of young heads in institutions, which compromises the experience and capacity of fulfilling these positions. Although it is important to improve equality and representation, the impulsive nature in which this is done results in important figures being unable to address the water security challenge. Added to this, multiple technical experts have migrated to the private sector due to more appealing working conditions. This has resulted in the public sector being mostly unqualified to create working systems or come up with adequate solutions to water security issues. Another outcome is that many institutions are run by individuals that are not trained for that post: issues such as missing routine maintenance may occur because of this limited capacity, which this negatively impacts water infrastructure and its management.

Funding

The city's water sector is seriously underfunded, since funding is prioritised to the education, infrastructure and transport and defence departments. There is no clear link between the money generated and the funds that are available for development, maintenance, and new infrastructure, which makes some stakeholder suspicious. Overall, the money shortage has meant that boreholes cannot be replaced, capital investment is impossible, and maintenance is virtually non-existent. The lack of technical expertise results in improper maintenance of equipment, even if this is new. All of this rapidly increases the deterioration of both novel and aged infrastructure. As a result, the government relies on external sources of funding rather than addressing this issue.

The allocation of funds is also a problem: multiple examples were listed of developments occurring because of political players becoming involved in decisions that should be technical. Major decisions are made top-down, without proper consultation of the water experts and with a short-term vision. This prevents decision makers from looking at the wider impacts of their decisions. Developments such as aquifer recharge, that consider a long-term sustainable supply climate mitigation strategy have come to a halt due to finances, however money is invested in other major projects that are not essential, such as road development. Another issue is that officials measure the rate of performance based on the money spent, even if this is not needed. This results in avoidable and hasty decisions that are made on the wrong principles.

Lastly, NamWater, MAWLR and the University of Namibia attempted to establish a water research fund, formed by channelling part of the taxpayer money. This was not successful, possibly due to the side-lining of the water institutes and projects. Adequate financing is essential to train staff, invest in new projects, maintain existing infrastructure, give weight to structures such as the BMCs and provide long-term water solutions. By not prioritising the water sector, the water security issue is likely to become increasingly serious.

Collaboration, coordination, cooperation

Beyond MAWLR, NamWater and the local municipalities, there are reduced opportunities for stakeholder involvement and participation. This most likely is the outcome of a lack of organisation that is embedded within structures and institutions, but also due to authority figures and their closed-door approach.

Organisation

The three entities in charge of the water resource have clear roles associated with them, but this clarity does not persist during the coordination of responsibilities.

For instance, the Local Authorities Act recently gave local authorities the responsibility to monitor and permit water resource, which was previously MAWLR's responsibility. In fact, local authorities do not have the sufficient technical expertise and capacity to do so. Additional institutions have been established: a technical committee of experts advises the president, taking on the work that MAWLR should be in charge of. Similarly, the BMCs also emerged out of the failure of the ministry to deal with the water challenge, or at least this is the pervasive perception amongst stakeholders. This is almost expected, considering the ministry encompasses agriculture, land reform and water resources: there needs to be an independent ministry of water that can address the security challenge from a strong, holistic and specialised perspective. There are diverting beliefs regarding what the technical committee and what the BMCs are supposed to do: although their roles are defined on paper, these become blurred during implementation. This underlines the need of strong drivers at the central level, with clear responsibilities attached, who can coordinate all activities. The coordinating aspect currently sits at the government level, and the degree of political involvement resulting from this trumps the cause and objective of securing water supplies: politics lacks a long-term permanency, and this impacts the long-term considerations that need to be made in the water sector.

Stakeholder involvement

In Windhoek and Namibia, stakeholder engagement is still at its infancy. Policy directions are set at governance levels, and only the stakeholders linked to cabinet members can influence these.

The BMCs are supposed to involve primary stakeholders who discuss, manage, and advise, however without the supporting regulations these institutions remain mostly inactive. The few that are active have been constrained to advisory roles, making them inconsequential to policy directions. Another issue is that the private sector struggles to be involved, since there is no platform that caters for this. This is a problem considering the number of technical experts that have migrated from the public to private sector. Above all, even within advisory positions, it is unclear whether stakeholders can influence policy development. For instance, NamWater's annual workshop, which is invite-only, features pre-determined outcomes that are communicated to stakeholders. There is no space for real, tangible discussions to take place.

This all suggests that Windhoek needs to come up with collective solutions beyond the local authority, ministry and NamWater, and that it needs a body that can take in all types of water treatment professionals and adequately consult them. The Country Water Partnership was a suitable platform for this; however, it has been inactive recently and does not feature active representation from local authorities, private sectors or international partners.

Closed door policy

The limited engagement opportunities and lack of open forums for discussion impact the ability for stakeholders to voice their concerns in a manner that leads to remediated action (section 5.4.2.2). The same few companies are commissioned most water-related projects and if stakeholder engagement is done, this occurs from behind closed doors. Being engaged with is more a result of contacts and friendships than expertise and experience. The decisions are reached in a top-down manner, and little discourse from stakeholders can influence this. These combined features have impacted the trust that stakeholders feel in their institutions.

Community

As shown by the GCF results, the community is well aware of the water security risks and the need to save water. However there is no promoting of why water needs to be saved, the decision is made at governance level and individuals need to conform: fines for over-consumption are distributed more than educational initiatives on the value of saving water. As a result, the community may not always act responsibly towards the resource. The trends in water consumption do not reflect the context, since these are more reactive to the crisis rather than making water conservation an embedded feature of daily life. Above all, local authority responses do not necessarily match the awareness campaigns: it may take days for a water leakage to be fixed, which contrasts the claimed water shortages.

This has fostered a mistrust in the local community towards authority figures and the urgency of the water security issue.

Short-term thinking

Water related issues such as drought or flooding are addressed when they arise: remediated actions are curative rather than preventative. For example, drought events may be predicted, but the action taken to offset their impacts materialises during the drought and not prior to it.

NamWater's annual workshops focus on water availability for the following two or three years: this is the extent of future planning. The result is that aquifer resources are extracted with short-term requirements in mind. Water security needs to be considered across longer periods of time, suggesting that more risk-based, prospective thinking needs to be encompassed in these workshops and subsequent actions.

In addition, there is no permanency in politics: politicians consider the short term and prioritise policies that are more likely to get them re-elected. The ambitions promoted by politicians might be different than the policy direction needed in the country. Water sector is a long-term focus: it is in need of a strong technical level that can maintain continuity even if governance figures change. Although this technical level exists, it is being infiltrated by the politically minded who promote short term, personal goals. For example, an irrigation policy may be implemented without adequately addressing the issue of water security.

3.5.6 Conclusions

The present research celebrates Windhoek's success of continuously providing water access throughout drought periods and crises. The city has achieved this by diversifying its water supply, including overcoming the psychological and technical barriers to wastewater reclamation. According to online literature, groundwater and drinking water quality is of a high standard, however this needs to be substantiated with updated research. A number of other discrepancies were identified, which may result in action that aggravates an already water-scarce context as well as the health of human beings. This highlights the need for data and additional research to validate or disconfirm existing results. Overall, there needs to be a databank featuring open-access, water-related information, so that this can easily be sourced and updated where necessary.

A number of issues need to be addressed, on the basis of which the following recommendations are made:

- The capacity to implement legislation needs to be enhanced. This is currently constrained by a Eurocentric approach, which models policies on European systems, resulting in a legislative framework that does not respond to Namibian context. In addition, more funding needs to support the water resource. Although 67% of NamWater's revenues are deployed for maintenance, these are insufficient because of pervasive issues in the urban water cycle that were substantiated by interviews. Education, infrastructure and defence are prioritised in terms of the funding, and this may need reconsidering. Lastly, numerous water experts have migrated to the private sector, creating a knowledge gap in the public sector that is negatively affecting the capacity to address the water challenge.

- Collaboration needs to be consolidated: there is an absence of cooperative approaches and proper consultation procedures prior to project development. Policies are formed "top-down", excluding the opportunities for expert opinion and sound knowledge to be integrated in legislation. There is a paucity of platforms for stakeholder engagement, and the annual workshop that is organised by NamWater features pre-determined outcomes that are simply communicated to stakeholders.

- Trust needs to be rebuilt: stakeholders and the community are sceptical of the institutions governing the water resource. Awareness campaigns do not reflect the actions taken by the municipality, which results in the questioning of the water crisis. It may be worth maintaining educational programmes alive to inform the public on why the water needs to be saved, rather than fine those that over-consume. In

addition, technical solutions are overridden by political priorities, which has the potential to compromise a long-term water supply.

The nature of the City Blueprint Analysis has allowed for a comprehensive overview of Namibia's water security challenge and how it is being managed. Once the TPF analysis is complete, policymakers and stakeholders will have access to a full baseline assessment of their water system, based on locally sourced information. The key issues are in agreement with literature findings, which strengthens the value of this data. Hopefully, an action plan with a long-term vision can be formed on this basis. This research paper will be published on an open-access journal for the global community to access, adding on to the existing literature on the City Blueprint globally and in Africa. Thus, a city-to-city learning approach can be truly achieved. Another objective will involve the organisation of a follow-up workshop in Windhoek, with the goal of bringing interviewees and any additional stakeholders together, to discuss these issues and how best to address them. Based on this information, the followings steps are recommended:

- A full, on-ground study effort of Windhoek's water cycle needs to be completed. This will source out the infrastructure that needs updating or changing.

- A data-port needs to be created, ideally online, that will feature academic and non-academic articles, technical data and status progress of the water systems in Windhoek.

- A workshop needs to be organised and maintained on a recurring basis, as a platform for stakeholders to discuss amongst each other and with policymakers.

In summary, the city of Windhoek has implemented positive measures to offset its water security crisis, but these are insufficient. The looming risks associated with urbanisation and climate change mean that the city's infrastructure is in need of serious maintenance and updating, and that governance strategies need to be reformulated to involve more expert inputs and a comprehensive and sustainable view on the water resource.

3.6 Yaoundé

3.6.1 City Introduction

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.

Source: https://elevation.maplogs.com/poi/mfoundi_cameroon.217835.html

Geographical coordinates are: 3°52' N and 11°31' E.; the surface is 183 km² or 183.000 ha. The relief: average altitude of 760 m (600 m to 1200 m). 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/year. The population of the greater metropolitan area is around four million (Worldpopulationreview.com) 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.

Source: https://commons.wikimedia.org/wiki/File:Cameroon-Yaounde01.jpg

3.6.2 Trends and pressures hampering water management

The Trends and Pressures for Yaoundé have been provided, scores have been calculated and reviewed and are provided in Table 13 and Figure 17. The TPI (Trends and Pressures Index) for Yaoundé is 5.1. It means that the arithmetic average of the 24 TPF indicators (TPI) of Yaoundé is relatively high.

Table 13 Trends and Pressures Framework's scores for Yaoundé, Cameroon. Great concern scores are depicted in bold. The Trends and Pressures Index is 6.0.

Category	Indicators		Score
I SOCIAL	1 Urbanization rate		7.8
	2 Burden of disease		**9.3**
	3 Education rate		**9.3**
	4 Female participation		2.8
II ENVIRONMENTAL	Flood risk	5 Urban drainage flood	**10.0**
		6 Sea level rise	**10.0**
		7 River peak discharges	0.0
		8 Land subsidence	**10.0**
	Water scarcity	9 Freshwater scarcity	0.0
		10 Groundwater scarcity	0.0
		11 Sea water intrusion	0.0
	Water quality	12 Biodiversity	5.8
	Heat risk	13 Heat island	0.0
	Air quality	14 PM2.5/10	**10.0**
III FINANCIAL	15 Economic pressure		**9.9**
	16 Unemployment rate		1.2
	17 Poverty rate		4.0
	18 Investment freedom		7.0
IV GOVERNANCE	19 Voice and accountability		7.2
	20 Political stability		**9.6**
	21 Government effectiveness		**8.4**
	22 Regulatory quality		6.6
	23 Rule of law		7.2
	24 Control of corruption		7.3

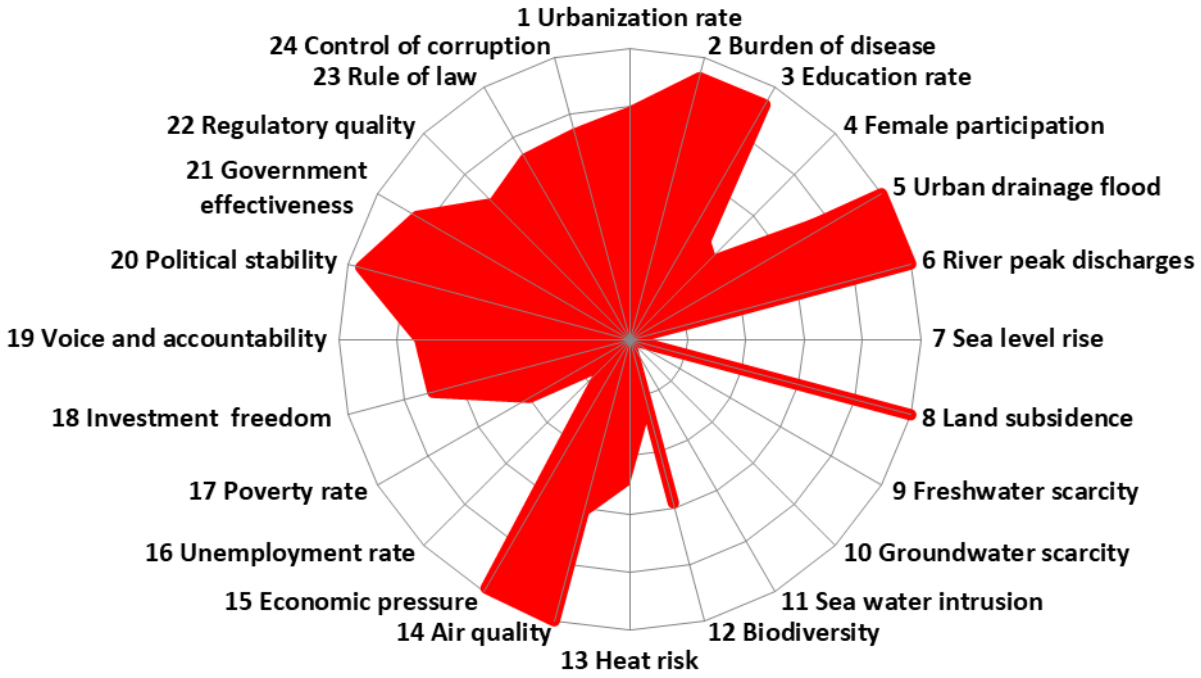


Figure 17 Trends and Pressures Framework's spider diagram of Yaoundé, Cameroon. The redder, the more pressures the city faces that may hamper water manager. Trends and Pressures Index is 5.2.

