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Access to basic urban services in secondary towns in Chad: An evaluative approach based on data from the town of Pala

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Abstract: Urban growth in Chad's secondary towns, although less pronounced than in the capital, presents significant challenges for access to urban services essential for residents' well-being and sustainable urban development. This study focuses on access to these services in the town of Pala, adopting an evaluative approach to identify the difficulties faced by residents and the coping strategies they employ. A mixed methodology was used, combining qualitative and quantitative data, with logistic regression analysis and other statistical tests. The results reveal that only 15% of the population has access to drinking water, while 70% rely on traditional wells. In terms of sanitation, 60% of inhabitants use inappropriate traditional latrines, and 66% of wastewater is discharged into the street or into nature due to a lack of sewerage systems. Regarding education, 67% of school-age children do not have access to adequate teaching, and 60% of educational infrastructure is in poor condition. These findings highlight the need for increased action by local stakeholders and the government to improve access to these critical services.

Keywords: *Basic urban services, Evaluative approach, Pala, Secondary city.*

1. Introduction

The process of urbanization is a major trend characterizing the 21st century Gerten, et al. [1] with over half the world's population already living in cities, and this figure set to rise to 68% by 2050, mainly on the African and Asian continents [2]. Creating more sustainable cities and conserving and restoring biodiversity are essential to achieving the Sustainable Development Goals [3]. Developing cities, particularly those in the South, can move beyond unsustainable development models by focusing on transformative pathways that prioritize sustainability, equity and, in particular, the socio-ecological system Lwasa, et al. [4] apid urbanization, coupled with poor urban governance in most African cities, has led to uncontrolled urban sprawl, discordant spatial developments and informal land governance systems [5]. Urban planning efforts in emerging and developing countries face multiple problems, particularly in small and medium-sized cities that can be considered poor by several criteria: socio-economic level of the majority of the population, low levels of public investment, low quality of local administration and high financial dependency. According to several authors, one of the main reasons is that the philosophy and methods of urban planning applied to these specific contexts are directly derived from a Western tradition that does not correspond to the local and national context in terms of needs, priorities and organization of financial resources [6]. However, this mode of planning exposes secondary cities to increasingly enormous challenges, accentuated by a continuing demographic boom. Basic urban services or necessities are therefore seen as the primary measure of well-being or quality of life in today's urban environment. The sixth Sustainable Development Goal (SDG) has highlighted

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universal and equitable access to safe drinking water, hygiene and sanitation by 2030, particularly for vulnerable populations. This objective incorporates the transboundary notion of water, essential to sustainable management but also conducive to peace and cooperation [7]. Despite this clarification, the situation in Chad is particularly worrying [3]. Studies show that secondary towns suffer from a lack of investment in infrastructure, which limits inhabitants' access to quality services [8].

Access to basic urban services is a crucial issue for the development of secondary towns in Chad in general, and Pala in particular. As the country faces rapid urbanization and growing socio-economic challenges, the availability and quality of urban services such as drinking water, electricity, collective and individual sanitation and transport infrastructure are becoming key indicators of the well-being of urban populations [9]. According to the Aduku, et al. [9] improving access to essential services such as water, sanitation, electricity, health and transport is fundamental to enhancing the well-being of urban populations and reducing inequalities [10]. Pala's urban health center, which serves a population of 30,000, faces a number of structural and organizational problems. Secondary towns, often overlooked in development policies, have unique characteristics that require special attention to ensure equitable access to these essential services [11]. An evaluative approach is essential to understand the dynamics of access to urban services in the city of Pala. This assessment must include performance indicators, user surveys and analyses of existing infrastructure, in order to identify gaps and the specific needs of the population [12]. In addition, the ability of communities to adapt to the challenges of accessing urban services is a fundamental aspect to consider. Coping strategies, whether individual or collective, play a crucial role in the resilience of populations in the face of environmental crises and economic constraints [13].

