



## MAPPING OF POTABLE WATER DISTRIBUTION NETWORK AND IDENTIFICATION OF PRIORITY AREAS FOR EXTENSION IN YAOUNDE - CAMEROON

Bouba Dieudonné, Ndi Roland Akoh\*, Jiba Bidjogo Joël,

Department of Geography, University of Yaoundé 1, Yaounde, Cameroon

### ABSTRACT

Rational and equitable distribution of potable water is one of the major challenges of our time. Numerous programmes and projects aimed at ensuring access to Potable water have been initiated in Cameroon in general and Yaounde in particular but the much-desired outcome of “access to all” is more of a theoretical than a practical reality. It is based on this premise that this paper provides a useful lens/window on the current state of the water distribution network in the city of Yaounde through the use of the Geographical Information Systems (GIS) with a view to provide a wealth of information that will enable decision-makers to have a strategic vision on the priority areas for extension of the Potable water network in the city of Yaounde. The methodology consisted of combining a set of tools and approaches such as GIS, multi-criteria analysis, grey data from population density, housing density, alternative water sources and the current water distribution network. The findings have revealed a mismatch/uneven distribution of the water network within the various neighbourhoods under study with a consequent imbalance between supply and demand. Such neighbourhoods with limited pipe borne water, the findings of this paper suggest are, priority areas for extension of the water distribution network in Yaounde. In these neighbourhoods, the populations have implemented coping strategies through the setting up of alternative water sources for their water supplies, which regrettably has a negative impact on health.

**Keywords:** Mapping, Potable water, Distribution, Network, Priority areas, Yaounde

### I-INTRODUCTION

Water is the most essential natural resource for life, without it, man’s existence will be impossible. This is because all peoples, whatever their stage of development and their social and economic conditions have the right to have access to drinking water both in quantity and quality equal to their basic needs (Azah, 2009). Next to air, water is the most esteemed requirement for survival on earth. Where provisions for water and sanitation are inadequate, the diseases that arise from contaminated food, water and hands are among the world’s leading causes of premature death and serious illness (Robinson et al, 2004). Where provisions for water and sanitation are inadequate, the diseases that arise from contaminated food, water and hands are among the world’s leading causes of premature death and serious illness. Anything that disturbs the provision and supply of water tends to disturb the very survival of humanity (Arms, 2008). Where provisions for water and sanitation are inadequate, the diseases that arise from contaminated food, water and hands are among the world’s leading causes of premature death

and serious illness(Chenoweth, 2008).Rational and equitable exploitation of water resources is, thus, one of the major challenges of our time as the international community considers access to water as a basic human right (UN, 2002).As such, scarcity of clean/fresh water is one of the world's most pressing environmental problems(Arms, 2008).The search for domestic water has thus been man's utmost concern since the beginning of civilization (Ojo, 2014).

It is, therefore, an obligation for governments to put in place policies that guarantee the right of access to water as access to drinking water is a daily struggle for hundreds of thousands of urban dwellers in developing countries. According to a report by the World Health Organisation (2006), 1.1 billion people, or 17% of the world's population lack access to drinking water. Many urban households living in precarious neighbourhoods, rely on local sources such as wells, boreholes and springs for their water which has impacted negatively on their health (Nkenfack *et al.*, 2017). According to Robinson *et al.*,(2004), it is not only water quality but also water quantity that is important in achieving health improvements. Global urban population without access to improved water services rose from 107 million in 1990 to 170 million in 2004(Robinson et al, 2004).It is predicted that by 2025, two thirds of the world's population will experience water scarcities, blighting the lives and livelihoods of 1.8 billion people by 2050.

In the countries of Sub-Saharan Africa where rapid population growth and lack of financial means for the exploitation of resources are combined, the problem of access to water is more than a priority, as it is a question of survival. Nkenfack et al (2017) noted that for sub-Saharan Africa as a whole, urban-rural disparities in water availability are glaring with 46% of the rural population and 81% of the urban population having access to drinking water. Jaglin (2001) noted that unequal access to water in developing countries is linked to high demand with a consequent increase in the marginal costs of supply. Africa has the lowest water supply and sanitation coverage than any other region in the world. More than 30% of Africans residing in urban areas currently lack access to adequate water services and facilities. In the year 2000, the World Health Organisation (WHO) estimated that Africa contains 28% of the world's population without water access to improved water supplies and 13% of the world's population without access to improved sanitation. Only 62% of the people in African countries have access to improved water supplies and only 60% have access to improved sanitation (WHO, 2000).