The results of the TPF analysis for Yaoundé show that the city faces many great concerns, as shown by the indicator scores between 8 and 10, in areas of education and unemployment. Scores of the World Bank governance indicators (Indicators 19-24) give also rise to concern. In fact, Yaoundé has nine indicators of "serious concern. These pressures can hamper the efforts of water managers to provide good urban water services, as measured by CBF.

3.6.3 City Blueprint water management performances

Public data or data provided by the (waste) water utilities in the city were obtained following the questionnaires, structured oral interviews and interactions with the various water sector stakeholders during field/facility visits. Scores of 0 (concern) to 10 (no concern) were adopted for the study following the CBF.

The results of the CBF for Yaoundé are provided in Table 14 and Figure18. The Blue City Index of Yaoundé is 2.5. Indicators 2, 9, 11 and 23 show very high performance scores. Indicator 12 shows an average score of 6 and all other CBF indicators score ≤ 5. This is also reflected in the spider diagram in Figure 18.

Table 14 City Blueprint Framework's scores of Yaoundé, Cameroon.

Category	Indicator	Score
I Basic water services	1 Access to drinking water	6.8
	2 Access to sanitation	9.3
	3 Drinking water quality	4.9
II Water Quality	4 Secondary WWT	3.5
	5 Tertiary WWT	0.0
	6 Groundwater quality	4.9
III Wastewater treatment	7 Nutrient recovery	0.0
	8 Energy recovery	0.1
	9 Sewage sludge recycling	0.0
	10 WWT energy efficiency	0.0
IV Water infrastructure	11 Stormwater separation	0.1
	12 Average age sewer	4.2
	13 Water system leakages	8.8
	14 Operation cost recovery	5.0
V Solid waste	15 Solid waste collected	7.6
	16 Solid waste recycled	0.2
	17 Solid waste energy recovered	0.2
VI Climate adaptation	18 Green space	1.3
	19 Climate adaptation	7.0
	20 Climate-robust buildings	7.0
VII Plans and actions	21 Management and action plans	7.0
	22 Water efficiency measures	7.0
	23 Drinking water consumption	9.3
	24 Attractiveness	6.0

Yaoundé scores well on issues such as drinking water quality, groundwater quality, operation cost recovery, solid waste collected, green space, climate adaptation and drinking water consumption. But it is obvious from Table 14 and Figure 18 that access to sanitation, waste water treatment and solid waste handling are major challenges for the city.

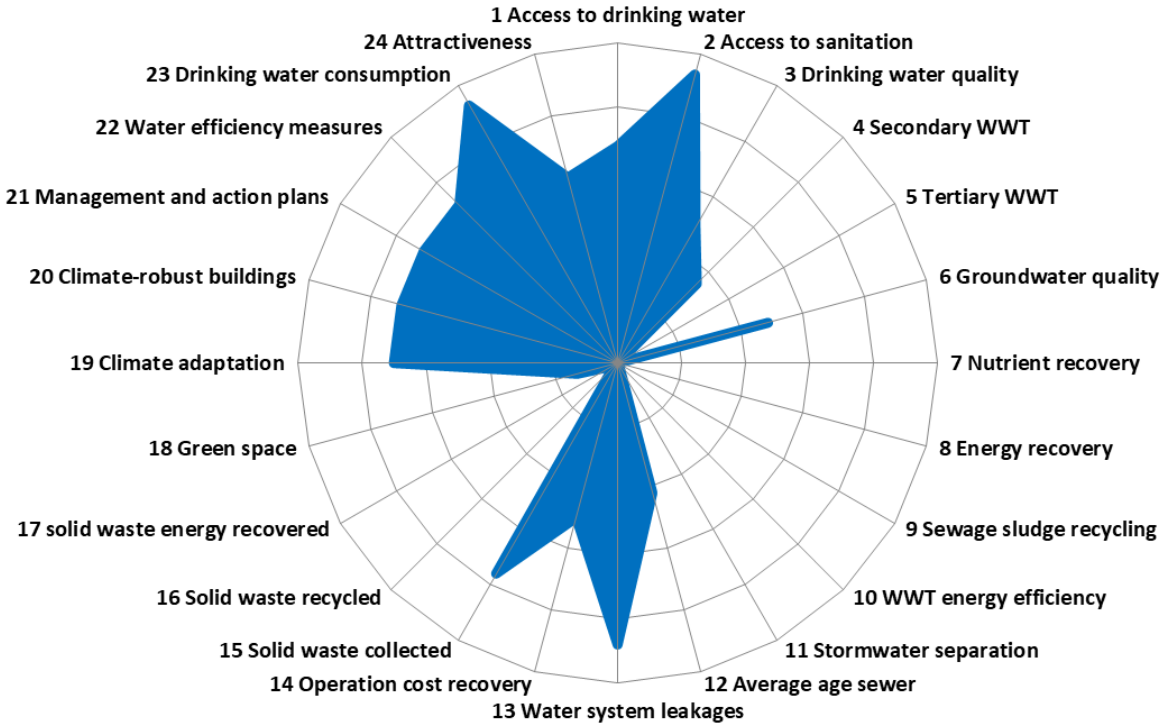


Figure 18 City Blueprint Framework's spider diagram of Yaoundé, Cameroon. The bluer, the better the water management performance. Blue City Index is 2.7.

3.6.4 Governance Capacity Analysis

Governance capacity was analysed to address these challenges with GCF by interviewing water-related stakeholders (government institutions, NGOs, universities, research officers, authorities).

Figure 19 shows the average score for each of the five water-related challenges for the 27 indicators. Governance capacities to address water scarcity and urban heat islands, respectively, are relatively well developed. To address these challenges, indicators 1.2 Local sense of urgency, 2.2 Transparency of information, 2.3 Consistency of knowledge, and 5.1 Ambitious and realistic management illustrate the well-developed governance capacity to address water scarcity and heat islands respectively. The development of the capacity to master the challenges related to flood risks, wastewater treatment and solid waste treatment with a few indicators that have a limiting to very limiting effect can be considered a priority. In particular, ten indicators limit overall governance capacity for almost all water challenges (Fig.2): 2.1 Information availability, 3.1 Intelligent monitoring, 3.2 Evaluation, 3.3 Capacity building among stakeholders, 5.2 Discourse integration, 6.2 Collaborative agents, 7.2 Clear division of responsibilities, 8.1 Accessibility, 8.3 Financial continuity, and 9.2 Compliance with the law. Indicator 2.1 is very limited (--). In Yaoundé, a lack of knowledge prevents informed decision making (Rowley, 2007; Van Rijswick et al., 2014). Authorities in many cities recognize the lack of knowledge about how future trends, such as urbanization and climate change, will affect those (Amundsen et al., 2010). In addition, responsibilities for IWRM are fragmented. They are distributed among a number of organizations. This fragmentation creates uncertainty due to overlapping responsibilities (Mees et al., 2014).

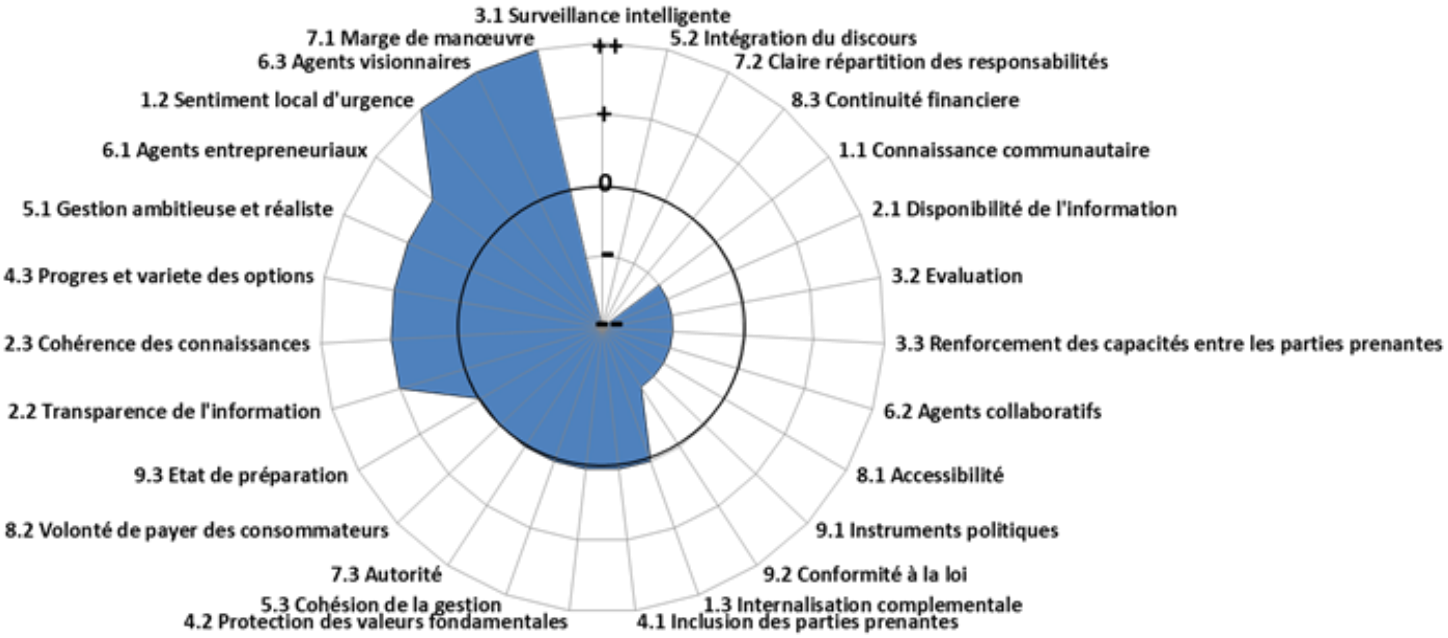


Figure 19 Results of the GCF analysis. Limiting GCF indicators, with scores below zero, are 2.1 Availability of information, 3.1 Intelligent monitoring, 3.2 Evaluation, 3.3 Capacity building among stakeholders, 5.2 Integration of discourse, 6.2 Collaborative agents, 7.2 Clear division of responsibilities, 8.1 Accessibility, 8.3 Financial continuity, and 9.2 Compliance with legislation.

3.6.5 Most viable solutions & recommendations

- **Water treatment**: our stations must be equipped with a tertiary treatment system,
- **Recycling of solid waste**: provide the town with a solid waste recycling station.
- **Energy recovery**: reuse of treated wastewater for energy production
- Disseminate the results of the study through conferences and workshops in order to inform public opinion. Share this information with municipalities and administrations for better decision making.

Based on the analysis of the governance capacity of the city of Yaoundé, it is proposed to improve intelligent monitoring and evaluation of projects and capacity building among stakeholders, for example through workshops that involve different levels of management, in order to increase continuous learning and make water governance more effective. Integration of discourse, clear division of responsibilities and compliance with legislation are among the factors that also need to be addressed. However, sufficient monitoring is first needed to analyse the impact of different measures and policies, to enable accountability and to know whether stakeholders are complying with existing regulations.

4 City-workshops

Due to the COVID-19 pandemic, not all city-workshops have taken place yet. Here follows a brief overview of the participants and key results of two workshops that have already taken place. More detailed reports are available (annex 3 in French) or forthcoming.

4.1 Workshop Yaoundé

The workshop in Yaoundé was organised on the 11th of June with key stakeholders of the city's water sector. The objective of the workshop was to (i) pesent the City Blueprint Approach, (ii) to provide an overview of the results of the study conducted in the city of Yaoundé, and (ii) to develop a roadmap to improve the management of the water cycle in the city of Yaoundé.

The workshop started with a roundtable to allow participants to describe their professional background, functions and expectations of the workshop. Subsequently, the objectives and agenda of the workshop were reviewed and then submitted for validation by the participants. The workshop consisted of an introductory plenary session and several intermediate plenary round tables facilitated by Mr. Mohamadou Djibrilla, Deputy Project Officer (Science) of the UNESCO Multisectoral Regional Office for Central Africa. Next, a brief introduction of UNESCO's international hydrological programme was provided by Dr NSOM-PIAL Annie-Claude, Specialist in the Exact and Natural Sciences programme. Mr. Mohamadou Djibrilla also provided a presentation of the City Blueprint Approach methodology and rationale. Leading researcher, M. Ibrahima Abdoulahi presented the assessment results of the city of Yaoundé. Finally, a roundtable discussions was held to reflect on the results and to formulate action points/recommendations.

The following list of key recommendations and actions was developed in the workshop and for each recommendation organisations were appointed with the primary responsiblity to act on the recommendation:

- Raise awareness among stakeholders and users of the challenges related to water, namely water scarcity, the risk of flooding, waste treatment and wastewater treatment

- Work towards the availability and sharing of data (essential water services, wastewater treatment, solid waste treatment, surface and groundwater quality), in particular by setting up information services on the water, the creation of multi-stakeholder platforms dedicated to water resources management issues
- Strengthen the system for collecting, treating wastewater and distributing water
- Systematic integration into their agenda of planning of adaptation measures and mitigation of the effects of climate change in investments in the water sector
- Continue advocacy aimed at mobilizing the necessary resources to promote the City Blueprint Approach
- Extend this study to other large cities in Cameroon and make comparisons
- Maintain the municipality as an assessment scale for the City Blueprint tool

The representatives of the seven municipalities that make up the city of Yaoundé actually took part in this workshop; the Ministries in charge of water and energy, the environment and sustainable development, scientific research, transport, housing and urban development; the Cameroonian National Commission for UNESCO (COMNAT); the staff of the SC and PI sectors of the UNESCO Yaoundé Office; international and national NGOs (GWP-Caf and RECOJAC, Water 4 Life), private sector companies, managers of treatment plants (INGEPRES and SOPREC) and ANT-Cmr.

