Functionality of water supply handpumps in sub-Saharan Africa: a review of data from Cameroon (Central Africa)

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Case Report

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Abstract

This review presents updated and expanded handpump functionality estimates for 310 councils in the ten regions of Cameroon. Overall, the study estimates that the number of handpumps used as the main source of drinking water supply in Cameroon is 20,572, of which 9,113 are installed in protected hand dug wells (wells) and 11,459 in boreholes. Our findings suggest that about one in three handpumps in Cameroon is nonfunctional, which in 2022 was roughly equivalent to 6,724 inoperative water points. According to this estimate, it is about 44.8 billion CFA francs, or 66.8 million USD, was invested in the construction of water points that are immobilized and do not generate any benefit. The review has found that the community-based management of handpump water supply seems not to have given the expected results. Further, there are questions in relation to the quality of handpump material and the corrosion of handpumps which have not been sufficiently taken into account in the various research projects in Cameroon and Sub-Saharan Africa. Finally, the implementation of post-construction monitoring, physical audits, and handpump rehabilitation campaigns could shed light on these issues in order to improve the performance of handpumps.

HIGHLIGHTS

- The study shows that one in three handpumps in Cameroon is nonfunctional.
- About 44.8 billion CFA francs, or 66.8 million USD, invested in the construction of wells and boreholes are immobilized and not generating any benefit due to non-functionality.
- About 1.3 million people in Cameroon (5% of the population) could gain access to a basic water supply by reducing the present non-functionality rate by half.

1. INTRODUCTION

Handpumps have revolutionized access to safe and reliable water supplies in Sub-Saharan African countries, particularly in rural areas. They constitute a healthy and viable alternative solution when surface water is contaminated. Danert (2022) estimates that 200 million people in sub-Saharan Africa depend on 700,000 handpumps to supply themselves with drinking water. Urban dependence is estimated at 7.3%, while rural dependence is 25.9%.

The problem of low performance in handpumps has received international attention for several decades. Statistics on the functionality of handpumps in sub-Saharan Africa and Asia suggest that one in four handpumps in sub-Saharan Africa is non-functional at any point in time, which in 2015 was roughly equivalent to 175,000 inoperative water points (Foster et al. 2019). Even a short-term outage can result in the use of unsafe surface water or require users to spend more time collecting water from a more distant source (MacDonald et al., 2019). Additionally, water service failure negatively impacts health and can hinder other human development gains (Baguma et al., 2017).

In Cameron, data on handpumps functionality is very sparse and dispersed with very little data available on the estimation of handpumps that are non-functional in the country. However, some studies show that 25–32% of handpumps in Cameroon are inoperative (RWSN, 2009; Deal and Furey, 2019; Foster et al., 2019). More recently, a study conducted by Mvongo et al. (2023) in eight councils in the Mvila Division (South region of Cameroon) indicated that handpump non-functionality ranged from 21.43–40.54% within councils in the division.

Previous reviews of handpumps functionality data in Cameroon have been conducted, including RWSN (2009) and Foster et al. (2019). The RWSN (2009) statistics were based on the informed estimates of a professional (J. Rihouey) who knew Cameroon well between 2000 and 2005. On the other hand, the data from Foster et al. (2019), although incomplete (189 out of 316 municipalities covered), gives a more precise estimate of the functionality of handpumps than that of RWSN. However, these estimations were based on partial data and thus may not reflect the situation in the country as a whole. In addition, the number of handpumps installed each year is constantly increasing, and there is a need to update functionality data.

This paper is therefore intended to update handpumps functionality estimations. It is based on data from the Council Development Plans (CDPs) and intended to mobilize national and international efforts in Cameroon. The data contained in the CDPs were collected following participatory diagnosis (participatory diagnosis at the village level and the diagnosis of the municipal urban space) by civil society organizations recruited by the National Community Driven Development Program (PNDP) in partnership with the municipalities. These data provide an idea of the situation of the handpump asset base in the municipalities covered.

2. METHODS

2.1. Study area

Cameroon is located in Sub-Saharan Africa between West and Central Africa at the extreme north-eastern end of the Gulf of Guinea (Fig. 1). It lies between latitudes 2° and 13° north of the equator and between longitudes 8° and 16° east of the Greenwich Meridian. It has a total surface area of 475,650 km^2, a mainland surface area of 466,050 km^2, and a maritime surface area of 9,600 km^2, respectively (NIS, 2001). The estimated population is 28 million (WHO & UNICEF, 2023).