Far from stifling other related research, this study is justified by the fact that little research is focused on secondary cities in sub-Saharan Africa in general, and in Chad in particular. Secondary towns have undergone a major demographic boom, and the problems of development, planning, the environment and its corollaries are acute. The town of Pala, because of its location in the south-west of the country, has not seen much literature on access to basic urban services. Research has focused more on large cities, yet secondary towns have many more problems than large cities. It is also important to emphasize that, through this study, we want to compare the rates of access to various urban services in order to make better recommendations for improving the living conditions of local populations. The main objective of this study is to explore access to basic urban services in the city of Pala, adopting an evaluative approach that highlights the challenges faced by residents and the coping strategies put in place.

2. Literature Review

Access to basic urban services in sub-Saharan Africa's secondary cities is a complex challenge influenced by economic, social and governance factors. Studies show that although progress has been made in some areas, many cities continue to struggle to provide adequate services to their growing populations. The city of Pala in Chad is no exception, and requires particular attention to improve its infrastructure and resilience. Access to basic urban services, such as drinking water, sanitation, electricity and transport, is essential for human well-being and sustainable development.

2.1. Urbanization and Governance

By 2050, the urban population of Sub-Saharan Africa (SSA) is expected to grow from 414 million to over 1.2 billion. This growth is likely to increase the challenges faced by municipalities trying to provide access to various basic urban services [14]. Modernization Theory Walter Rostow and Talcott Parsons [14] postulate that urbanization is a natural process by which traditional societies evolve into industrialized, modern societies. Modernizers argue that urbanization has positive social effects, promoting economic development and improved living conditions. Countries that urbanize tend to experience an improvement in their development indicators, such as income, education and health. For Parnell and Walawege [15] urbanization and access to services improve economic and social

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development. In contrast to modernization theory, the urban bias theory of Denis [16] argues that urbanization is often the result of government policies that favor urban regions to the detriment of rural areas. This leads to disparities between rural and urban areas, causing mass migration to cities. Proponents of this theory argue that resources are systematically redirected to cities, creating large agglomerations with long-term social consequences such as urban poverty and inequality. The rapid growth of the urban population in sub-Saharan Africa poses considerable challenges for urban governance. Current governance structures are often unable to meet the growing need for basic infrastructure and services, exposing a large proportion of the urban population to high levels of risk [17]. This situation is particularly critical in small and medium-sized cities, where local governments often lack the capacity and funding to provide adequate infrastructure and services. Most small urban centers in the region have local governments with very little capacity or funding to meet their responsibilities for risk reduction infrastructure and services. Among these problems, the best known are those relating to water supply and sanitation [18].

2.2. Access to Water and Sanitation

Access to drinking water and sanitation is a fundamental human right and an essential element of every person's health. Yet many people around the world do not have access to these basic needs [19]. People deprived of access to improved water and sanitation services are less likely to realize their full potential [3]. Unimproved drinking water and sanitation is the second leading cause of child mortality worldwide. Around 10,000 people die every day from water and sanitation-related illnesses, and thousands more suffer from a range of debilitating diseases. Access to improved water sources and sanitation significantly reduces water-borne diseases [20]. Access to safe drinking water and adequate sanitation is a persistent problem in many secondary cities in sub-Saharan Africa. A study of 31 major cities in the region revealed significant variability in access to water and sanitation, with notable progress in some cities but setbacks in others. In addition, small and medium-sized cities often suffer from greater deficits in infrastructure and services, exacerbating public health risks [21]. A 25-year analysis has shown that although improvements have been made in access to improved water sources, access to sanitation facilities has declined in some periods, highlighting disparities between rich and poor households [22]. To address disparities in access to water and sanitation, Sustainable Development Goal (SDG) 6 aims to ensure universal and equitable access to safe drinking water and improved sanitation for all by 2030. It is important to monitor inequalities in access to drinking water and sanitation in order to assess progress towards universal coverage. The SDGs address inequalities, with Goal 10 aiming to reduce inequalities between and within countries. Annual reports from the Joint Monitoring Program (JMP) continually highlight inequalities between rural and urban areas, between rich and poor and between other groups. The 2030 Agenda further commits member states to "leave no one behind" and stipulates that SDG indicators should be disaggregated, where necessary, by income, gender, age, race, ethnicity, migratory status, disability and geographic location [23]. Finally, according to the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF), the proportion of the population with sustainable access to an improved water source (urban and rural areas) is the percentage of the population using any of the following types of drinking water supply: piped water, public fountain, borehole or pump, protected well, protected spring or rainwater. Improved water sources do not include water supplied by a vendor, bottled water, water supplied by a tanker truck or unprotected wells and springs [24]. Adequate access to drinking water is therefore defined as the use by a given population of facilities (water points) recognized as adequate [24].