The scarcity of water in Cameroon is taking a new dimension as residents of many urban and semi-urban areas do not have access to a readily available source of domestic water. Cameroon, like many other African countries has developed programmes and projects that promote access to water for its various uses. Despite the authorities' growing concern to guarantee 'access to all', the supply of water in many parts of the country is inadequate. This is indeed a tragic and unpalatable irony as, the Food and Agricultural Organisation (FAO) noted that Cameroon has one of the largest undergrounds and surface water reservoirs in Africa. One, therefore, wonders how the rate of drinking water supply is only 33% (African Development Bank, 2010); that is 67% of Cameroonians not connected to the water supply network, with a prevalence rate of 19% of water and sanitation-related diseases. In fact, it is estimated that more than 68% of the population still lacks access to drinking water in the country as a whole (9,520,000 inhabitants). The city of Yaounde has been experiencing a rapid rate of urbanization and urban development, estimated at 6% per year. This urbanisation is reflected in an increase in the population on the one hand, and, on the other hand, in an extension of the housing stock, which leads to the creation of new neighbourhoods and a growing demand for water. Meeting the demand for water

in terms of quality and quantity as well as sustainable management of public services is, therefore, a major policy concern and thus a focus of interest for many researchers.

## **II- MATERIAL AND METHODS**

The multi-criteria analysis enabled us to relate the parameters of housing distribution, population distribution taking into account physical elements like relief to identify priority areas for extension. Two types of data were required for this research; data from primary and secondary sources. Primary data dealt with the identification of the water distribution network in the city of Yaounde, with a view to come out with maps showing their spatial distribution. This data was collected from some resource persons in the Camerounaise Des Eaux (CDE), the structure in charge of water distribution in Cameroon. The data was geo-referenced and projected onto Google Earth. Given the fact that the information on the water distribution network in Yaounde was incomplete, it was updated with information from a technician in the structure in charge of water network maintenance. A total of 537 water points were identified and located with the aid of the Global Positioning System device (GPS). Data from secondary sources included documentary research (books, articles, theses and reports). This enabled us to better understand the problem of access to drinking water in a broader context (sub-Saharan African) in general and Yaounde (Cameroon). Other important data sources used included; the distribution of the built in Shapefile and the digital file of roads in Yaounde. The data was analysed using numerous tools which are commonly encountered in remote sensing and GIS (ArcGis, Mapinfo, GPS software).

## **III- RESULTS AND DISCUSSION**

### **1. Yaounde: a city with strong urban expansion**

Yaounde, capital of the Center Region and Mfoundi Division is situated at an average altitude of 950m in its Northern part and 750m in the South (Kuété, 1977; Tchotsoua, 1994; Tchindjang et al., 2011; Kengne and Youana, 1996). This City (Yaounde), also known as the 'city of seven hills' was founded in 1887 by a German called Lieutenant Kund Tappenbeck who transformed it into a military station in 1889 due to the slave trade. In 1894, another German, Major Hans Dominik transformed this single village of 300 inhabitants into a great military base so as to enable him have a perfect grip of the entire country especially towards the east and the north. Following the defeat of the Germans in Cameroon during the First World War, the French still made Yaounde the capital of French Cameroon in 1922.

After independence and reunification, Yaounde was again made the capital of the Federal Republic of Cameroon till today. From this premise, one discovers that, Yaounde has been an administrative area throughout the evolution of Cameroon. This strategic role of Yaounde attracted many migrants into the city throughout history leading to the rapid urbanization of the area. In the horizontal dimension (spatial) as shown on Figure 1, the urban perimeter of the city of Yaounde has evolved exponentially, with the consequent conquest of new spaces, often in a disorderly and anarchic manner. In fact, the surface area of the eastern part of the city has evolved considerably. It increased from 38.07 km<sup>2</sup> in 1980 to 159.19 km<sup>2</sup> in 2001. Presently, it is estimated at 310 km<sup>2</sup> with an urbanisation rate of around 5.5% (Assako *et al.*, 2011).