Average gross domestic product (GDP) growth in real terms in Cameroon has been around 4% over the past five years (NIS, 2015). This development has not been sufficient to significantly reduce poverty level. In fact, the population living below the poverty line is estimated at around 40%, which means that nearly half of the population is unable to access basic social services, including water and sanitation. This socio-economic snapshot of the country has a direct impact on the water, sanitation, and hygiene sectors. Indeed, the rate of access to drinking water is 70%, while that of sanitation is 43% (WHO & UNICEF, 2023).

This situation of poor access to water, sanitation, and hygiene services is accentuated by a high number of non-functional drinking water supply infrastructures, coupled with extreme climatic phenomena (flooding, high winds, increased temperature, long periods of drought, heavy precipitation). These factors, particularly in the North and the Far North regions of Cameroon, combine to contribute to a reduction in available water and threaten the sustainability of water-related uses.

2.2. Data collection

This review aimed to update estimations for handpump functionality in Cameroon. To do so, we searched, collected, and analyzed relevant data from the 310 Councils Development Plan (CDP) that had been collected from 2010 to 2022. Information sources included data sets and documents available online through the data portals of the National Community-Driven Development Program (PNDP). The database of Participatory Development Assistance Software (Pro-ADP) was also used to complete the information collected in the CDP. The Pro-ADP is a database set up by the PNDP to ensure the consolidation of data collected at the Council level. The Pro-ADP is a tool that was designed to facilitate the use of the mass of data contained in CDP. It contains information on the socio-economic infrastructure existing in the various councils of Cameroon. The Pro-ADP database provides information on the functionality of handpumps and other water infrastructure.

2.3. Data processing

Microsoft Excel was used to analyze quantitative data. It was a question of carrying out a count of functional and non-functional handpumps in the Pro-ADP in order to calculate the non-functionality rate. The definition of handpump functionality used to populate the Pro-ADP database by civil society organizations was based on the binary indicator (functional or non-functional). However, the usefulness of this indicator is increasingly questioned (Danert, 2022). Indeed, a handpump can be broken down at the time of the one-off technical inspection, although there is an effective maintenance system. Likewise, a handpump functional at the time of technical inspection may actually have considerable downtime throughout the year. Thus, poorly performing handpumps could be classified as functional, and functional pumps could be classified as non-functional. However, in the absence of reliable data on the operating state of the pumps, the binary indicator can constitute a starting point to describe the operating state of the handpump fleet.

The rate of non-functionality (T) is the quotient of the number of non-functional handpumps (n) by the total number of handpumps (N), all multiplied by one hundred, which allows us to use Eq. (1).

$$\mathrm{T} = \frac{\mathrm{n}}{\mathrm{N}} \times 100$$

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Similarly, data on the cost of non-operational handpumps was analyzed using Microsoft Excel. As part of public procurement in Cameroon, the average construction prices of rural water supply systems are fixed

by the Mercurial Price List. It is a tool for controlling public expenditure used solely within the framework of transactions with the State of Cameroon. According to the Mercuriale des Prix, the cost of construction and commissioning of a borehole equipped with a handpump is 8 million CFA francs (11,940 USD). Likewise, the average cost of constructing and installing a well equipped with a handpump is 5 million CFA francs (7,463 USD). Thus, the average prices above were used to calculate the cost of an immobilized water point.

3. RESULTS AND DISCUSSION

3.1. Functionality of handpumps

Overall, based on the data analysed, the number of handpumps used as the main source of drinking water supply in Cameroon is 20,572, of which 9,113 are installed in modern wells and 11,459 in boreholes. This number is higher than that obtained by Foster et al. (2019), which is 12,203 handpumps. Likewise, this figure is higher than the estimates (9,000 handpumps) made by RWSN (2009). In addition, in order to estimate the number of people using handpumps, a scenario was considered according to which, on average, handpumps serve 400 people (Danert, 2022). Based on this assumption, approximately 8.2 million people in Cameroon rely on a handpump for their main drinking water supply, which is equivalent to 36.8% of the population of Cameroon.