4.2 Workshop Libreville

Libreville's UNESCO office organised an online workshop on the 9th of September with some of the key stakeholders of the capital's water sector. The main purpose of this workshop was to present the results of the City Blueprint and Governance Capacity analysis frameworks applied in Libreville, along with a road map (*feuille de route*) outlining the key recommendations for improving the water sector of the city and discussing these with the participants. The main outcome of the workshop was that communication between the relevant stakeholders, especially the institutions in charge of dealing with water related issues, needed to improve and that this is to be done through organising meetings on a monthly basis between the relevant stakeholders.

The workshop began with an opening speech by M. Enzo Fazzino, Libreville's UNESCO chief representative, followed by a brief introduction of the City Blueprint Approach by Maud Berthelot, from the division of water sciences of the UNESCO headquarters in Paris. Subsequently, the consultant Glawdis Ovenga presented her findings of the Trends and Pressures, as well as City Blueprint framework for Libreville, before KWR's intern (consultant) Fritz Jaax presented the results of the Governance Capacity Framework for water pollution in Libreville. Finally, Fritz, also presented the main recommendations of the road map which preceded a discussion between the participating stakeholders on these recommendations for improving Libreville's water sector.

The main key recommendations for the short term were the following;

- The implementation of an intelligent water quality monitoring system;
- the creation of water code incorporating policy objectives that consider urban realities and clearly identify the responsibilities of institutions dealing with water issues;
- creating an IWRM office in the ministry of Water Resources serving as a platform for interdisciplinary communication and evaluation between the water related institutions;
- holding regular meetings between this regulatory IWRM office, relevant institutions, municipalities, NGOs and the private sector.

For the longer term it was deemed necessary to;

- Separate rain from waste water, i,.e. pluvial drainage channels and the sewer system;
- Construct a wastewater treatment plant and connect it to the wider sewer system;
- Implement a smart water monitoring system;

- Improve and create community sanitation in the informal settlements;
- Insert topics of Climate Change and water-related issues into primary and secondary school curriculum.
- Adapt the city to climate change

Around 32 participated from start to finish (9am – 12.45 LBV time).
The workshop was attended by representatives of; the Ministry of Energy and Water Resources, the Ministry of Water Forestry Sea and the Environment, UNESCO, FAO, the African Development Bank (ADB), the French Development Agency (AFD), the National Commission for UNESCO, the National Agency for National Parks (ANPN), the Gabon IHP Committee, the Energy and Water Company of Gabon (SEEG), the NGO Génération Eau Claire, RECOJAC youth association Gabon, the Institute of Public Hygiene and Sanitation, the National Centre for Scientific and Technological Research (CENAREST), Omar Bongo University, the Institute for Research in Tropical Ecology (IRET), the National School of Water and Forestry (ENEF) and PAYNCOP Gabon and Durable TV.

5 Methodological tailoring for African cities

5.1 Suggestions for additional indicators

a. The TPF indicators

A Summary of the Trends and Pressures Framework (TPF) is provided below. Previously, the TPF indicators were standardized to a 0-4 range and three categories are distinguished: social indicators (1-4), environmental indicators (5-8), and financial indicators (9-12). Details are provided in Koop and van Leeuwen (2015a). We have made a number of major changes in the set of TPF indicators. First of all, we decided to rescale the framework to a 0-10 range as we did with the CBF framework. This improved the internal consistency. Next, the following indicators were included to provide a better representation of social, environmental and financial pressures that hamper water management, in particular in African cities:

- Indicator 4: Female participation
  - Principle: The labour force participation rate is the proportion of the female population ages 15-64 that is economically active: all people who supply labour for the production of goods and services during a specified period.
  - Calculation method: X = % of women (ages 15-64) participating in the labour force
  - Example: The city of Libreville (Gabon) has a female participation of 45.2%. The score for air quality becomes:
    $10 - \left[\frac{45.2}{10} \right]$ = 4.9 points.
- Indicator 14: Air quality
  - Principle: The measurement of air quality consists of the measurement of particular matter (as Parts per Million or PM).
  - Calculation method: X_1 = PM2.5 and X_2=PM10
    If there is only a value for X_1 than use: $\left[\frac{X_1 - 5.1}{63.6 - 5.1} \right] * 10$
    If there is only a value for X_2 than use: $\left[\frac{X_2 - 9.5}{118.9 - 9.5} \right] * 10$
    If X1 and X2 are both available use: $\left[\frac{X_1 - 5.1}{63.6 - 5.1} \right] * 5 + \left[\frac{X_2 - 9.5}{118.9 - 9.5} \right] * 5$
  - Example: The city of Yaoundé (Cameroon) has a PM10 of 65. Data for PM2.5 is not available. The score for air quality becomes: $\left[\frac{X_2 - 9.5}{118.9 - 9.5} \right] * 10$ = 5.1 points.
- Indicator 18: Investment freedom
  - Principle: The Investment freedom index evaluates a variety of investment restrictions (burdensome bureaucracy, restrictions on land ownership, expropriation of investments without fair compensation, foreign exchange controls, capital control, security problems, a lack of basic investment infrastructure, etc.). Points are deducted from the ideal score of 100 for each of the restrictions found in a country's investment regime. High scores are obtained if the investment freedom is low.
  - Calculation method: X = investment freedom index
    Score = $\frac{100 - X}{10}$
  - Example: The city of Harare is situated in Zimbabwe. The investment freedom index for Zimbabwe is 25. The score for investment freedom becomes:
    $\frac{100 - 25}{10}$ = 7.5 points.
- Indicator 19, 20, 21, 22, 23 & 24: World Bank Governance indicators
  - Principle: Based on a long-standing research programme of the World Bank, the Governance Indicators include six dimensions of a country's good governance (Voice & Accountability, Political Stability and Lack of Violence, Government Effectiveness, Regulatory Quality, Rule of Law, and

Control of Corruption). The estimates of the indicator are aggregates of sub-indicators normalized by a standard normal distribution ranging from -2.5 to 2.5.

- Calculation method: X = World Bank indicator value.
  Score = $1 - \frac{X+2.5}{0.5}$
- Example: Abuja is situated in Nigeria.Nigeria's governance effectivenss (indicator 21) is -1: $1 - \frac{-1+2.5}{0.5}$ = 7.0 points.

An additional indicator that worth to include in the assessment of African cities is:

- Informal settlements
  - Principle: % of the population living in informal settlements or slums.
  - Calculation method: X = % of the population living in informal settlements or slums
    Score = $\frac{X}{5}$ (note that in this way 50% slums would mean a score of 10 great concern)
  - Example: The city of Abuja is situated in Nigeria. About 50.0% of the Zimbabwian population is estimated to live in informal settlements or slums. The score for informal settlements becomes: $\frac{50.0}{5}$ = 10 points.

Category	Indicators	
I SOCIAL	1 Urbanization rate	
	2 Burden of disease	
	3 Education rate	
	4 Female participation	
II ENVIRONMENTAL	Flood risk	5 Urban drainage flood
		6 Sea level rise
		7 River peak discharges
		8 Land subsidence
	Water scarcity	9 Freshwater scarcity
		10 Groundwater scarcity
		11 Sea water intrusion
	Water quality	12 Biodiversity
	Heat risk	13 Heat island
	Air quality	14 PM2.5/10
III FINANCIAL	15 Economic pressure	
	16 Unemployment rate	
	17 Poverty rate	
	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	

Details can be found here: https://library.kwrwater.nl/publication/61396712/

b. The CBF indicators

Based on the discussions with the young professionals and the need to simplify the methods further, major changes have been made to the TPF framework over the last year, whereas the CBF has hardly changed. We use the CBF to assess the current status of water management sustainability. The geometric average of these indicators is the Blue City Index (BCI) which also varies from 0-10. Most of the data for calculating each indicator are collected from public sources. In the last year the following decisions have been taken:

1. We delete CBF indicator 23 Public participation, as we include that more or less by introducing the six World Bank Governance indicators in the TPF
2. We change the order of the indicators. We start with the category basic water services
3. We change the title Governance to Plans and Actions, to better highlight the GCF as developed by Koop et al. (2017).

The current CBF (version August 2020) can be found here: https://library.kwrwater.nl/publication/61397318/

Indicators that are worth to include in the assessment of African cities are:

- Collection coverage solid waste
  - Principle: % of solid waste that is collected as share of total solid waste production in a city. Often this can be deduced from a service coverage number.

    Calculation method: X = % of solid waste collected as share of total solid waste production

    Score = $\frac{X}{5}$ (not that in this way 50% coverage would imply a score of 10 (great concern)

    Example: The city of Belem is situated in Brazil. The collection coverage of solid waste 58.7%. The score for investment freedom becomes:

    $\frac{58.7}{5}$ = 10 points (actually more but 10 is the maximum score).

c. The GCF indicators

The Governance Capacity assessment Framework has not changed. Details are provided here:
https://library.kwrwater.nl/publication/61397218/

d. The NBF

The National Blueprint Framework activity has been commissioned by the Amsterdam International Water Week (AIWW 2019) and Waternet (Amsterdam, the Netherlands). KWR has been asked to develop a National Blueprint Framework focusing on Sustainable Development Indicator 6. The results can be found here:
Essex B, Koop SHA, Van Leeuwen CJ. (2020). Proposal for a National Blueprint Framework to Monitor Progress on Water-Related Sustainable Development Goals in Europe. Environmental Management 65 (1):1–18. https://link.springer.com/article/10.1007/s00267-019-01231-1

The work focused on 28 EU countries as data availability was the bottleneck in providing a broad framework non-EU countries. As announced in the publication this needs further work as the implementation of the SDG6 goals in non-EU countries, especially in many African countries is a major challenge. Currently we are exploring the options to broaden this framework and to make it applicable to all countries.

What are the options for additional indicators?

- The first remark is that data availability drives the entire process of working with indicators. It is not what we want, but what is available that drives this process.
- Adding indicators, also means deleting indicators. More is not always better
- Using different framework also implies that the comparability of cities across the world will be hampered. So we need to be cautious to change the CBF framework
- An option to overcome this is to provide additional indicators and leave the CBF unchanged.

- On the other hand, how can we serve the African continent with indicators that are relevant for all African cities? Here are some suggestions:
  1) *Informal settlements*. Our work in Asia and Africa, and many reports of UN-Habitat show that it is important to address the issue of informal settlements as many poor people live in these areas. Their main problems are access to water, food, energy, healthcare etc. This can be addressed in the CBF or TPF.
  2) *Solid waste*. From an African perspective (and the CBF as a whole), one might think of solid waste uncollected. It is very important to add such an indicator as it is relevant for water too as most of the solid waste in oceans is land-based.
  3) *Circular economy*. Transitioning to a circular economy (CE) requires strategic investments in infrastructure, but it also requires policy coherence, coordination and collaboration among stakeholders across sectors and governance levels. In a recent study in Naivasha it was observed that there is a moderate level of awareness about the CE and resource recovery from organic waste streams in Naivasha. The awareness is based on precedents including biogas toilets, making briquettes, wastewater reuse for irrigation, composting and combined heat and power from biogas.
     However, many stakeholders do not seem to fully acknowledge the environmental and economic benefits that could accrue from circularity. So in the area of waste, or more positively formulated CE, there are options.
  4) *WEF-nexus.* The other option is to broaden the City Blueprint Framework with indicators from the list of UN-SDG indicators as energy and food are closely linked to water, so to focus on the Water-Energy-Food nexus.

5.2 Suggestions for alternative methods & procédures

There are different options to communicate the diagnoses of cities to politicians and managers

1. Access to information: From the experience of assessing non-African cities, we have adviced the young professionals to first spend substantial time in scoring the indicators through the consultation of publicly available information. However, the young professionals have provided valuable lessons in this respect. Contrary to most cities in Europe, America or Asia, access to information is much more challenging in the African context. Even for larger cities. Hence, key advice is that contacts to stakeholders and information requests are being send out at the very start of the assessment period. In addition, as a matter of principle, we have so far not paid for information and only used information that was accessible to everyone. In African cities, this point of view has to change. In many cases, paying for information is the only way to complete the assessments and de facto it will make this formely unaccesible information publicly available.

2. Green space: CBF-indicator number 18 green space, requires an alternative scoring systems that should be explained in the questionnaire. Often the detailed information from the European Environment Agency that is available for European cities, is not readily available for most African cities. The indicator is however essential for understanding water management performances because green space is important to mitigate extreme rainfall, air pollution and urban heating. Hence, we propose to keep the indicator but propose an alternative scoring system that makes use of google maps as a rought estimation. After all, less accurate information is much better than no information.

3. Wastewater treatment related indicators: The following indicators all relate to Waste Water Treatment (WWT): Indicators 4 secondary WWT, 5 tertiary WWT, 7 nutrient recovery, 8 energy recovery, 9 sewage sludge recycling and 10 WWT energy efficiency. It is important to clarify that for assessments of African cities indicator 4 is relevant to sort out first. Next step is to map the existence/number of wastewater treatment

plants and/or alternative wastewater management schemes. Based on this information most indicators can be scored via two routes. First, if there are no wastewater treatment plants, indicators 4, 5, 7, 8, 9 and 10 score by default 0 points. In this case it is important to find out whether there are alternative small-scale biogas systems or community-based sanitation programmes that can provide information for the scoring of these indicators. Second, if there are wastewater treatment systems, try to contact local experts from these wastewater treatment plant for an expert judgment or access to reports because it is likely that this information is publicly available. In parallel, small-scale wastewater treatment systems such as community-based sanitation programmes also need to be taken into account in this case.

4. Database with methodological examples: The scoring of indicators in the African context is, due to information limitiations, less straight forward compared to other data-rich situations. Hence, it is suggested to make a list available that provides examples of how each indicator is scored in a number of African or other cities. In this way, future young professionals can learn how they can overcome data limitations.

5. Todays researchers are tomorrow's supervisors: Because the young professionals in the five cities have now invaluable experience in applying the CBF in the context of African cities, their methodological knowledge but even more so their tacit knowledge, makes them excellent supervisors of future researchers in other cities. Hence, we propose that from now on each young professional that successfully completed an assessment also commits to supervising another young professional in another African city in the future.