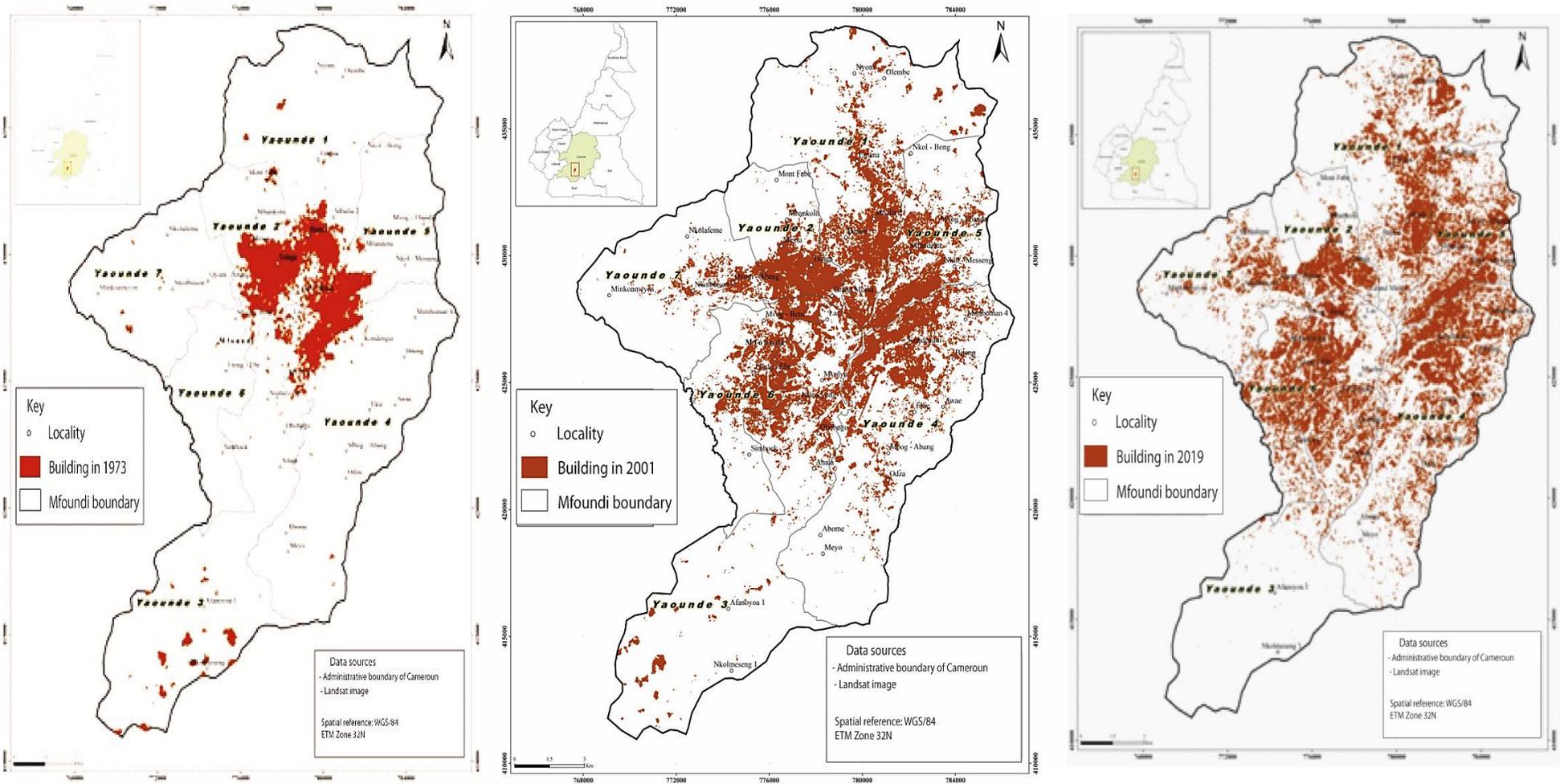


Figure 1: Spatial evolution of the Yaounde urban area between 1973, 2001 and 2019

The spatial extension of Yaounde (Figure 1) follows a two-stage evolutionary pattern: firstly, Yaounde has experienced a densification of the central and peri-central sectors; secondly, there is an occupation of the peripheral areas which are gradually being incorporated into the city (Mougoue, 2006). The population of Yaounde is divided into three type of neighbourhoods; modern housing neighbourhoods, progressive housing neighbourhoods and spontaneous housing neighbourhoods, representing 60% of the surface area of Yaoundé and comprising 70% of the population (PDU-Yaounde, 2008).