Globally, one in three handpumps in Cameroon is non-functional, which in 2022 was roughly equivalent to 6,724 inoperative water points. To put this in perspective, this number is about 33% of the total number of handpumps, enough to supply 2.7 million people, assuming 400 inhabitants per handpumps. These results are higher than the average value of non-functionality (26%) in Sub-Saharan Africa (Foster et al., 2019). Furthermore, these results are an increase compared to the 25% found by the RWSN (2009) and compare well with the 32% found by Foster et al. (2019) and the 32.61% found by Mvongo et al. (2023) in the Mvila Division (South Region of Cameroon). However, the number of inoperative handpumps that we have found is three times higher than those found by the RWSN (2009) and two times higher than those found by Foster et al. (2019). In addition, this result fits within the range of data of those obtained in several countries in sub-Saharan Africa, where the percentage of non-functional handpumps varied from 11% in Burkina Faso to 58% in Burundi (Foster et al., 2019). More generally, high levels of non-functionality of handpumps have persisted since the 1970s (Bonsor et al. 2018) in Sub-Saharan Africa, where all countries have reported non-functionality rates greater than 10% (Danert, 2022).

Table 1 provides estimates of the cost and value of the non-functionality of handpumps by region of Cameroon. According to this estimate, it is about 44.8 billion CFA francs, or 66.8 million USD, invested in the construction of water infrastructures that are immobilized and do not generate any benefit (improved health, nutrition, or education). If the global rate of non-functionality handpump were reduced by half the current level in Cameroon—a reasonable objective—1.3 million people could gain access to basic water supply and thousands of jobs would be created to support labor-intensive maintenance activities.

Table 1
Handpump functionality statistics for Cameroon

Region of Cameroon	Total Handpumps	Functioning Handpumps	Non-Functioning Handpumps	Percentage Non-Functioning Handpumps	Cost value of non-functional handpumps	
					Billion of CFA francs	Million of USD
Adamawa	1,249	713	536	43%	3.8	5.6
Centre	3,728	2,604	1,124	30%	7.2	10.8
East	1,934	1,176	758	39%	4.9	7.3
Far North	4,938	3,578	1,360	28%	9.4	14.0
Littoral	990	626	364	37%	2.4	3.6
North	2,860	1,871	989	35%	6.9	10.2
North-West	925	649	276	30%	1.8	2.7
West	758	519	239	32%	1.6	2.4
South	2,377	1,555	822	35%	5.2	7.7
South-West	813	557	256	31%	1.7	2.5
National	**20,572**	**13,848**	**6,724**	**33%**	**44.8**	**66.8**

Table 1 also presents estimations of non-functionality in the ten regions of Cameroon. This table shows that the region that had the highest level of non-functional handpumps is the Adamawa region (43%), followed by the East regions (39%), the Littoral (37%), the North (35%), the South (35%), the West (32%), the South West (31%), the Center (30%), the North West (30%), and the Far North (28%). In addition, the analysis of the data in Appendix 1 shows that the rate of non-functionality of handpumps varies greatly from one municipality to another, ranging from 0% in the municipalities of Yaoundé 4, Maroua 3, and Mayo Oulo to 74% in the Municipality of Ma'an. Furthermore, the analysis of handpump functionality data in Table 2 shows that the functionality rate of the handpumps fitted to the boreholes is 32%, while that of the handpumps installed on the wells is 33%. These two values compare well with the global non-functionality rate.

Table 2
Handpump functionality statistics on borehole and well

Region	Total Number of HP		HP non-functional		Percentage (%) of HP non-functional	
	Well	Borehole	Well	Borehole	Well	Borehole
Adamawa	347	902	177	359	51%	40%
Centre	1,970	1,758	588	536	30%	30%
East	983	951	397	361	40%	38%
Far North	1,829	3,109	500	860	27%	28%
Littoral	441	549	175	189	40%	34%
North	972	1,888	349	640	36%	34%
North-West	510	415	141	135	28%	33%
West	306	452	92	147	30%	33%
South	1,339	1,038	475	347	35%	33%
South-West	416	397	120	136	29%	34%
National	**9,113**	**11,459**	**3,014**	**3,710**	**33%**	**32%**

However, although the functionality rate is an indicator of how handpumps are handled, it should be taken with great caution. Indeed, two regions or municipalities can have the same rate of non-functionality, but the number of handpumps out of order is different. The Central region and the North West region, for example, have the same rate of non-functionality (30%), but the number of broken handpumps differs (1,125 for the Centre and 276 for the North West). In addition, this indicator relies on the judgment of evaluators, does not take seasonal differences into account, only provides one-off information, and does not provide information on the reasons for the breakdown as well as repairs (Danert, 2022; Carter and Ross, 2016).