2.3. Urban Mobility and Access to Energy

Cities in sub-Saharan Africa suffer from degraded transport infrastructure and inadequate urban planning, requiring redesign to better integrate various modes of transport and improve safety [25]. Urban mobility is another crucial aspect of basic urban services. In many sub-Saharan cities, transport infrastructure is inadequate and poorly planned, limiting mobility options for residents, particularly the

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poorest [22]. Reliance on walking and cycling, combined with frequent traffic jams and ineffective governance, negatively affects residents' quality of life and economic opportunities. Sustainable solutions to urban energy challenges in sub-Saharan Africa require social transformation through community mobilization and empowerment [26]. The challenges of sustainable energy supply have become major concerns in African cities. Given the links between vegetation change and the production, consumption and exchange of wood fuels in cities, academics and political players are focusing on this issue as a major challenge for social and environmental sustainability [26]. Chad has the lowest rate of access to electricity in the sub-region. This situation is characterized by an electricity access rate of 6.4% at national level, 20% in urban areas and 0.6% in rural areas. Average annual electricity consumption per capita in Chad is estimated at 47 kWh/capita (kilowatt hour per capita), compared with 109 kWh/capita for Central Africa. By comparison, Africa south of the Sahara (SSA) consumes 525 KWh/capita, while the world consumes 3031 KWh/capita [27].

2.4. Access to Health and Education

Access to healthcare in Chad remains difficult due to poverty and inaccessibility, resulting in higher morbidity and mortality rates [28]. Poor quality of services in urban health centers in Chad, including lack of interest, confusion and knowledge of target populations, contribute to repeated epidemic situations [28]. A qualitative study explored displaced people's experiences of access to healthcare using [15] theory of access [29] which includes geographical accessibility, availability, affordability, acceptability and accommodation [30]. Access to education in Chad is a major issue that is often at the heart of debates on human and economic development. Several authors analyze the multiple facets of this problem, each bringing a unique perspective on the challenges and solutions. Chad has one of the lowest literacy rates in the world, particularly in rural areas. According to a study by QEDCGrantmakingStrategy [31] "the quality of education in developing countries is influenced by a lack of infrastructure and resources". This is particularly true in Chad, where school infrastructure and educational resources are inadequate. Gender disparities are also marked, especially for girls, whose access to education is often limited by socio-cultural norms [32]. Poverty is a significant obstacle to education in Chad. According to a United Nations U. N. Development Programme (UNDP) [10] "low-income households are often forced to dismiss education from their priorities, prioritizing immediate subsistence". Government budgetary limitations, exacerbated by political instability and conflict, directly impact investment in the education sector. In this context, Laderrière [33] note that education policies must take into account the economic realities of families if they are to be effective.

The main obstacles to access to basic education in Chad are political and legal challenges, poor infrastructure, weak institutions, culture, religion, ethics and corruption [34]. Efforts have been made to improve education in Chad. According to the World vision [35] the Chadian government has launched several initiatives to improve access to education, including the construction of schools in rural areas and awareness-raising programs for girls' education. However, for these reforms to be sustainable, they must be accompanied by funding and effective management of educational resources. To improve access to education, it is imperative to consider an integrated approach. According to Raveaud [36] an effective strategy must include investment in education, promotion of gender equality and enhanced collaboration between government and NGOs. In addition, systems for evaluating educational policies are needed to adjust initiatives according to the results obtained. Access to education in Chad remains a complex challenge requiring multilateral efforts. As Raveaud [36] point out, education is not only an avenue to economic prosperity, but also a form of social emancipation that contributes to justice and equity in society.