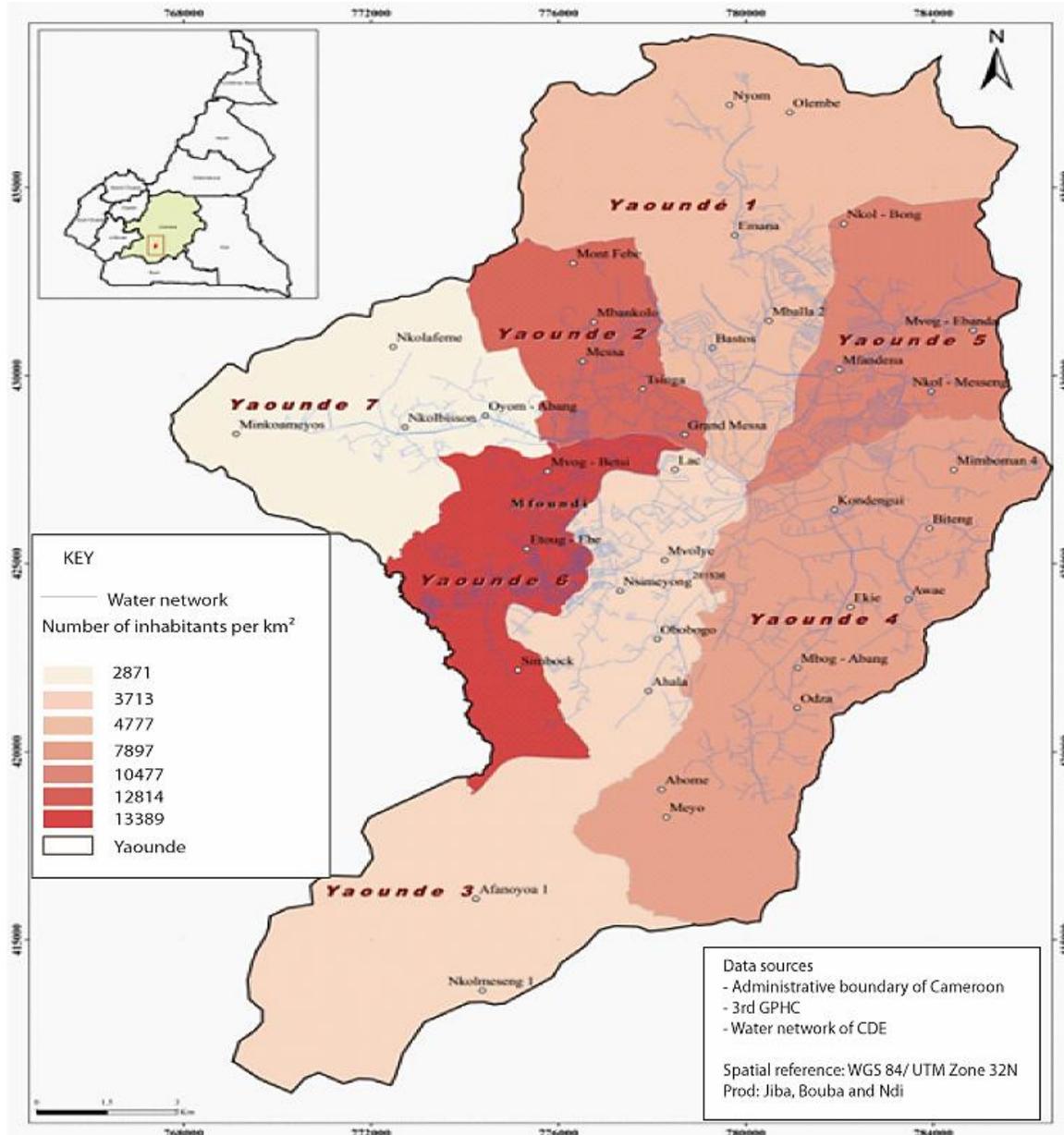
The city is largely located in the catchment area of the Mfoundi river. There are four types of landscapes;

- low-slope ridges whose land is easily urbanized;
- hills that can be developed, with slopes varying from 5 to 15%;
- hills that are very difficult to develop, with a slope of more than 15%;
- floodable valley bottoms, generally with a slope of less than 5%.

From these types of landscape, can be identified there are two main zones: areas that are not aedificandi, that is areas with a gentle slope (less than 5%) and areas with a steep slope, where there is permanent erosion and landslides; and areas that can be built on or developed, which are the slopes and sites with a slope of between 5 and 15%.The city's hydrographic network is very dense and is essentially made up of the Mfoundi river and its tributaries. These ensure the natural drainage of runoff and surface water that is discharged by the Mefou River, which in turn discharges its waters into the RiverNyong. Theupstream of this last discharge point currently serves as thecatchment area intended for the production of drinking water for the inhabitants of the city of Yaounde and its environs.