6 Guidance for upscaling

Based on the current approach, we propose the following procedure for supporting the assessment of the remaining 49 Capital African cites. Either one or two young professionals, each with a local UNESCO supervisor will be appointed by UNESCO headquarters. The local supervisors support the work and particularly support in reaching out to local organisations and stakeholders for data collection and, at the later stage, constructive discussions of the results. Each new assessment will involve a 'young peer' which is someone who has successfully completed an assessment and can give important guidance especially due to her/his experience in the African context. KWR Water Research Institute will provide (i) a kick-off webinar for methodological questions and a general presentation, (ii) an intermediary one-on-one feedback session with the young professional and the 'young peer' based an a written preliminary draft assessment report. In addition, (iiI) KWR Water Research Institute can provide a quality assurance on the final assessment results. Based on the different stages we exemplify how the work of the young professionals can be supported:

1. Step 1: Administrative arrangements
   A young professional and a local supervisor from a UNESCO focal point are appointed and contractual arrangements are made. The young professional is connected with a young peer (who has previously conducted the assessment in another city). At this stage the young professional receives an official letter from UNESCO headquarters, to help her/him to reach out stakeholders for the data collection process. UNESCO also sends a letter to inform the ministry of the country concerned.

2. Step 2: Preparation period
   Young professionals in each city start with studying documentation, i.e., a set of reading materials on the City Blueprint Approach's rational, methodology and applications. Simultaneously they start with the indicator assessment as specified by the questionnaires. Through consulting public reports, websites, policy documents or scientific studies they already provide preliminary scores of the indicators for which information is publicly available. By starting the assessment, the young professionals were also encouraged to prepare questions about the indicator scoring, rational, and reporting or data demands.
   - *Helpdesk: The TPF, BCF and GCF are available in both English and French. In addition, a database with methodological examples of how indicators have been scored in other African cities can be made available. Due to information limitiations, the scoring of indicators can be less straight forward for African cities and this database can provide guidance. An online web-environment can be created to store and share information for each city as well as general information.*

3. Step 3: Kick-off webinar: A presentation on the methodology is provided and detailed instructions on conducting the assessment can be presented. Next, the questions of the young professionals are discussed.
   - *Helpdeks: An online webinar, one in English and one in French, are organised by UNESCO headquarters and KWR Water Research Institute.*

4. Step 4: Field work & individual feedback sessions: The young professionals complete the assessment through networking with local authorities, developing alternative methods or information sources to score particular indicators. A deadline will be determined for the definitive report.
   - *Helpdesk: A one-on-one feedback session for each city can be organised to go through every detail and discuss how to deal with methodological and practical barriers.*

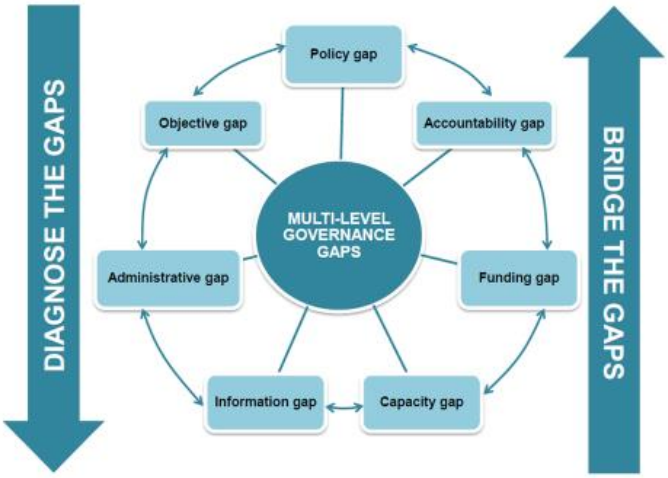
5. Step 5: Quality assurance: The assessment report including the indicators scores calculation, methodological reporting and substantiation as well as detailed referencing of consulted documentation, stakeholder visits and the like is made available by the young professionals.
    - *Helpdesk: KWR provides a detailed quality assurance and for some indicators request some clarifications, additional information or guidance. A second revised version of the indicator scores will then be provided in preparation of step 6.*

6. Step 6: Workshops: In each city, a workshop with local decision-makers will be held. Here the assessment results can be presented, followed by a discussion on how the city can best improve their water management performances.
    - *Helpdeks: Standardized presentation format can be made available by KWR Water Research Institute. It is recommanded that in preparation for the workshop a professional training (how to present results, formulate advice and basic media training) is given by UNESCO headquarters and KWR Water Research Institute.*

7. Step 7: (optional) Conference presentation and publicatons: Young professionals that have completed their assessments are encouraged to attend conferences and publish in local and international journals.
    - *Helpdesk: Opportunities of co-writing with UNESCO headquaters, KWR Water Research Institute and the wider scientific community should be seized. A key requirements is that whenever it is a case-study paper, the lead investigator (i.e., the young professional who has conducted the research and contributes to the paper writing)will be the first author.*

7 Conclusions

The excellent work done by the young professionals has shown, that doing a baseline assessment is an essential first step. The data gathering process is burdensome and sometimes shows how organizations - all dealing with water, waste or climate change - are working in pillars. That is observed everywhere as highlighted in OECD's work on water governance. In some cases in Africa, data could only be obtained if compensated by money.



- The City Blueprint® Approach (CBA) consists of three indicator assessments: (1) the Trends and Pressures Framework (TPF), (2) the City Blueprint Framework (CBF) and (3) the Water Governance Capacity Framework (GCF).
- The attractiveness of the CBA lies in the fact that this tool can help cities in their decision making, in particular in assessing the challenges of water, waste and climate change.
- In this report young professionals have successfully applied the CBA and identified priorities for addressing integrated water challenges in African cities: Abuja, Bangui, Harare, Libreville and Yaoundé.
- Based on the results of the TPF analysis, we conclude that urbanization, burden of disease, tertiary education, economic pressure, air pollution in some cities, and governance arrangements affect African city-dwellers in general and the water sector in African cities, in particular.
- Wastewater treatment can be improved. This is often only limited to primary and secondary treatment, leading to large-scale surface water pollution. Also, solid waste collection and processing are great challenges in African cities.
- The CBA also provided good training on integrated water resources management, water management, water governance and how to approach stakeholders to assist in bridging data gaps.
- If this work on five cities in Africa is regarded as a feasibility study, the successful results show that upscaling is a necessary next step. This can be organized in collaboration with UNESCO, the University of Bath and KWR.
- After diagnosis, cure may be necessary. This means that the results have to be presented at higher policy and/or political levels, to discuss the results, discuss the options and decide on investment decisions, if needed. Further steps are needed with relevant stakeholders to accelerate actions to make African cities water wise.

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Annex 1 Governance Capacity analysis Libreville

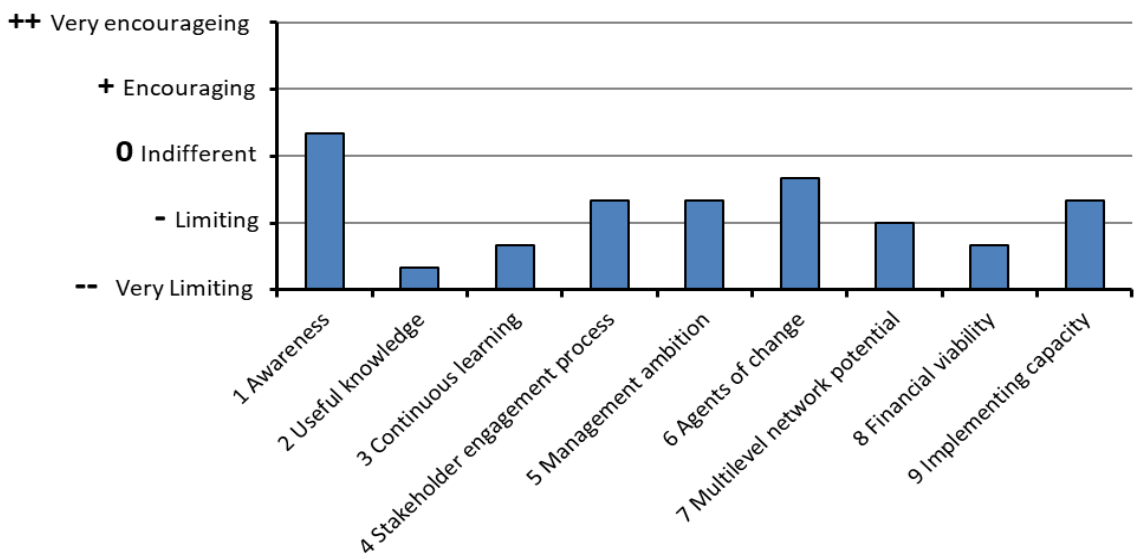

Figure 1 Scores of nine Governance Capacity Frameoworks' conditions with respect to Libreville's capacity to govern water pollution.

Condition 1: Awareness

Knowledge regarding the current and future risks surrounding the issues of water pollution are generally underestimated by the communities and stakeholders in Libreville (indicator 1.1: neutral (0) contribution to the capacity to govern water pollution). Most people within the general population seem to know the basic health-related risks of consuming improper water (interviewee 5). However, the wider, more specific risks of water pollution to the environment are not known or considered, let alone the future risks such as environmental degradation and its indirect consequences on the economy, such as fishing. Although polluted surface waters in the city can be clearly perceived through olfactory as well as visionary senses, the general sense of urgency to address such problems seems relatively small (indicator 1.2: encouraging (+) contribution). It seems that although the general population does not voluntarily throw their waste into the environment, it often does not have any other choice of behaviour as rubbish bins are scarce and overflowing (interviewee 1). Thus, it is quite common for households and small businesses to discharge solid or liquid waste into juxtaposed water bodies interviewee 1 5 and 8). This is a main source of water, soil and food contamination. Most stakeholders are aware of this, however, there are only small changes in actions and behaviour in response (indicator 1.3: exploration (0)). Concluding sentence

Condition 2: Useful knowledge

There is a severe lack of data available on water pollution and its causes and related issues (indicator 2.1: very limiting (--) contribution to the capacity to govern water pollution; Binga, ND; Interviewee 4). The little information that is readily accessible online on the topics of water pollution is extremely difficult to access by the wider public and may to a lesser extent may be challenging to comprehend for non-experts (indicator 2.2: very limiting (--) contribution), as it is usually in the form of scientific papers and reports or grey literature (Mombo and Edou, 2007, Babijes 2007). Acquiring information about sanitation and wastewater treatment provides substantial barriers. First of all, transparency about which information is available is not readily available through public communication challenges. Second, most reports are only available on request and may take a long time to arrive. Information found on such matters is usually sector specific and very rarely shared between ministries (indicator 2.3: limiting (-) contribution).

As such, different methods of producing information are rarely shared, as for example the ministry of mines who is equipped with analysis laboratories, seldom lends their equipment or laboratories to other ministries or academics which the latter do not possess (interviewee 4).

Condition 3: Continuous learning

There are no measures in place which systematically gather data on surface or groundwater bodies, as well as domestic and industrial wastewater throughout the city, except for drinking water supply quality management, in the supply station (interviewee 6 and 7; (indicator 3.1: very limiting (--) contribution to the capacity to govern water pollution). A smart monitoring system in which real time measurements are taken at multiple locations in the city is missing. For example, the city of Bristol in the UK, has multiple measuring station across the city and all of the data are automatically relayed to a central data base through the internet, making it possible to see daily changes in surface water quality (Chen & Wan, 2018).
With such a smart monitoring system especially underlying trends such as groundwater acidification and contamination of heavy metals (Ondo, 2011) from garages, food or chemical companies and hospitals in Libreville may be identified. Accordingly, eutrophication and algal blooms and its environmental impacts on water pollution are relatively unknown (interviewee 8). Without a consistent monitoring system in place throughout the city it is quite challenging to evaluate whether policies aiming at reducing water pollution work or not and how they can be made more effective (indicator 3.2: limiting (-) contribution). Hence, without a monitoring system in place or specific policies aiming at reducing waste-water discharge into the environment or sanitary regulations, it is difficult to consistently evaluate the effectiveness of policies that aim to reduce water pollution (interviewee 4 and 6). With respect to addressing water pollution in Libreville, there is not much collaboration between different relevant stakeholders such as between the municipality and the ministry of water and energy or that of the environment (indicator 3.3: limiting (-) contribution). In fact, top-down the government legislation and priorities do not always align with local water pollution challenges that municipalities and communities face (interviewee, 7; Allogho, 2006).

Condition 4: Stakeholder Engagement Process

Some stakeholders, such as NGOs or affected communities, are consulted before new water pollution or sanitation related projects are initiated. However, various local experts (interviewee 4, 5 and 7) representing different interests all indicate that there are no clear procedures for stakeholder participation and stakeholders usually have low influence on the outcomes of the decisions made and if they are included, they get involved at a late stage in the decision-making process (indicator 4.1: limiting (-) contribution to the capacity to govern water pollution). As a result, many projects are developed without active engagement of or efforts to alignment with local stakeholders which in many causes can impede effective project implementation (e.g. (Glucker et al. 2013; OECD 2015; UNDP 2008)(interviewee 9). Thus, it seems that stakeholder's core values such as people livelihoods or key business interests are not optimally protected throughout the stakeholder engagement process. Key reason cannot be attributed to a lack of goodwill but is rather a result of weakly defined engagement procedures that are not consistently applied (Allogho, 2006; interviewee 1 and 4; indicator 4.2: neutral (0) contribution). In addition to community-based engagement, private actors like Veolia or Averda have had disputes with the government about payments (Takoleu, 2019). No clear examples of transparent clear and realistic exit procedures in the stakeholder consultation processes are found. Accordingly, no clear examples have been observed that indicate that a variety of alternatives are co-created with stakeholders to address water pollution related projects (indicator 4.3: limiting (-) contribution).

Condition 5: Management ambition

In Gabon there are rather ambitious goals concerning the mitigation of water pollution, sanitation and to a lesser extent waste water treatment (indicator 5.1: limiting (-) contribution to the capacity to govern water pollution). However, these big objectives are not consistently supported by short-term targets. For example, one long-term vision in the Strategic Plan for an Emerging Gabon seeks to provide access to improved sanitation for everyone by 2025 (PSGE, 2011). 'Action 13' and Objective 19 in the Strategic Plan for an Emerging Gabon (PSGE, 2011) draw on

'the fight against pollution and nuisances' and mention that water should be addressed in anti-pollution efforts, yet it is not specified how this will be done in practice (Gabonese Republic, 2012).