The factors causing variations of non-functionality rate between the region of Cameroon are economic (Low economic viability of water point management, the lack of real collection of revenue from the sale of water, and the low willingness of populations to pay for water), managerial (the weak functionality of water point committees, the capacities limited of rural communities, and the lack of transparency in management), technical (weak structuring of the handpump maintenance chain and lack of repair artisans) and institutional (The poor post-construction monitoring of the water points committees, Insufficient qualified technical personnel in the councils, and the weak financial resources of the councils and the State of Cameroon). These factors, echo those mentioned in the literature on rural water supply in developing countries by several authors (Murray et al., 2024; REAL-Water, 2023a; 2023b; REACH and RWSN, 2023; Mvongo et al., 2023; Mvongo et al., 2022a; Mvongo et al., 2022b; Mvongo et al., 2022c;

Mvongo et al., 2021; Mvongo et Defo, 2021) are interrelated and need to be addressed to reduce the rate of non-functionality handpump.

3.2. Issues of reducing handpump non-functionality rate in Cameroon

3.2.1. Material quality and Corrosion of handpump

The corrosion of handpumps is a phenomenon that has been known for more than 30 years in Sub-Saharan Africa (Danert, 2019), which water professionals have not fully grasped until now, and which poses a risk to the achievement of Sustainable Development Goal No. 6 in Cameroon. This phenomenon leads to high maintenance costs, multiple breakdowns, and the rejection of numerous water points by communities because the water there is of poor quality. In Cameroon, there is very little data on the extent of this phenomenon. A quick review of the literature on this issue shows that this issue has not received the attention of local researchers.

However, a study by Mvongo et al. (2023) in eight councils in Mvila Division in the South region of Cameroon on 647 handpumps shows that 29% of the handpumps show cracks on the lifting column and signs of corrosion. This high percentage of handpumps showing signs of corrosion comes from pumps made from unsuitable materials for the groundwater conditions. In fact, a study of 20 pumps conducted by Linjouom (2023) in the West and Far North regions of Cameroon showed that non-compliance with the quality standards of the materials used is a major cause of the non-functionality of handpumps. In addition, the same study reveals a virtual absence of standards from the Standards and Quality Agency (ANOR) on the specific standards of handpump materials.

In order to reduce the extent of this phenomenon, it is important to establish a specification of norms and standards on the quality of materials importable and marketable by local suppliers of handpump materials, as well as a mapping of the regions of Cameroon with a high risk of PMH corrosion depending on the pH content and the natural iron content of groundwater.

3.2.2. Service delivery model

Community-Based Management (CBM) of handpumps water supply has played a significant role as the world has achieved the MDGs for water supply (Hutchings et al., 2015; Hayes and Fawcett, 2023). It is estimated that 70% of handpumps managed by the Water Point Committee (WPC) in the sub-Saharan environment are functional (Naughton, 2017). In Cameroon, about 63% of handpumps under WPC are functional.

However, the financial viability of CBM constitutes a limiting factor in the sustainability of the water supply handpump in Cameroon (Mvongo et al., 2023; Mvongo et al., 2022a; Mvongo et al., 2022b; Mvongo et al., 2022c; Mvongo et al., 2021; Mvongo et Defo, 2021; Mvongo et al., 2019). In fact, rural communities are characterized by a smaller population, dispersed settlements, and economic disadvantages, which may reduce opportunities for economies of scale and complete cost recovery

(REAL-Water, 2023a). In addition, water demand in rural areas fluctuates seasonally, as residents often alternate between using several water sources (Hope et al., 2020).

This low financial viability of CBM has been highlighted in several countries in sub-Saharan Africa by several authors (Murray et al., 2024; REAL-Water, 2023a; 2023b; REACH and RWSN, 2023; Mohanty and Rout, 2023). In fact, the financial flows generated by the sale of water are very low and do not cover all repairs to the handpump, which partly explains their vulnerability and the difficulty in supporting long-term monitoring of handpumps. In addition, water prices in middle rural water tariffs are often below cost recovery levels, although they are much higher than urban water tariffs (which are often subsidized) (REACH and RWSN, 2023).