## **2. Spatial distribution of potable water network in Yaounde**

The water distribution network in the various neighbourhoods that make up the city of Yaoundeis unevenly distributed (Figure 2). Areas with a high density of water distribution aremostly located in and around the city center, medium-density areas and low-density areas in the growing peripheries. Other neighbourhoods are completely devoid of these distribution networks, due mainly to low population density as a result of the presence of natural factors such as high relief and vegetation which deters urban sprawl.



**Figure 2: Spatial distribution of water network in Yaounde**

Looking at Figure 2, the administrative centre, Bastos, Grand-Messa, Elig-Esson, Tsinga are the neighbourhoods best served with pipeborne water in Yaounde while Olembe, Nkol-Bong, Nkol-Messeng, Simbock, Mbalngong, Obobogo, Damascus, which are very densely populated, are poorly served. Such an unequal distribution of the water network in the city of Yaounde is explained by the fact that efforts to extend the water network are commensurate with the unbridled growth of the population (5% annual growth rate). Besides, limited economic resources and the low budget allocated to the water sector have negatively impacted on water distribution projects. It should, however, be noted that the presence of the distribution network in no way means the presence of water. In fact, some networks have existed for years but water does not flow. This is because the population in certain localities have surpassed their carrying

capacities with consequent saturation of the distribution network with the end result being water shortages.

### 3. Alternative Solutions to Inadequate Water Distributions in Yaounde

The current mapping of the water distribution network in the city of Yaounde has provided a clear picture of the situation of the existing distribution infrastructure, notably neighbourhoods with a dense network of water supply and those where a significant lacuna in water distribution exists. Due to such inadequacy in the water network in the city on the one hand and the scarcity of water in the distribution channels on the other hand, several alternative solutions are being put in place, either by the least served urban populations, the public authorities and local communities to enhance sustainable water supply. This alternative constitutes other sources of water supply developed by the population apart from those implemented by the company in charge of water production and distribution (CAMWATER). Such alternative sources consist of wells, boreholes and natural springs.



Figure 3: Zones covered by alternative water supply in priority extension areas

Despite the efforts made by the public authorities to extend access to drinking water in Yaounde, as well as the individual strategies to gain access to water (wells, boreholes, springs...), some neighbourhoods are still void water supply networks like the southern part of the city (Yaounde 3 Municipality). Besides, in the northern part (Yaoundé 1 municipality), water shortage is more acute because an inadequacy exists between the CAMWATER water distribution networks as well as the absence of alternative sources in addition to very high population densities.

**4. Priority areas for the extension of the water distribution network in the city of Yaounde**

Taking into account the spatial distribution of the water distribution network in the city of Yaoundé it was necessary to identify the priority areas for extension (Figure 4). These are, those neighbourhoods that are totally devoid of the water supply in the city of Yaounde, both the CAMWATER network and alternative water sources (wells, boreholes and springs).