3. Materials and Methods

3.1. Study Area

The town of Pala is located in the southwest of the country, in the Mayo Kébbi-Ouest region, at 9°21'36" N; 14°52'20" E. The hub of the region, Pala is around 360 km from the capital N'Djamena and

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140 km from the Cameroon border, towards Figuil. It is crossed by the Figuil-Léré-Kélo-Moundou national road. Administratively, Pala is the capital of the Mayo Kébbi Ouest region, the Mayo Dallah department and the commune of the same name. Established as a medium-sized commune on June 21, 1961 under the name of Pala, the town has evolved to include 24 districts, structured into 117 squares. According to this delimitation, the municipal territory of Pala covers an area of 192.7 Km², or 19,270 ha. It is bounded to the north by the Gouin and Gouey-Goudoum cantons, to the east by the Tagal and Gagal cantons, to the south by the Goumadji canton and to the west by the Doué canton. The 24 districts of the commune of Pala are divided into four (4) arrondissements. The map below shows the administrative division of the study area.

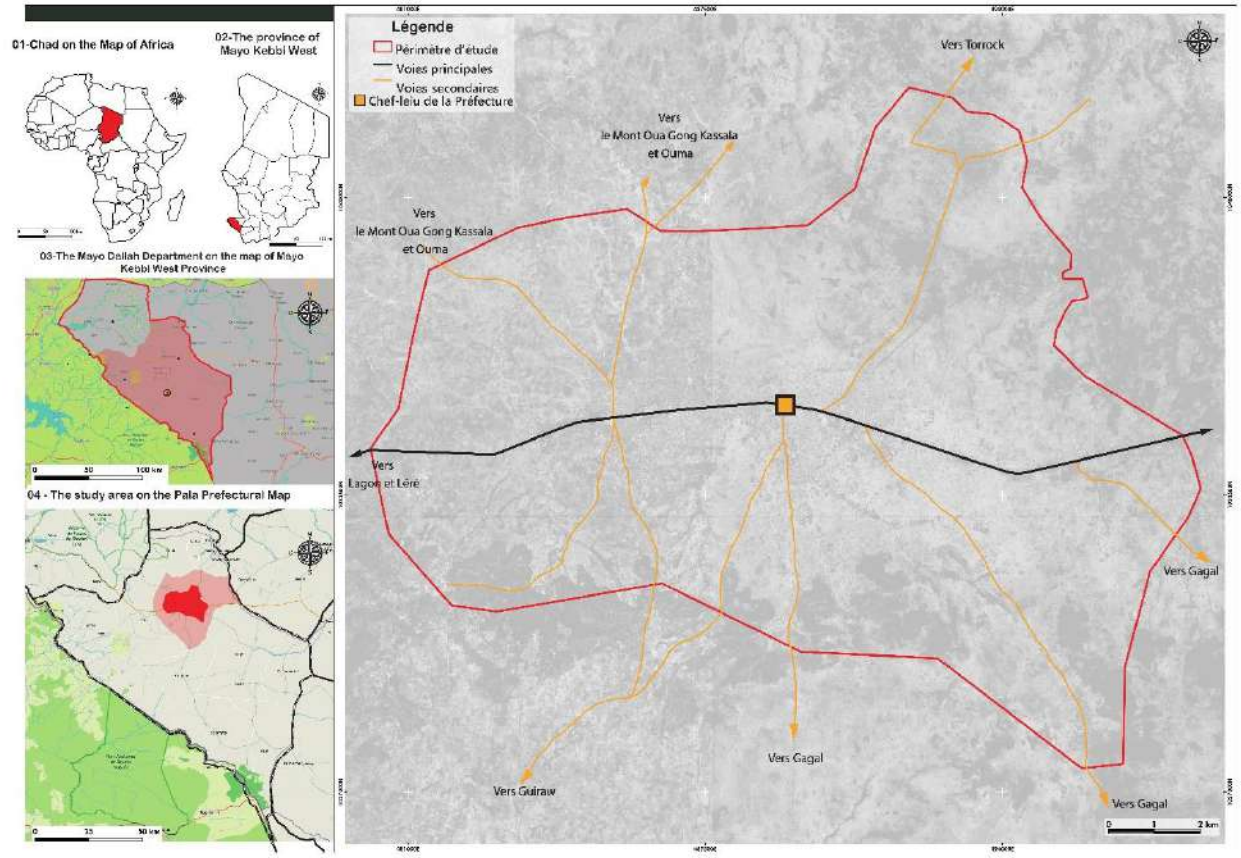

Figure 1.
Location of study area.

3.2. Sampling and Data Used

This study was carried out using a methodological approach based on documentary research, the collection of data relating to access to necessary urban services, group interviews with managers of public structures in charge of urban management and individual interviews with the populations of the city's four (4) districts. The literature search enabled us to review similar studies carried out in other geographical areas and dealing with the same issues. Data relating to access to the necessary urban services came from the Urban Reference Plan (PUR), the Communal Development Plan (PDC), study reports and empirical work in this field. Interviews were held with the heads of decentralized government departments in the four arrondissements, and all the departments concerned responded. The profile of those in charge of the structures included technicians in urban management, as well as

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other profiles such as law, the environment, sociology and geography. Individual surveys were also carried out among sampled households in the town of Pala. The data collection forms used for the population surveys took into account the following information: socio-economic characteristics (gender), stakeholders' views on access to various basic urban services, the resilience of local communities in the face of under-equipment and difficult access to, or absence of other services. In the end, the advice of technicians from the Chadian water company regarding the branching and refueling process. For the household interviews, we visited a number of households in each arrondissement whose size was proportional to the total number of households. A simple random sampling method was used to select the households to be interviewed. To determine the sample size, we used the inverse of the margin of error formula proposed by Daniel Schwartz. Let n be the sample size for a district q, and we have the following.