In response to this challenge, some authors (McNicholl and Hope, 2024; Lockwood and Le Gouais, 2015) have proposed more professional management models. Professionalization, in its simplest form, means strengthening the capacity of the state to provide high-quality services by hiring professional staff or outsourcing to private companies or NGOs that can deliver services efficiently at high performance levels. In recent years, this interest has been strengthened further, with evidence that private operators can deliver a handpump with higher performance, whether delivered by civil society or private ownership (McNicholl and Hope, 2024; Kolker, 2022).

More generally, there is a debate between two schools of thought aimed at professionalizing rural water services: one that advocates decentralization and support for local authorities in their mandate, and the other that seeks to centralize (partly or completely) service authorities, allowing the delegation of services on a larger scale (REACH and RWSN, 2023). This is a debate that is taking place in Cameroon as well as in other sub-Saharan African countries, including Benin, Burkina Faso, Ivory Coast, Mali, Mauritania, Niger, Senegal, and Togo (REACH and RWSN, 2023).

3.2.3. Data acquisition and monitoring

Cameroon, with the support of the United Nations System, led in 2015 the process of inclusive localization of the SDGs. At the end of this process, the National SDG-6 indicator framework for Cameroon was developed in October 2018. However, the data currently available on drinking water access are those from surveys conducted as part of the Joint Monitoring Program (JMP) of the WHO and UNICEF and the Multiple Indicator Cluster Survey (MICS). These surveys are done by sampling and are not disaggregated according to the guidelines of the Sustainable Development Goals (SDG) implementation monitoring system.

To take into account the particularity and complexity of the calculation of the SDG-6.1 indicators, Cameroon has a Water Sanitation and Hygiene Infrastructure Data Management System housed in the Water Information System Unit and initiated in 2015 the inventory and geolocation of water supply systems (Mvongo et al., 2022c). However, the results of this inventory are not yet available, and the mechanism put in place to monitor the implementation of SDG-6 is not yet operational (Mvongo et al., 2022c). In addition, Cameroon lacks the financial, institutional, and human resources to acquire and

analyze data to support water governance. Efforts must therefore be made to make this mechanism operational. In fact, data acquisition and monitoring provide the foundation for good governance (United Nations, 2018). It is not possible to plan, manage, and evaluate water services without available data.

3.2.4. Capacity development

In Cameroon and in most countries in Sub-Saharan Africa, the capacity of communities and councils to manage the handpump once the water point has been built is limited. In fact, with the country's adherence to the "Structural Adjustment Program" of the 1990s, the recruitment of executives for the benefit of the water sector was frozen. This situation has resulted in a drastic reduction in the workforce in the water sector, jeopardizing the capacity of the public water administration to properly carry out its missions. The current situation reveals that human resources are almost nonexistent in the councils. For example: the vast majority of local authorities do not yet have qualified personnel able to assume the new missions assigned to them under decentralization (Mvongo et al., 2022b).

In addition, illiteracy, lack of information, education, and communication among rural populations are the main obstacles to their conscious and responsible participation in the sustainable management of infrastructure and even water resources (Mvongo et al., 2022c). In view of the above, it is important that the capacities of all actors involved in water point management be strengthened. In this perspective, it is worth mentioning the establishment of initial, continuous, or professional training in the water and sanitation professions, which can be mobilized in state universities. In addition, recruitment of additional staff and sensitization of users should be undertaken. Raising user awareness will enable water users to take an active part in the water service management process.

4. CONCLUSION

This review has presented updated functionality statistics for handpump water supplies in 310 councils in Cameroon. The study estimates that the number of handpumps used as the main source of drinking water supply in Cameroon is 20,572, of which 9,113 are installed in modern wells and 11,459 in boreholes. Approximately 8.2 million people in Cameroon rely on a handpump for their main drinking water supply. About one in three handpumps in Cameroon are non-functional, enough to supply 2.7 million people. According to this estimate, it is about 44.8 billion CFA francs, or 66.8 million USD, invested in the construction of wells and boreholes that are immobilized and do not generate any benefit (improved health, nutrition, or education). The handpumps, like the CBM, seem not to have given the expected results. The fact that some handpumps fail prematurely seems to indicate that technical defects (poor quality components and rapid corrosion) contribute to handpump failure and underperformance. However, this review notes that questions related to the quality of handpump material and the corrosion of handpumps have not been sufficiently taken into account in the various research studies in Cameroon and Sub-Saharan Africa. Thus, the implementation of post-construction monitoring of handpumps, physical audits, and handpump rehabilitation campaigns could shed light on these issues in order to improve the performance of handpumps.