However, it is hardly specified how that can be achieved in relation to the fact that only about half of the city's population has access to improved sanitation, especially in the poorer informal settlements of the city where archaic pit latrines are still commonly used (Mombo & Edou, 2007; Chaignaud, 2008). Short-term targets, such as providing improved sanitation facilities and solid as well as liquid waste collection services to all informal settlements of Libreville by 2025 could be implemented. Policies aimed at reducing water pollution do not formally address the informal settlements of Libreville in more case tailored efforts, (indicator 5.2: limiting (-) contribution) taking the socio-economic and cultural characteristics of these areas into account (interviewee 4 and 7). Such informal settlements like the *bas-fonds* are often located in drainage basins and inhabited by mostly poorer people or recent immigrants from rural areas. These neighbourhoods have especially severe water pollution as most domestic solid and all liquid waste ends in the adjacent watersheds which poses a severe health threat due to flooding during the rainy season (Mombo and Edou, 2007). Because these policies are not coherent across geographic boundaries and as there often is a dysfunction between technicians who depend on the central administrations and the local policies of municipalities (interviewee 8 and 9), policies are also insufficiently aligned according to different governmental levels (indicator 5.3: neutral (0) contribution).

Condition 6: Agents of Change

Through community representatives, it may be possible for communities to somewhat influence decision-making (indicator 6.1: neutral (0) contribution to the capacity to govern water pollution) Entrepreneurial individuals may seek opportunities with NGOs and in some cases to officials from mayors' office or local political leaders or even the media, who may then transmit messages further to the 'top' (interviewee 1 and 10). Next to such collaborations, there are also novel collaborations between young people who volunteer and assemble to improve sanitation efforts (Provost, 2009; indicator 6.2: neutral (0) contribution). There are some visionary agents of change (indicator 6.3: neutral (0) contribution) such as the mayor of the Libreville, the general directorate of the technical services to the environment and urban amenities, or the minister of water and energy and even the prime minister, who put forth long-term visions on sanitation.

Condition 7: Multi-level network potential

In theory actors in the civil society are not allowed to just take the decision in their own hands of managing their waste water (interviewee 9). In practice, however, there are community sanitation initiatives, who work with NGOS who listen to and help the former (interviewee 10), as well as private beverage companies and some hotels and hospitals, who have autonomously built their own onsite waste water treatment facilities, which is tolerated by the government (indicator 7.1: limiting (-) contribution to the capacity to govern water pollution). A major impediment for effectively addressing water pollution issues in Libreville is the unclear division of responsibilities as to who must do what in regard to water pollution (indicator 7.2: very limiting (--) contribution). A great deal of informants stressed that responsibilities are not clear and competences between various ministries are not clear and often overlap (interviewee 4, 6, 7, 8 and 9). For example within the ministry of the environment, both the General Directorate for the Environment and the Protection of Nature (DGEPN) and the ministry of health's institute for Public Hygiene and Sanitation (IHPA) carry out controls of surface water quality and deal with complaints (Interviewee 9, 2020; Kramkimel et al., 2005).This also hampers the authority to ensure good pollution control measures in practice (indicator 7.3: neutral (0) contribution) of some institutional bodies as it is not always clear who may ensure compliance with pollution regulation when and what penalties may be applied as the planned water code is not yet in place (interviewee 6 and 9). On the other hand, it is not clear whether companies like Sobraga received subsidies from the state for constructing their won on site waste-water treatment facilities.

Condition 8: Financial viability

There is limited affordability and availability of sanitation services as the informal neighbourhoods of Libreville rely on shared pit latrines and septic tanks, as standard toilets and such are unaffordable and unavailable (interviewee 6;

(indicator 8.1: limiting (-) contribution to the capacity to govern water pollution). Wastewater treatment services on the other hand are simply inexistent. Most communities are willing to pay for the sanitation of the environment (indicator 8.2: limiting (-) contribution). However, they may not always have access or the financial resources to afford such services (interviewee 8 and 10). Overall, there is a severe lack of financial arrangements to secure long-term anti water pollution policy implementation and risk reduction (indicator 8.3: very limiting (--) contribution) as the state budget is struggling to address the water quality goals (interviewee 6 and 8). Numerous public-private-partnerships between state utilities and private companies have collapsed due to termination of funding from the Gabonese state, such as the rupture between the SEEG and Veolia contract (interviewee 4; Reuters, 2018).

Condition 9: Implementing capacity

Implementing capacity is considerably lacking in Libreville as for example policy instruments such as the polluter pays principle are seldom used in practice (indicator 9.1: limiting (-) contribution to the capacity to govern water pollution). The polluter pays principle does exist, however, whether it is applied in practice remains questionable (interviewee 9).Due to unclear division of responsibilities as well as incomplete legislation regarding water quality control, statutory compliance of wastewater discharge from industries is insufficient (interviewee 3 and 9). Thus, there is only moderate compliance to existing legislation in the capital (indicator 9.2: limiting (-) contribution) which leads to much uncontrolled and unknown water pollution. There are laws in place for industries to have their own action plans (indicator 9.3: neutral (0) contribution) to prevent polluting accidents (interviewee 2). However, there are no action plans to target gradual diffuse pollution, as this is mostly a symptom of uncontrolled urban development.

Synthesis

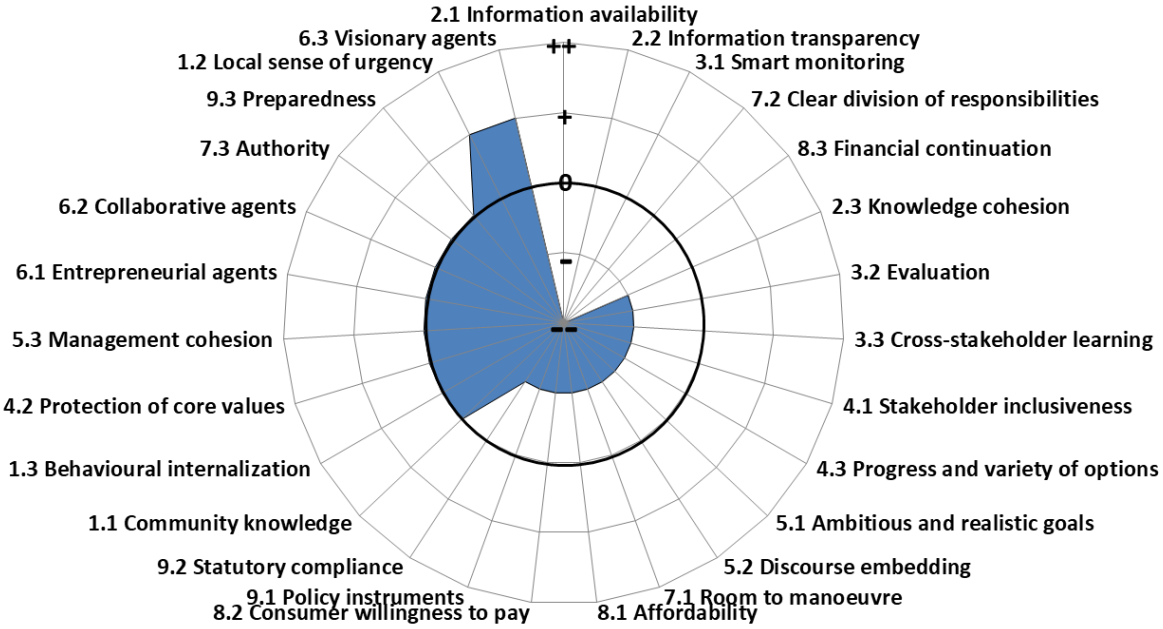

Figure 2 Spider diagram of Governance Capacity Framework's results of Libreville with respect to water pollution.

In the context of climate change and urban growth, water pollution issues are likely to play a more decisive role in Libreville's near future social and economic development. The issues hampering the capacity of stakeholders and authorities to together govern water pollution challenges are highly inter-related. Without a consistent water quality monitoring system (indicator 3.1) in place throughout the city, it is challenging to know what is going on the system, to determine where most pollution sources originate and test what can be done

to stem these. Because there is a lack of data and information on water pollution (indicator 2.1) as well as no monitoring system in place (indicator 3.1), it is also difficult for the relevant institutions to know which policies have to implemented where (condition 5), which policy instruments have to be applied (indicator 9.1) and how to evaluate if they work or not (indicator 3.2). Also, how may one prepare action plans for sudden pollution incidents or gradual increases in water pollution (indicator 9.3), or determine who complies or does not (indicator 9.2). Hence, insufficient monitoring of water pollution - both domestic and industrial – directly inhibits statutory compliance (indicator 9.2) and evaluation and improvement (indicators 3.2 and 3.3) of existing policies instruments (indicator 9.1).

A lack of financial arrangements (indicator 8.3) and human capacities are also a major barrier at mitigating water pollution in the city. Not only could more financial arrangements help secure an efficient smart water quality monitoring system (indicator 3.1), but are also necessary for the construction of a separate sewage network and wastewater treatment facilities. The continuation of financial arrangements (8.3) might also help secure the completion of projects aiming at reducing water pollution.

In addition to this, the fragmented policies (indicator 5.1) on wastewater treatment, sanitation and water pollution hamper a clear division of responsibilities (indicator 7.2) as to who must do what in practice in regard to these issues. The ministry of water and energy, the ministry of the environment, the ministry of health and the ministry of public works all work on the issues of water pollution, more explicitly sanitation, yet some seem to have similar functions as others. For example, both the ministry of the environment and the ministry of public health check water quality and may sanction. However, the ministry of water and energy, which also may control water quality and is involved in sanitation efforts, cannot ensure compliance with pollution regulation. Thus, an unclear division of responsibilities also makes sanctioning (indicator 7.3) more difficult and facilities statuary incompliance (indicator 9.2).

A water code, in which competencies as well as the concepts of sanitation and wastewater treatment would be clearly defined, could help resolve issues of overlapping function and unclear division of responsibilities (indicator 7.2) as well as clarify authority to sanction (indicator 7.3). Next to this, an independent regulatory organisation could check the work of these institutions and organise regular meetings between officials of these institutions or create a communication platform between them. In this way, information between the relevant institutions could be shared improving cross-stakeholder capacity building (indicator 3.3) and make information accessible to the public enhancing information availability (indicator 2.1). However, in order to address water pollution issues in Libreville the first most beneficial step is the implementation of a smart water quality monitoring system (indicator 3.1). Consequently, a monitoring system and a larger amount of available information (indicator 2.1) on water quality would make foreign investment into addressing these issues more attractive as a return on investments would be secure. Hence, this would strengthen financial continuation (indicator 8.3) for projects aiming at addressing water quality and investment in hard infrastructure as well as the education of professionals in the field. Secondly, a water code with new laws and short-term policy goals would be beneficial at guiding the work of institutions in charge of addressing water pollution by clearly identifying their responsibilities (indicator 7.2) and authority (indicator 7.3). Third, a regulatory organisation could help improve communication between ministries and evaluate their efforts as well as new policies in place. Fourth, regular meetings organised between this regulatory body, the relevant institutions, municipalities, NGOs and the private sector may serve to improve stakeholder inclusiveness and protection of core values (indicator 4.1; 4.3) as well as even alter the behaviour of stakeholders (indicator 1.3).

Annex 2 Manuscript – 3 Central African Cities

City Blueprint Assessment in 3 Central African Cities: A Contribution for the improvement of Urban Water Security

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KEYWORDS

City Blueprint Approach - Trends and Pressures Framework – City Blueprint Framework - Governance Capacity Framework – Water management

ABBREVIATIONS

BCI: Blue City Index

CAR: Central African Republic

CBF: City Blueprint Framework

GCF: Governance Capacity Framework

IHP: Intergovernmental Hydrological Programme

IWRM: Integrated Water Resources Management

NGO: Non-Governmental Organization

TPF: Trends and Pressures Framework

UNESCO: United Nations Educational, Scientific and Cultural Organization

WWT: Waste Water Treatment

ABSTRACT

The strength of City Blueprint Approach lies in the fact that this tool can help large cities in their decision-making, in particular in assessing management challenges related to water, waste and climate change. In the present paper, we have tried to identify priorities in the way of addressing integrated water challenges in Central African cities: Bangui, Libreville and Yaounde. We have tested the City Blueprint® approach, which is based on three assessments indicators: (1) the Trends and Pressures Framework (TPF), (2) the City Blueprint Framework (CBF) and (3) the water Governance Capacity Framework (GCF). The TPF summarizes the key social, environmental, financial and governance pressures that can hinder water management. The CBF provides an integrated overview of a city's management performances.

Finally, the GCF provides a framework through which are identified the main obstacles and opportunities for developing governance capacity. It appears from the results obtained that, vulnerability to river flooding and economic pressure have a great impact on the water sector in Central African cities and wastewater treatment can be improved in these cities. Sometimes, only wastewater is only submitted to a few part of primary and secondary treatment, leading to large-scale of pollution. Yaoundé's water governance and more specifically smart monitoring and evaluation of projects and cross-stakeholder learning are capacity-building priorities.

1 INTRODUCTION

Cities in developing countries face recurrent weather events, including floods and droughts, which hamper the provision of basic services. This situation is likely to worsen as a result of climate change and rapid urbanization. It is estimated that by 2050, 87% of the population will live in cities while at the same time the supply of water will be 40% less than demand. Cities are therefore obliged to adapt their water management to avoid falling prey to inaction and growing social inequalities. But how can a city quickly understand which elements of its water cycle are already sustainable and which ones need to be adapted? The City Blueprint is a practical communication tool that can help cities on their way to becoming water sustainable cities.

The City Blueprint approach is a diagnostic tool for Integrated Water Resources Management (IWRM) in cities. It is being integrated into the operational framework of UNESCO's Intergovernmental Hydrological Program (IHP) and is composed of three complementary frameworks: (i) the Trends and Pressures Framework (TPF), which is a framework for the challenges of cities, (ii) the City Blueprint Framework (CBP) for urban water management performances and (iii) the Governance Capacity Framework (GCF). The TPF and CBF have been applied in 125 cities across the globe, the relatively new GCF has been applied in about 15 cities, including Amsterdam, Quito (Ecuador), Melbourne, New York, Seoul, Cape Town, Bandung (Indonesia) and Ahmedabad (India) (EIP Water, 2020c). It is an important tool for understanding and developing a framework for water resources management in cities to contribute to the prevention of disaster risks in particular, and to improve the resilience and living conditions of populations. Hence, it may be a useful tool to apply in African regions. Accordingly, we aim to identify priorities for responding to integrated water challenges in Central African cities. To do so, we apply the City Blueprint Approach in three Central African capitals (Bangui in Central Africa Republic, Libreville in Gabon and Yaoundé in Cameroon). This article is structured as follows: section 2 provides the methodological description of the City Blueprint Approach. Section 3 reports the assessment's results and finally section 4 ends with the conclusion.