$$N_q = \frac{[(Za)^2 x\ P\ (1\text{-}P)]}{d^2} \qquad (1)$$

With Z being the fixed or reduced deviation at the 5% risk (1.96), corresponding to a 95% confidence interval, d being the margin of error set at 5%, and P being the proportion of households per district. Unable to survey all households in the city, a survey of 300 households in the city of Pala was carried out to gather socio-demographic data on the population. This approach was also used in a recent study carried out in Central Africa by Attipo, et al. [37]. To obtain more detailed information on the approach to developing planning tools, the following specific criteria were defined for the population to be studied. At least 18 years of age and have lived in the city for more than 10 years (this residence criterion was used to emphasize accessibility to services). The survey was based on a questionnaire with closed and open-ended questions. This method was used by Watson [38]. Households were divided according to population density in the 24 districts of the city of Pala. For example, densely populated districts, comprising mainly residential areas and old urban cores, made up a larger sample than less popular districts, comprising mainly administrative and service areas. To establish this distribution, the quota method based on population density was used to ensure a spatial distribution of households proportional to the population density of the four districts. This technique was used by Admasu and Jenberu [39] in a study of the town of Arba Minch (Ethiopia) [39]. Table 1 shows the number of respondents per district.

Table 1.
Distribution of respondents by district of the city of Pala.

Pala	Number of respondents	Percentage (%)
First district	100	33.33
Second district	100	33.33
Third district	70	23.33
Fourth district	30	10.01
Total	300	100%

The first and second arrondissements have a significant demographic weight in the city, as they are the former village cores on which the town of Pala was built. The 3rd arrondissement follows, and the newly-created 4th arrondissement does not have a high population density. The distribution is designed to ensure that each district is representative. In addition, individual interview questionnaires have been designed to gather the knowledge and opinions of users and experts in the field of urban service management. Accordingly, individual interview questionnaires were administered to thirty-four (34) executives from deconcentrated state services, technical services from the municipality of Pala and representatives of civil society. Table 2 shows the distribution of respondents by district.