DECLARATIONS

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author, upon reasonable request.

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Appendix

Appendix 1 is not available with this version.

Figures

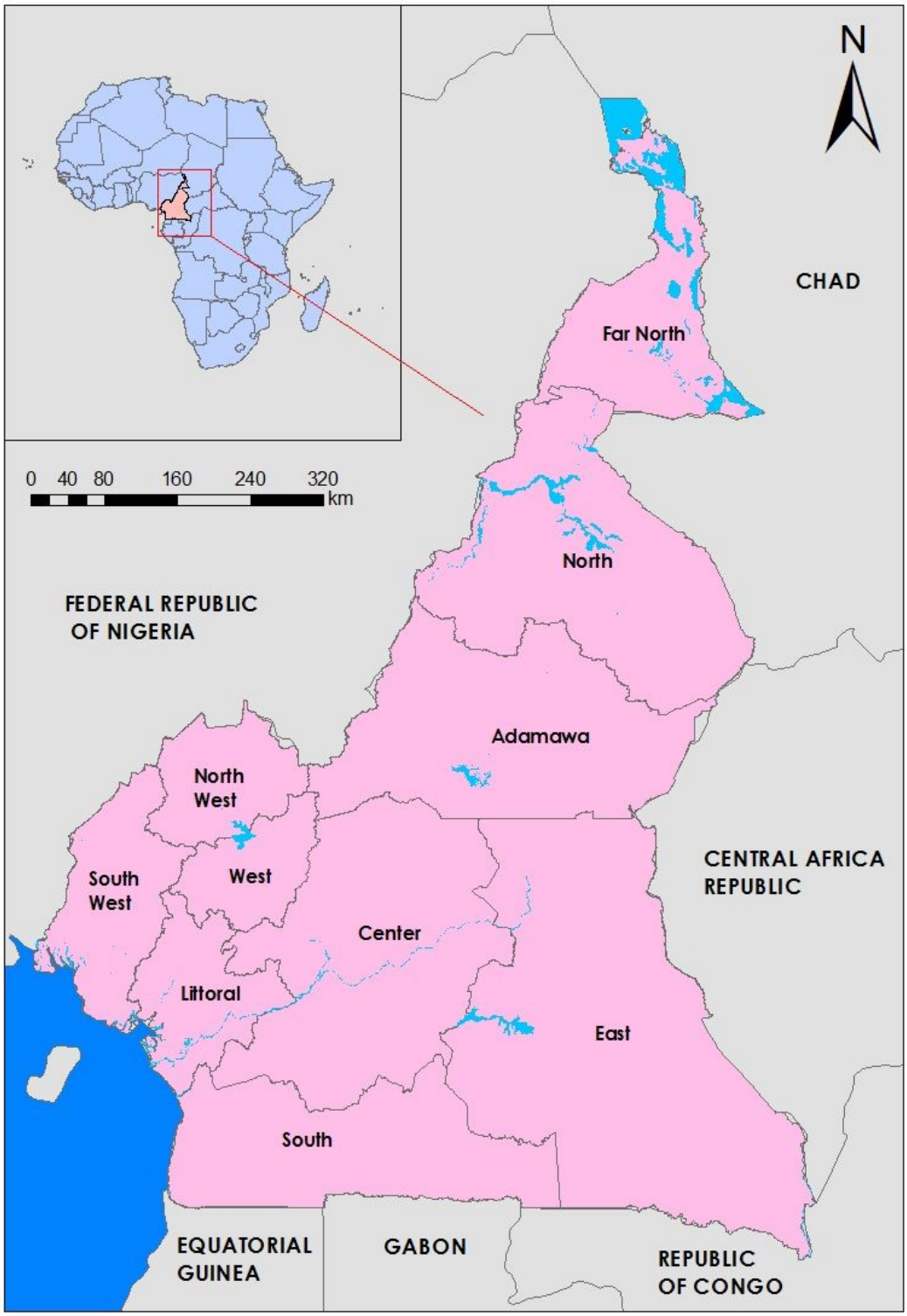

Figure 1

Location of Cameroon (Adapted from Mvongo et al., 2022c)

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