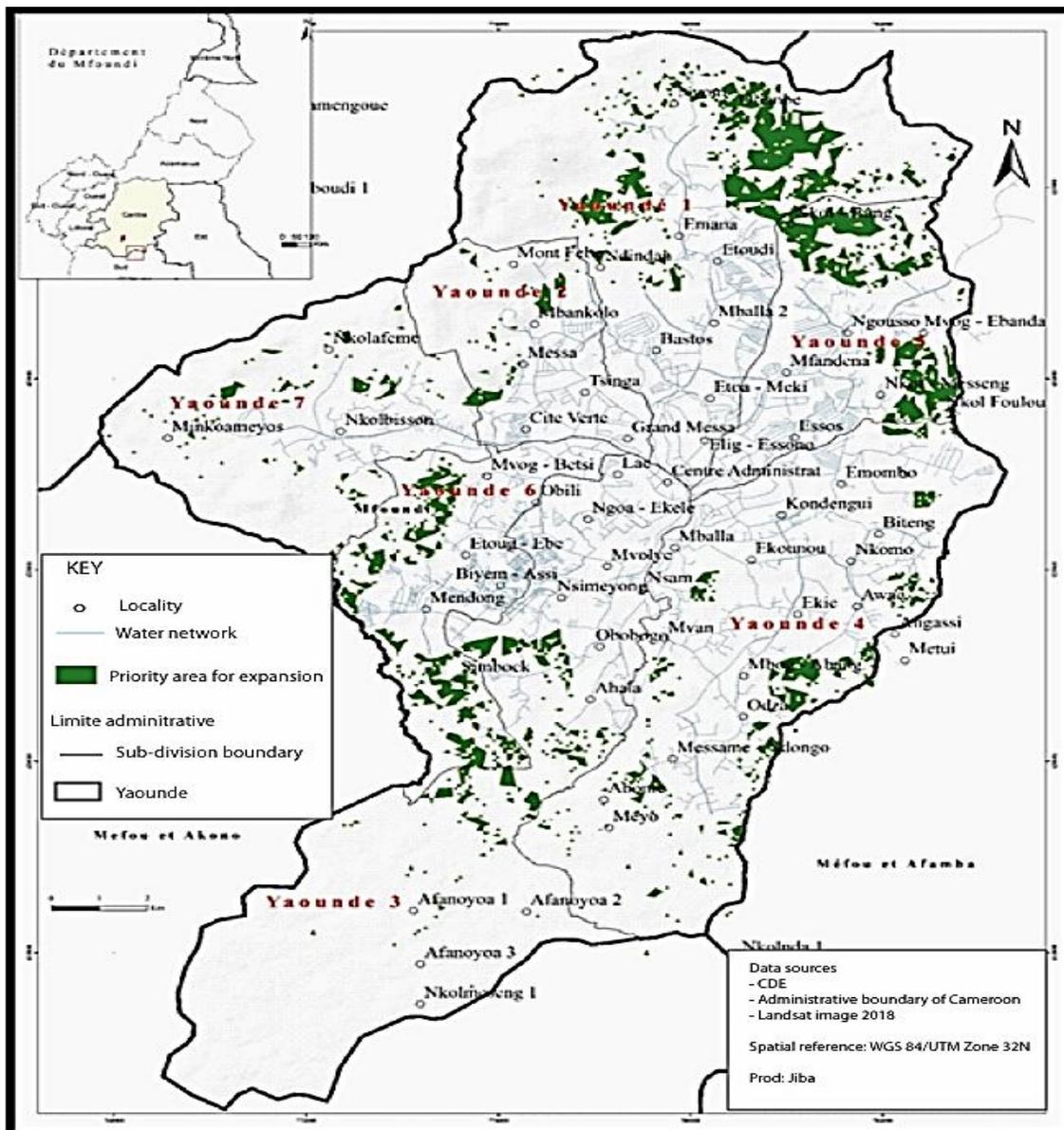


Figure 4: Priority area for the extension of the water network

Taking into account the parameters of our analyses (density of the water distribution network, spatial analysis around the alternative sources and the road network) for the realization of the map of the priority areas for the extension of the water network in the city of Yaoundé, with the aim of reducing the distances travelled for water supply, it became possible to identify the priority areas for extension. These are the Nkong-Bang, Nkol Foulu, Nkol Messeng, Nyom, Olembe and Simbok.

## 5 CONCLUSIONS

The 2030 agenda of sustainable development which will steer future research and development includes a dedicated goal on water and sanitation (SDG 6) that sets out to “ensure availability and sustainable management of water and sanitation for all”. SDG 6 extends the Millennium Development Goal (MDG) of “use of improved sources of water”. This emphasis suggests the need for an integrated approach to water service delivery through rational and equitable distribution. This paper has mapped the water distribution network in the city of Yaounde in a bid to identify priority areas for extension with the aid of tools of the geographic information system. The findings have revealed a mismatch/uneven distribution of the water network within the various neighbourhoods under study with a consequent imbalance between supply and demand. The implementation of a vigorous policy in the water sector to reduce pressure on the constantly increasing demand in the short term is a necessary prerequisite in the Yaounde Metropolis. Based on this, the decision to make access to drinking water a national priority so as to consolidate and ensure economic growth, reduce waterborne diseases and improve the population's living conditions cannot be over emphasized. This will require a strong political will that will check the controversies surrounding water distribution in the short, medium and long term. This paper has identified neighbourhoods to serve as an essential reference for decision and policy makers for priority action (installation of the water network) to reduce the disparities that is currently observed in the distribution of water in Yaounde. This calls for a strong political commitment backed by resources for the authorities that be to reduce the widening gap between served and unserved neighbourhoods.

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