2 METHODS

The City Blueprint Approach

In order to identify priorities for addressing integrated water challenges in Central African cities, we apply the City Blueprint Approach. Through this methodological approach, we identify the main challenges, highlight water management priorities and give recommendations based on the analysis of

these three Central African cities. The City Blueprint Approach is a diagnostic tool for assessing the sustainability of IWRM that consists of three complementary frameworks. First, the main challenges of the cities are assessed using the Trends and Pressures Framework (TPF; EIP Water, 2020a). Second, the question how cities manage their water systems is assessed using the Blueprint for Cities Framework (CBF; EIP Water, 2020b). Third, areas where cities can improve their water governance are assessed using the Governance Capacity Framework (GCF; EIP Water, 2020c; Van Leeuwen et al., 2019). By the end of 2020, this tool has been tested in approximately 125 municipalities in over 40 countries (EIP Water, 2020; Koop and Van Leeuwen, 2015a).

The Trends and Pressures Framework (TFP)

The TPF consists of 24 indicators under the following broad categories: social pressures, environmental pressures, financial pressures and governance (Table 1). Each indicator is scaled from 0 to 10 points, with a higher score representing a greater pressure or concern in which water managers have to operate (Koop and Van Leeuwen, 2015a; Koop and Van Leeuwen, 2015b). Most indicator scores are calculated from international data sources, for example, the World Bank (World Bank, 2019) and some Non-Governmental Organizations (NGOs). Details of the indicators, data sources and examples of calculations are presented in the online (EIP Water, 2020a).

Table 1: Indicators of the Trends and Pressures Framework.

Categories	Indicators		Indicator number
Social pressures	Urbanization rate		1
	Burden of disease		2
	Education rate		3
Environmental pressures	Flood risk	Urban drainage flood	4
		Sea level rise	5
		River peak discharge	6
		Land subsidence	7
	Water scarcity	Freshwater scarcity	8
		Groundwater scarcity	9
		Sea water intrusion	10
	Water quality	Surface water quality	11
		Biodiversity	12
	Heat risk	Heat island	13
	Air quality		14
Financial pressures	Economic pressure		15
	Unemployment rate		16
	Poverty rate		17
	Inflation		18
Governance	Voice end accountability		19
	Political instability		20

Government effectiveness	21
Regulatory quality	22
Rule of law	23
Control of corruption	24

The City Blueprint Framework

CBF is a baseline assessment that evaluates the actual state of IWRM in a city and shows the indicator scores in a spider diagram (Koop and Van Leeuwen, 2015a; Koop and Van Leeuwen, 2015b). The result of this assessment is the first in the strategic planning process for IWRM in cities (EIP Water, 2020b). The CBF consists of 24 indicators divided into seven broad categories (Table 2). All 24 indicators are rated from 0 (low performance) to 10 (high performance). The CBF provides an in-depth understanding of the main challenges and can help prioritise IWRM management options. The geometric mean of these indicators is the Blue City Index (BCI; Koop and Van Leeuwen, 2015a; Koop and Van Leeuwen, 2015b). Details of the indicators, data sources and examples of calculations are available online (EIP Water, 2020b).

Table 2: Indicators of the City blueprint framework.

Categories	Indicators
Basic water services	1. Access to drinking water
	2. Access to sanitation
	3. Drinking water quality
Water quality	4. Secondary WWT
	5. Tertiary WWT
	6. Groundwater quality
Wastewater treatment	7. Nutrient recovery
	8. Energy recovery
	9. Sewage sludge recycling
	10. WWT energy efficiency
Water infrastructure	11. Stormwater separation
	12. Average age sewer
	13. Water system leakages
	14. Operation cost recovery
Solid waste treatment	15. Solid waste collected
	16. Solid waste recycled
	17. Solid waste energy recovered
Climate robustness	18 Green space
	19 Climate adaptation

	20 Climate-robust buildings
Plans and actions	21 Management and action plans
	22 Water efficiency measures
	23 Drinking water consumption
	24 Attractiveness

Based on BCI and similarities in indicator scores, cities are classified into the following five categories provided in Table 3 (Koop and Van Leeuwen 2015b; EIP Water, 2020d).

Table 3: Categorization of different levels of IWRM (Koop and Van Leeuwen 2015b).

BCI score	Categorization of different levels of sustainable IWRM in cities
0 – 2	Cities lacking basic water services
2 – 4	Wasteful cities
4 – 6	Water efficient cities
6 – 8	Resource efficient and adaptive cities
8 – 10	Water wise cities

The Governance Capacity Framework

Governance capacity was analysed to address these challenges with GCF by interviewing stakeholders and water authorities (government institutions, NGOs, universities, research officers, authorities). GCF is analysing the capacity of all stakeholders involved to together govern a specific water challenge. The first city in which this assessment was carried out is the city of Amsterdam (Koop et al., 2017). The GCF is a standardized methodology for assessing governance aspects (Table 4) on, for example, IWRM, water scarcity, flood risk, wastewater treatment, solid waste treatment, urban heat islands and/or water reuse. This is done by conducting semi-structured interviews with stakeholders from relevant authorities, government agencies and researchers to assess the local situation. The GCF is structured in three dimensions (knowledge, will and empowerment), nine key conditions and 27 indicators (Table 4; EIP Water, 2020c). A Likert-type scale is used to provide scores on each indicator, ranging from very encouraging (++) to very limiting (--) (Koop et al., 2017; Madonsela et al., 2019; Van Leeuwen et al., 2019; Ddiba et al., 2020).

Table 4: Governance Capacity Framework indicators.

Dimensions	Conditions	Indicators
Knowing	**1 Awareness**	**1.1 Community knowledge** **1.2 Sense of urgency** **1.3 Behavioural internalisation**

	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 goals 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	2.1 Room to manoeuvre 2.2 Clear division of responsibilities 2.3 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

Data Collection

The data needed to calculate the TPF and CBF indicators are collected from publicly available sources, such as international databases, national and local reports, government websites and scientific articles. The data is collected jointly with local stakeholders (i.e., municipal officials, departmental representatives, NGOs and water and sanitation user groups), who provide feedback and additional input on preliminary results. The GCF data was collected by conducting fifteen semi-structured qualitative interviews. The interviews were conducted with respondents who work for the state or city government and with respondents who work for non-governmental organizations (NGOs) that are influential in water governance in Yaoundé. An independent research institute - KWR Water Research Institute located in the Netherlands - provided feedback to ensure consistency of indicator scores with other cities that were assessed using the City Blueprint approach. In this way, the exchange of learning practices between cities is enabled.

3 RESULTS

Trends and Pressures Framework

For all TPF indicators, the scores range from no concern to great concerned. Two indicators score a "great concern" for Bangui: the education rate and the unemployment rate. Libreville has five indicators of "great concern": urbanization rate, vulnerability to river flooding, economic pressure, unemployment rate and poverty rate. Yaoundé, on the other hand, has eight indicators of "great concern":, floods, vulnerability to river floods, land subsidence, surface water quality, air quality, economic pressure, political instability and corruption. Pressures can hamper the efforts of water managers to provide good urban water services, as measured by CBF.

City Blueprint Framework

The scores for the 24 CBF indicators are presented in Figure 1. The three Central African cities score relatively low on all City Blueprint indicators, with several possibilities for improvement. All these cities score high on drinking water consumption. A high score for drinking water consumption means that people do not consume a lot of water. The City Blueprint indicators for which rather low scores are observed are: tertiary wastewater treatment; groundwater quality; solid waste recycled; energy recovered from solid waste; nutrient recovery from wastewater; average age of sewers; energy recovery from wastewater; sludge recovery; energy efficiency; storm water separation; water systems leakages and green spaces. Some indicators do not score high because of the social, environmental and financial pressures that these cities face. On the basis of overall performance, cities can be ranked according to the BCI scores assigned to each of them (Table 3). Libreville and Yaoundé, with BCI scores between 2 and 4, are classified as wasteful cities, while Bangui (BCI 1.9) is classified as a city with insufficient basic water services. Cities are given a medium score for climate adaptation through the implementation of publicly accessible local climate adaptation plans, but a low score for green spaces (except Libreville which has a high score) and rainwater separation, which increases vulnerability to climate change. The attractiveness of water bodies is limited due to pollution. In addition, blue infrastructure in cities such as fountains and ponds are very few, and a considerable number of these blue infrastructures are currently out of service.

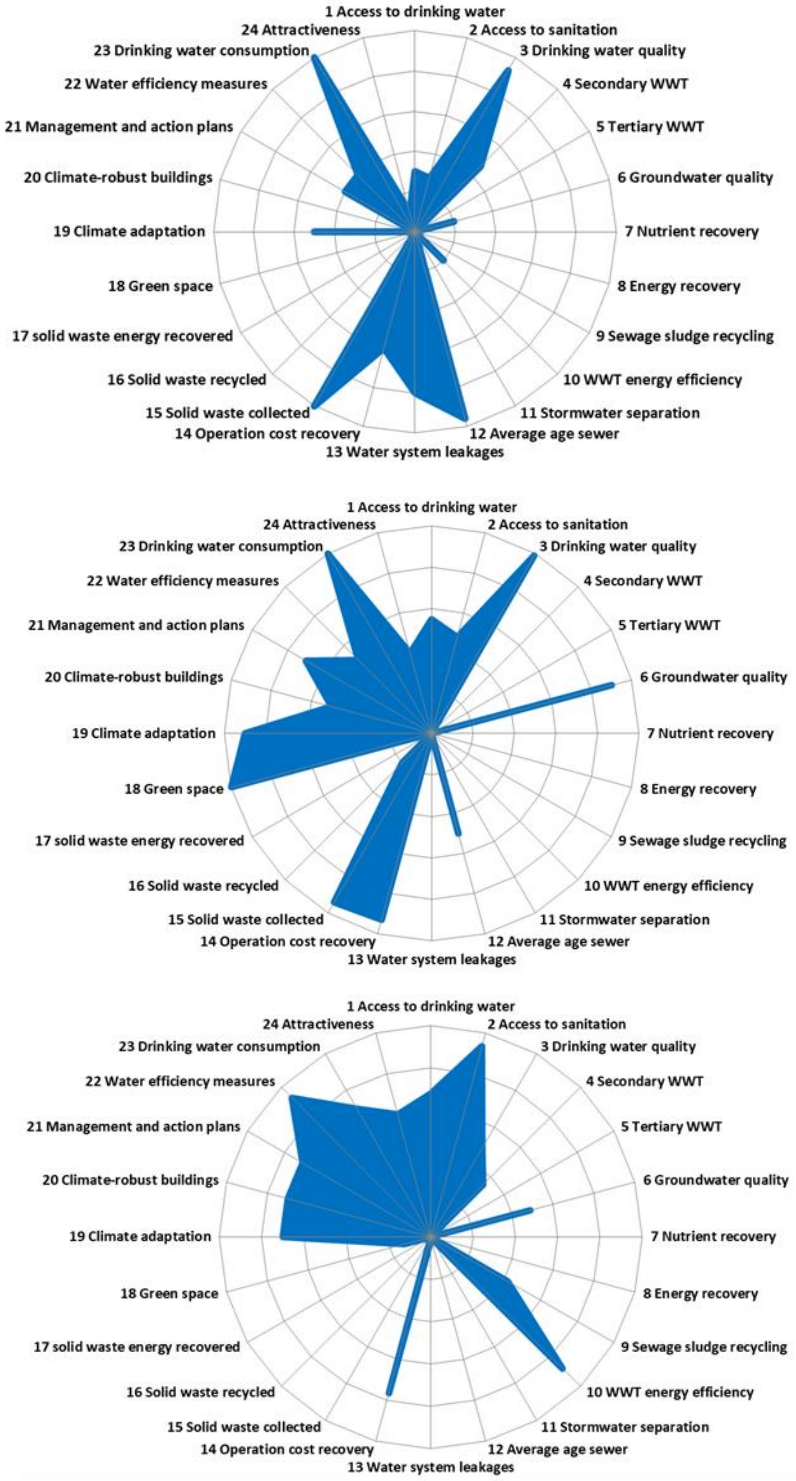

Fig.1: City blueprints of Bangui (top), Libreville (center) and Yaoundé (bottom), based on 24 performance indicators. The geometric mean of the indicators, the BCI scores, are 1.9, 2.6 and 2.7 respectively.

Governance Capacity Framework of Yaoundé

The analyses show seven out of 27 GCF indicators with a very limiting (--) score. Further on, eight indicators returned a limiting (-) score, eight indicators with an indifferent (0) score, two encouraging (+) indicators and one very encouraging (++) indicator. Figure 2 shows the average score for each of the five water-related challenges for the 27 indicators.

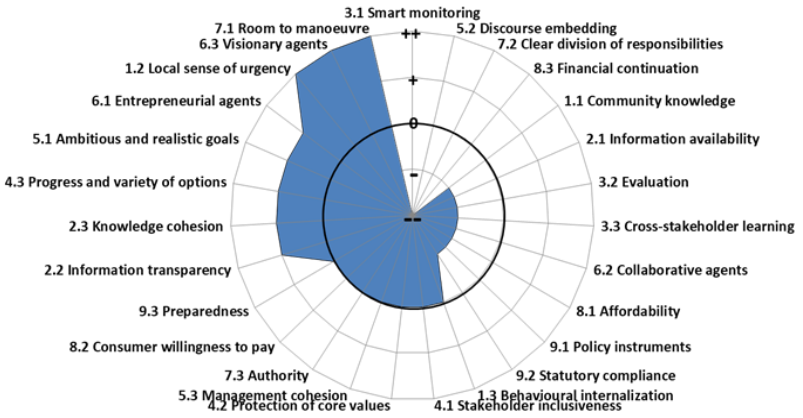

Fig. 2 Results of the GCF analysis of Yaoundé. Limiting GCF indicators, with scores below zero, are 2.1 information availability, 3.1 smart monitoring, 3.2 evaluation, 3.3 cross-stakeholders learning, 5.2 discourse embedding, 6.2 collaborative agents, 7.2 clear division of responsibilities, 8.1 affordability, 8.3 financial continuation, and 9.2 statutory compliance.

Governance capacities to address water scarcity and urban heat islands, respectively, are relatively well developed in Yaoundé. To address these challenges, indicators 1.2 local sense of urgency, 2.2 transparency of information, 2.3 consistency of knowledge, and 5.1 ambitious and realistic management illustrate the well-developed governance capacity to address water scarcity and heat islands respectively. The development of the capacity to address the challenges related to flood risks, wastewater treatment and solid waste treatment have a few indicators that have a limiting (-) to very limiting (--) effect which can be considered a capacity-development priority. In particular, 10 indicators limited the overall governance capacity for almost all water challenges (Figure 2): 2.1 information availability, 3.1 smart monitoring, 3.2 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 statutory compliance. As shown in Figure 2, indicator 2.1 is very limited (--). In Yaoundé, a lack of knowledge which in turn prevents informed decision-making (Rowley, 2007; Van Rijswick et al., 2014). Authorities in many cities recognize the lack of knowledge about how future trends, such as urbanization and climate change, will affect their city (Amundsen et al., 2010). In addition, responsibilities for IWRM are fragmented. They are distributed among a numerous organizations. This fragmentation creates uncertainty due to overlapping responsibilities (Mees et al., 2014).

Conclusions

The challenges of water, waste and climate change in the context of rapid urbanization underline the need for good water management in cities. The objective of the research was to identify priorities for addressing integrated water challenges in Central African cities. In doing so, the City Blueprint Approach was to be tested in three Central African capitals to assess the sustainability of integrated water resources management which consists of three complementary frameworks. Based on the results of these broad diagnostic frameworks the following conclusions can be drawn:

1. Based on the trend and pressure analysis, vulnerability to river flooding is a major concern for two of the three Central African cities. Economic pressure is a major concern for both Yaoundé and Libreville.

2. Based on the CBF, WWT and resource recovery are the highest priorities in terms of improving

water management. Often, only primary wastewater and a small portion of secondary wastewater are treated, resulting in large-scale pollution of surface and deep waters. Long-term strategic planning and increased capital investment are required to improve tertiary wastewater treatment, solid waste recycling, nutrient recovery from wastewater treatment, storm water separation, and maintenance and improvement of urban water infrastructure. However, local municipalities, with the support of government and possibly donors, need to take the lead in introducing forms of energy recovery (technology) and tertiary treatment to avoid pollution of surface and groundwater. This will not only provide a source of clean energy, but will also create jobs for the population of Cameroon, especially the youth, and can be cost-effective. In addition, the small area of green spaces in Bangui and Yaoundé increases the vulnerability of flooding during heavy rains due to a lack of water storage capacity, sometimes leading to the destruction of roads and houses. Increasing green spaces in these cities would help fight air pollution.

3. During the information collection process, a lack of open source information was observed. Without transparent data, evaluation and, indeed, learning about existing policies and management practices is severely hampered. Thus, transparency of information is essential to support constructive discussion, evaluation and learning to continuously improve existing policies and management practices.

4. Based on the analysis of the governance capacity of the city of Yaoundé, it is proposed to improve smart monitoring and evaluation of projects and cross- stakeholders learning efforts. For example, through workshops that involve different levels of management, stakeholder empower each other to continuously learn and together make the city's water governance more effective. Integration of discourse, clear division of responsibilities and statutory compliance are among the factors that also need to be addressed. However, sufficient monitoring is first needed to analyse the impact of different measures and policies, to enable accountability and to know whether stakeholders are complying with existing regulations.

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Annex 3 Workshop report - Yaoundé

Organisation des Nations Unies pour l'éducation, la science et la culture

Programme hydrologique intergouvernemental

KWR

PROJET CITY BLUEPRINT

Atelier national de restitution des résultats de l'expérimentation de l'Approche City Blueprint® dans la ville de Yaoundé

RAPPORT FINAL

Photo de groupe des participants à l'atelier- Bureau Régional Multisectoriel de l'UNESCO pour l'Afrique Centrale, Yaoundé, 11 juin 2020

Sommaire :

1. INTRODUCTION

1.1 Contexte

Les villes des pays en développement sont confrontées à une récurrence des phénomènes météorologiques, notamment les inondations et sécheresse qui handicapent la fourniture des services de base. Cette situation risque de s'aggraver du fait du changement climatique, dans un contexte d'urbanisation galopante. Il est estimé qu'en 2050, 87% de la population vivra dans les villes alors qu'en même temps, l'offre en approvisionnement en eau sera inférieure de 40% à la demande. Les villes sont par conséquent obligées d'adapter leurs cycles de l'eau pour éviter de tomber sous le coût de l'inaction et accentuer les inégalités sociales.

Pour faciliter cette adaptation, l'approche du City Blueprint a été élaborée par KWR et est en cours d'intégration dans le dispositif opérationnel du Programme Hydrologique Intergouvernemental (PHI) de l'UNESCO. La valeur ajoutée de cet outil de diagnostic de la gestion du cycle de l'eau réside dans le fait que les villes peuvent, avec relativement peu d'efforts, améliorer la gestion du cycle de leur eau tout en contribuant à la prévention des risques de catastrophe, à l'amélioration de la résilience des populations. Le City Blueprint est composé de trois cadres complémentaires : le Cadre des Tendances et des Pressions (CTP) qui évalue les principaux défis socioéconomiques et environnementaux, le Cadre d'Empreinte Bleu de la ville (CEB) qui évalue la gestion du cycle de l'eau et le Cadre de Capacité de Gouvernance (CCG) qui évalue l'amélioration de la gouvernance en eau.

Le CCG, nouvellement élaboré a été expérimenté dans la ville de Yaoundé par l'entremise d'un consultant junior sélectionné par l'UNESCO. Le rapport d'étude soumis par le consultant, comporte des recommandations permettant d'améliorer la capacité résiliente de cette ville. Un atelier de restitution a été organisé le 11 juin 2020 dans la salle de conférences du Bureau UNESCO de Yaoundé, à l'intention des parties prenantes, pour partager les résultats de l'étude.

1.2 Objectif de l'atelier

L'objectif général de l'atelier est de partager les résultats de l'expérimentation de l'approche du City Blueprint menée dans la ville de Yaoundé.

Les objectives spécifiques sont :

- Présenter l'approche du City Blueprint ;

- Donner un aperçu des résultats de l'étude menée dans la ville de Yaoundé ;
- Elaborer une feuille de route pour améliorer la gestion du cycle de l'eau dans la ville de Yaoundé.

2. Résultats attendus

- L'approche du City Blueprint est mieux appréhendée par les participants ;
- Les résultats de l'expérimentation de cette approche à Yaoundé sont connus ;
- Une feuille de route pour la prise en compte des recommandations est élaborée.

A long terme :

- Mise en œuvre des recommandations issues de l'expérimentation de l'approche du City Blueprint pour améliorer la sécurité de l'eau dans la ville de Yaoundé.

3. Participants

Ont effectivement pris part à cet atelier, les représentants des 7 municipalités que compte la ville de Yaoundé ; les Ministères en charge de l'eau et de l'énergie, de l'environnement et du développement durable, de la recherche scientifique, des transports, de l'habitat et du développement urbain ; la Commission Nationale camerounaise pour l'UNESCO (COMNAT) ; le staff des secteurs SC et PI du Bureau UNESCO de Yaoundé ; les ONG internationales et nationales (GWP-Caf et RECOJAC, Water 4 Life), des entreprises du secteur privé, gestionnaires des stations d'épurations (INGEPRES et SOPREC) et ANT-Cmr.

La liste des participants présents à l'atelier est en annexe 1 de ce rapport.

4. Déroulement des travaux

Les travaux de l'atelier national de restitution des résultats de l'expérimentation de l'approche du City Blueprint dans la ville de Yaoundé se sont déroulés le 11 juin 2020, à partir de 9h00, dans la salle de conférence du Bureau Régional Multisectoriel de l'UNESCO pour l'Afrique Centrale basé à Yaoundé.

Trois articulations ont meublé les travaux de l'atelier :

- ❖ La cérémonie d'ouverture
- ❖ Les travaux en plénière organisés autour des exposés, des échanges et l'élaboration de la feuille de route ;
- ❖ La cérémonie de clôture.

Dès leurs arrivées, les participants se sont enregistrés sur la feuille de présence et ont été installés dans la salle selon une configuration qui permettait le respect des mesures barrières.

4.1 Cérémonie d'ouverture

Sous la modération de M. Mohamadou Djibrilla, Chargé de projet Adjoint (Science) du Bureau régional multisectoriel de l'UNESCO pour l'Afrique centrale, la cérémonie d'ouverture a été marquée par une seule allocution. Celle du Dr NSOM-PIAL Annie-Claude, Spécialiste du programme Sciences Exactes et Naturelles par intérim dudit Bureau. Elle a souhaité la bienvenue aux participants et souligné l'importance de la thématique abordée au cours de l'atelier mais aussi de l'opportunité que représente cette nouvelle approche en cours d'expérimentation. Elle a émis le vœu que les travaux se déroulent dans une ambiance conviviale et exhorté les participants à formuler des recommandations pertinentes au terme de l'atelier.

4.2 Sessions plénières

Sous la conduite du Modérateur, un tour de table a été organisé pour permettre aux participants de décliner leurs identité, fonctions et attentes de l'atelier. Par la suite, les objectifs et l'agenda de l'atelier ont été examinés puis soumis à la validation des participants.

La méthodologie de travail de l'atelier comportait une session plénière introductive, la présentation des résultats du consultant et enfin la formulation des recommandations. Toutes ces présentations étaient entrecoupées de sessions d'échanges.

Exposé n°1 : Introduction au PHI et état de mise en œuvre des activités PHI en Afrique Centrale

Dans cet exposé, le **Dr NSOM-PIAL Annie-Claude** est revenu sur l'historique du PHI, notamment sa création en 1975, à la fin de la Décennie Internationale de l'Hydrologie (DHI), initiée par le Système des Nations Unies pour accélérer la recherche sur les thématiques liées à l'eau, ses missions, sa structuration, ses activités définies par phase. A ce jour le programme est à sa huitième phase qui couvre la période 2014-2021. Les activités phares de ce programme intergouvernemental en Afrique centrale ont pour objectifs d'améliorer les bases scientifiques et technologiques sur lesquelles peuvent se

fonder les méthodes de gestion rationnelle des ressources en eau respectueuses de l'environnement. Sa structuration est organisée autour de quatre niveaux de représentations : les comités nationaux PHI, le conseil intergouvernemental, les bureaux régionaux de l'UNESCO et enfin le secrétariat assuré par la Division des Sciences de l'eau au siège de l'UNESCO. Ses programmes phares que sont HELP, FRIEND, ISARM, JIIHP ainsi que son institut de catégorie I appelé UNESCO-IHE contribuent au renforcement des capacités à travers l'organisation des formations, l'octroi des bourses et les financements dédiés à la recherche.

Des échanges entre les participants ayant suivi cet exposé, il ressort que le programme PHI bien qu'il constitue un instrument de coopération et d'échanges incontournable pour les pays en développement en matière de recherche, de renforcement de capacité et de gestion des ressources en eau, n'est pas très connu en Afrique centrale. Or, le PHI offre des opportunités intéressantes aux chercheurs et étudiants, aux décideurs du domaine de l'eau et aux PTF appuyant les efforts de développement des pays. Les comités nationaux, interface du PHI dans les Etats n'ont pas été mis en place dans de nombreux pays de la sous-région. Seuls des Points Focaux existent dans plusieurs de ces pays, ils ne jouent malheureusement pas pleinement le rôle d'un Comité national PHI. Quelques cadres de concertation qui gagneraient à être formalisés existent cependant dans certains pays, notamment au Congo.

Exposé 2 : Introduction à l'Approche du City Blueprint

Ce deuxième exposé a été présenté par **M. Mohamadou Djibrilla** et a consisté à présenter cet outil de diagnostic qui peut faciliter le processus de planification stratégique de la ville. L'exposant est revenu sur les trois cadres complémentaires :

- Le Cadre des tendances et des pressions (CTP), qui évalue les principaux défis de la ville à travers 24 indicateurs repartis en 04 grandes catégories : (i) Pressions sociales : constituées de 3 indicateurs (ii) Pressions environnementales : constituées de 11 indicateurs ; (iii) Pressions financières : constituées de 4 indicateurs et (iv) Gouvernance : constituées de 6 indicateurs.
- Le cadre d'Empreinte Bleue (CEB) qui évalue la gestion de l'eau de la ville est composé de 24 indicateurs divisés en 7 catégories :(i) les services essentiels de l'eau composés de 3 indicateurs ; (ii) la qualité de l'eau est constituée de 3 indicateurs ; (iii) la valorisation des produits des eaux usées est constituée de 4

indicateurs ; (iv) les infrastructures constitués de 4 indicateurs, (v) le traitement des déchets solides constitué de 3 indicateurs; (vi) la robustesse du climat constituée de 3 indicateurs ; (vii) la gouvernance constituée de 4 indicateurs.

Pour ces deux premiers cadres, chaque indicateur est calculé par une formule spécifique et la valeur est ramenée à un score qui varie de 0 à 10 et divisé en classes ordinales exprimées en " degré de préoccupation ". Ces différents calculs sont obtenus à partir des données collectées auprès des institutions ciblées lors des enquêtes.

- Le cadre de la capacité de gouvernance (CCG), qui est un nouveau cadre permettant d'évaluer l'amélioration de la gouvernance de l'eau de la ville. Ce cadre est constitué de neuf conditions, chacune étant définie par trois indicateurs. Il permet d'améliorer la gouvernance sur 5 défis liés à l'eau : (i) la rareté de l'eau, (ii) les risques d'inondation, (iii) le traitement des déchets solides, (iv) le traitement des eaux usées et (v) l'ilot de chaleur urbaine. Pour chaque indicateur, une échelle de notation de type Likert a été développée, qui va de très encourageant (++) à très limitant (--) à la capacité de gouvernance.

<u>Exposé 3</u> : Résultats de l'expérimentation de l'Approche du City Blueprint dans la ville de Yaoundé

Le consultant junior, M. **Ibrahima Abdoulahi,** a commencé son exposé en donnant les caractéristiques de la ville de Yaoundé. Il s'agit notamment de la géographie, la démographie, l'hydrologie et l'hydrographie. Il a aussi mentionné la provenance de l'eau consommée dans la ville. Elle est issue du réseau d'approvisionnement de la CAMWATER, des forages, des puits et sources protégées et de l'eau en bouteille (Eau minérale). Il est revenu sur la méthodologie mise en œuvre dans le cadre de son étude et en a profité pour s'appesantir sur les difficultés rencontrées lors de la collecte des données. A côté des réticences manifestées par les institutions à compléter les enquêtes, il faut ajouter l'indisponibilité des données. C'est le cas par exemple de l'indicateur 11 du cadre d'Empreinte Bleue, où il était question de déterminer la longueur totale (km) du réseau d'évacuation des eaux pluviales et des eaux usées. Ces insuffisances ont certes entravé la conduite optimale de cette étude, mais elles n'altèrent en rien la pertinence des résultats obtenus.

Les principaux résultats indiquent que :

- dans le cadre des tendances et des pressions : 6 indicateurs (élévation du niveau de la mer, rareté de l'eau douce, rareté de l'eau souterraine, intrusion de l'eau de mer et chaleur urbaine) sont non préoccupants ; 2 indicateurs (taux de pauvreté et inflation) sont faiblement préoccupants, 3 indicateurs (taux d'urbanisation, fardeau des maladies et écosystèmes aquatiques ou biodiversité) sont moyennement préoccupants ; 3 indicateurs (voix et responsabilité, efficacité du gouvernement et qualité règlementaire) sont préoccupants ; et enfin 10 indicateurs (Accès à l'éducation, Inondation de drainage urbain, Débits des points des cours d'eau, Affaissement de sol, Qualité de l'eau de surface, Qualité de l'air, Seuil de pauvreté, Instabilité politique, Règles de loi et Corruption) sont très préoccupants et sont à améliorer.
- Dans le cadre d'Empreinte Bleue de la ville, l'analyse révèle un indicateur non préoccupant (Accès à l'assainissement) ; 6 indicateurs faiblement préoccupants (Fuite dans le réseau d'eau, Production de déchets solides, Adaptation au climat, Bâtiment climatiquement résistant, Gestion et plans d'actions, et Action visant à économiser l'eau) ; 4 indicateurs moyennement préoccupants (Accès à l'eau potable, recouvrement de frais d'exploitation, Consommation d'eau et Attractivité) ; 4 indicateurs préoccupants (Qualité de l'eau potable, Accès au traitement secondaire des eaux usées, Qualité de l'eau souterraine, et Age moyen des égouts) ; 8 indicateurs très préoccupants (Accès au traitement tertiaire des eaux usées, Récupération des nutriments, Récupération d'énergie, Récupération des boues, Efficacité énergétique, Recyclage des Déchets solides, Récupération d'énergie à partir de déchet et Espace vert) et un indicateur (Séparation des eaux pluviales) dont les données ne sont pas disponibles. Il ressort de ce second cadre que l'indice de la ville de Yaoundé est de 2,7, ce qui signifie que Yaoundé est une ville de gaspillage. Cela signifie que les services de base en matière d'eau sont largement assurés, mais que le risque d'inondation peut être élevé et que le traitement des eaux usées est insuffisant. Le diagramme en araignée illustre clairement la faible performance du traitement des eaux usées et le traitement des déchets solides en général. Souvent, seul le traitement primaire et une petite partie du traitement secondaire des eaux usées sont appliqués, Le traitement tertiaire quant à lui n'existe pas, ce qui entraîne une pollution à grande échelle. Les infrastructures sont moins élevées en raison de leur entretien insuffisant. Les

coûts d'exploitation sont plus élevés que les revenus d'exploitation des services d'approvisionnement en eau et d'assainissement. Certains des égouts pluviaux sont connectés aux égouts sanitaires et pendant les périodes de fortes pluies, les systèmes sanitaires sont clairement affectés. Le traitement de déchets solides est opérationnel et presque tous les déchets sont mis en décharge, pas de recyclage ni de récupération d'énergie, ce qui contribue à la pollution de l'eau. De plus, les indicateurs des actions climatiques sont généralement déficients. L'attractivité des plans d'eau de la ville de Yaoundé est limitée en raison de la pollution. Les infrastructures bleues de la ville telles que les fontaines et les étangs sont très peu nombreuses et un nombre considérable de ces infrastructures bleues sont en fait hors service.

- L'analyse du cadre de la capacité de gouvernance a révélé qu'un total de 12 indicateurs sur les 27 indicateurs ont un score limité. En outre, 6 indicateurs ont obtenu une note encourageante et 9 autres indicateurs ont obtenu une note indifférente à la capacité globale de gouvernance de l'eau. Cela montre qu'il existe une marge de manœuvre suffisante pour améliorer à la fois la gestion des eaux et la gouvernance de l'eau à Yaoundé. Comme l'a montré le diagramme en araignée, l'indicateur 7.2 (Claire répartition des responsabilités) est considéré comme limitant. A Yaoundé, les responsabilités liées à la gestion des ressources en eau sont fragmentées. Elles sont réparties entre un certain nombre d'organisations gouvernementales. Cette fragmentation a créé une incertitude en raison du chevauchement des responsabilités. En outre, l'indicateur 1.1 (Connaissance communautaire) est considéré comme indifférent. Cela illustre le fait que la plupart des communautés ont une compréhension de base des défis liés à l'eau. Cependant, les risques, les impacts et les fréquences réels ne sont souvent pas entièrement connus et sont généralement sous-estimés. De plus, l'indicateur 1.2 (Sentiment local d'urgence) est jugé encourageant, il reflète la perception de l'importance du défi de la gouvernance, qui peut ou non se traduire par des actions et des politiques à long terme.

Après la pause-déjeuner, des discussions très intéressantes et enrichissantes se sont articulées autour des trois cadres et des résultats obtenus sur les indicateurs. Les débats qui s'en sont suivis ont permis aux participants dans leur grande majorité de saluer l'idée de l'Approche City Blueprint. Ils ont pu au travers des questions posées au consultant,

comprendre la méthodologie de ladite approche, et proposer des améliorations pour le calcul des indicateurs, notamment la prise en compte des sources de données plus localisées (le consultant vérifiera ces sources au préalable).

Des données plus localisées ont donc été proposées pour améliorer le calcul des indicateurs du cadre des tendances et des pressions ci-après : Accès à l'éducation, Inondation de drainage urbain ; Débits des points des cours d'eau ; Affaissement de sol ; Qualité de l'eau de surface ; Qualité de l'air ; Seuil de pauvreté ; Instabilité politique ; Règles de loi ; et Corruption. Il en est de même du deuxième cadre d'Empreinte Bleue, les calculs à revoir portent sur : Traitement des eaux usées, Qualité des eaux souterraines, Récupération des nutriments ; Récupération d'énergie ; Récupération des boues ; Efficacité énergétique ; Séparation des eaux pluviales ; Recyclage des Déchets solides ; et Récupération d'énergie à partir de déchet. Le dernier cadre de la capacité de gouvernance suggère que le niveau de connaissance des communautés et l'accès à des informations compréhensibles pour les non-experts peuvent légèrement limiter le sentiment d'urgence local et la volonté de payer des consommateurs. La surveillance intelligente, l'intégration du discours et la claire répartition des responsabilités doivent être considérées et améliorées pour tous les défis liés à l'eau. Les agents de changement (entrepreneuriaux et visionnaires) doivent envisager des approches adaptatives à long terme et être capables d'orienter les politiques et les actions pour un changement efficace. Le respect de la législation et la préparation augmente la capacité de mise en œuvre. L'existence de plans d'action, de procédures et de scénarios bien établis soutient la politique et prépare la ville à des changements et des événements à long terme. Relever ces défis nécessite une bonne gouvernance, car elle implique de gérer des risques à long terme, complexes, incertains et partiellement connus qui peuvent avoir des impacts importants. La capacité de gouvernance ne conduit pas à un changement efficace, mais constitue plutôt une condition préalable ou un facteur de changement efficace.

Au cours des échanges, les participants ont apprécié la pertinence de l'approche qui peut constituer une des solutions efficaces pour le diagnostic de la gestion intégrée des ressources en eau et peut ainsi être une contribution à l'évaluation de l'indicateur 6.5.1 des ODDs sur la gestion intégrée des ressources en eau. Ces échanges ont aussi permis de comprendre les défis et challenges des institutions et municipalités. Ils ont évoqué et soulevé quelques préoccupations à savoir : la multiplicité des acteurs dans la gestion

des ressources en eau sans structure pour assurer le lead ; l'intégration de l'aspect culturel dans le cadre des tendances et des pressions du fait que l'eau a aussi une valeur culturelle ; l'utilisation de l'Approche du City Blueprint pour chaque arrondissement de Yaoundé quoique l'accès à des données vérifiables soit une condition préalable ; la participation de tous les acteurs (privés et surtout celle des acteurs de l'assainissement) est encore très souvent négligée. Les participants ont aussi relevé que le gouvernement fait des efforts pour rendre effectif la décentralisation qui va apporter des solutions aux défis liés à la gestion et à la gouvernance de l'eau. Ils ont aussi noté une régression du pourcentage de femme au niveau décisionnel dans les municipalités. Enfin, les participants ont élaboré une série de recommandations consignées dans le tableau ci-dessous.

Recommandations	Responsabilités	Echéances
Sensibiliser les acteurs et usagers sur les défis liés à l'eau à savoir la rareté de l'eau, le risque d'inondation, le traitement des déchets et le traitement des eaux usées	CTD, MINEE, OSC, MINHDU, MINEPDED,	Continue
Œuvrer à la disponibilité et au partage des données (services essentiels de l'eau, traitement des eaux usées, traitements de déchets solides, qualité de l'eau de surface et souterraine) notamment par la mise sur pied de services d'information sur l'eau, la création des plateformes multi-acteurs dédiées aux questions de gestion des ressources en eau.	MINEE, Tous les acteurs	Continue
Renforcer le dispositif de collecte, de traitement des eaux usées et de distribution de l'eau	MINHDU et MINEE	Le plutôt possible
Intégrer systématiquement dans leur agenda la planification des mesures d'adaptation et d'atténuation des effets des changements climatiques dans les investissements dans le domaine de l'eau	Tous les acteurs	Continue
Poursuivre le plaidoyer visant la mobilisation des ressources nécessaires à la promotion de l'approche City Blueprint	UNESCO	Continue

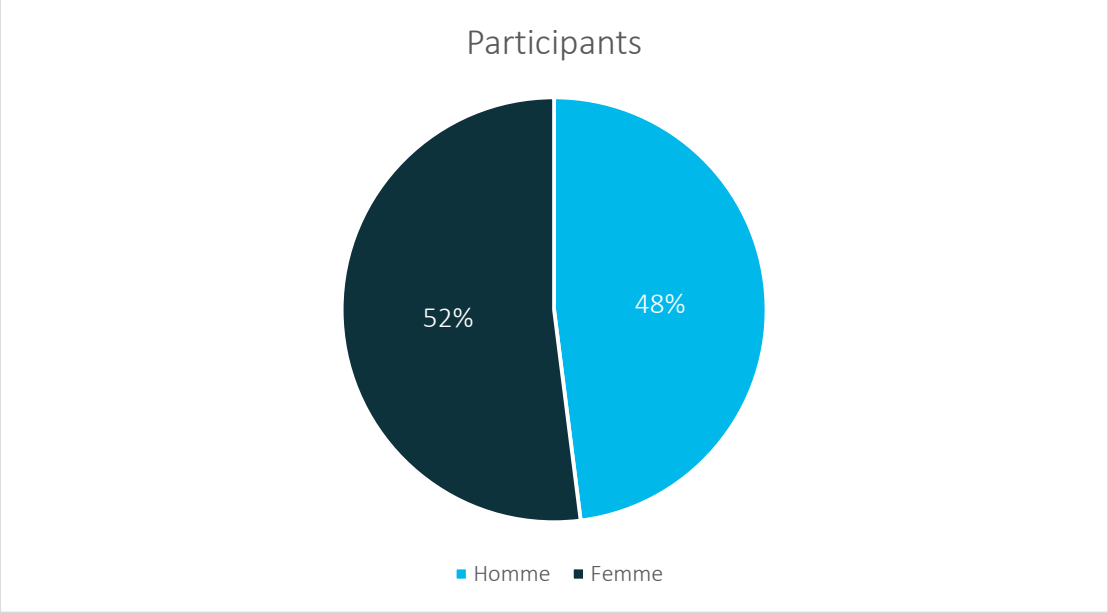
Recommandations	Responsabilités	Echéances
Etendre cette étude aux autres grandes villes du Cameroun et faire des comparaisons	UNESCO	Continue
Maintenir la municipalité comme échelle d'évaluation de l'outil Blueprint	UNESCO	Continue

4.3 Cérémonie de clôture

La cérémonie de clôture a été présidée par le Dr NSOM-PIAL Annie-Claude. La Présidente de session a apprécié la qualité des échanges et a remercié les participants pour leur participation effective. Elle s'est réjouie que l'atelier ait été très enrichissant et que les échanges ont contribué a éclairé la lanterne des participants sur l'Approche du City Blueprint en général et sur son application dans la ville de Yaoundé.

Quelques statistiques

Sur un total de 25 participants, on dénombre 13 femmes et 12 hommes provenant de 20 institutions. La participation des jeunes est quant à elle estimée à 56 % (14 personnes).



4.4 Annexe 2 : Agenda de l'atelier

Horaire	11 juin 2020
8h30 – 9h00	Arrivée et enregistrement des participants

9h00 – 9h30	Cérémonie d'Ouverture • Mots de bienvenue de l'UNESCO • Présentation des participants • Présentation des objectifs et de l'agenda de l'atelier
9h30 – 10h00	Présentation PHI Introduction à l'approche du City Blueprint Questions – réponses
10h30 – 11h00	**Pause-café et photo de famille**
11h00 – 11h30	Présentation du consultant (Objectifs, méthodologie et résultats) Questions – Réponses
11h30 – 13h00	Retour des participants sur la présentation du consultant
13h00 – 14h00	**Pause déjeuner**
14h00 – 15h30	Elaboration de la feuille de route sur la base des recommandations
15h30 – 16h30	**Mots de clôture et pause-café**

4.5 Annexe 3 : Illustration du déroulement de l'atelier