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Table 2.
Distribution of respondents to interviews and focus groups.

Pala town	Number of participants	Participant typology
1st district	10	4 district chiefs, 2 representatives of civil society associations, 1 youth representative, 2 heads of government departments.
2nddistrict	10	4 district chiefs, 2 traditional chiefs, 2 youth representatives, 1 district women's representative, 1 government department head.
3rd district	8	3 district chiefs, 1 traditional chief, 2 representatives of civil society associations, 2 heads of government departments.
4th district	6	2 district chiefs, 1 district delegate, 1 youth representative, 1 women's representative, one government department head.
Total	34	

3.3. Research Methodology

To carry out our studies, we adopted a methodology combining qualitative and non-qualitative data. The qualitative method was used to obtain the perceptions and opinions of users of basic urban services. The quantitative method was used to calculate the different levels of access to services on the basis of available data, in order to compare or normalize them with existing evaluation grids or standards. Figure 2 below gives an overview of the methodology used.

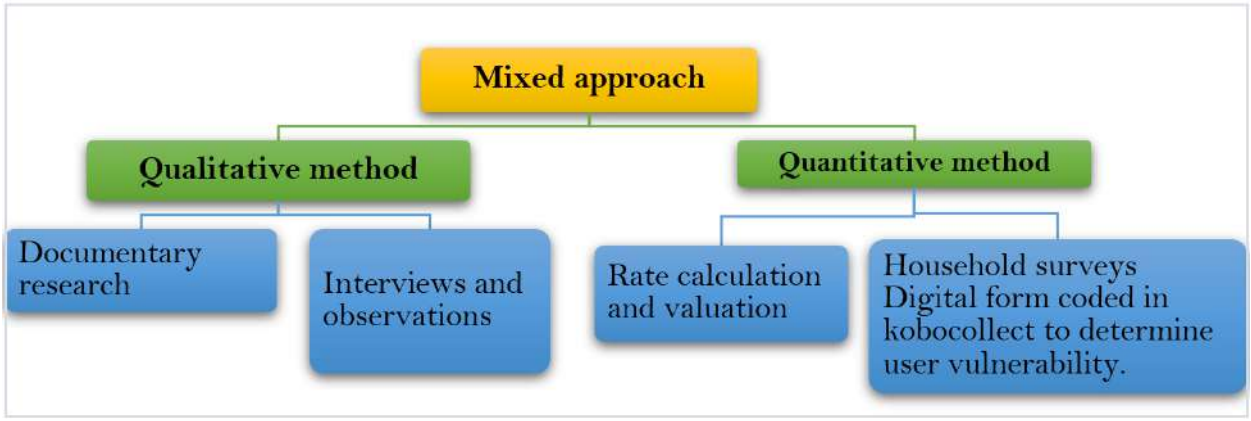

Figure 2.
Methodological diagram.

The methodology adopted consists in measuring the theoretical rate of access to basic urban services distribution systems. It is based on the notion of service, and proposes evaluation and monitoring indicators in line with the regulations in force in the Sahelian zone. It is based on the concept of a service scale, the levels of which are articulated around the basic service as defined by the standards of international organizations. The proposed tools enable the methodology to be put into practice, so that populations' real access to essential services can be assessed, access can be monitored over time and, finally, the provision of basic urban services can be managed at municipal level. To assess access to basic urban services in Pala, we adopted a mixed-methods approach based on direct observations and interviews with local stakeholders. This method enabled us to gather data on current practices, challenges encountered and perceptions of users and service providers.

3.4. Data Collection and Processing Tools

For data processing and analysis, Microsoft Excel 2019 was used to organize and format the data collected from the KoboToolbox platform. Next, Jamovi and GraphPadPrism software were used with special packages to process the data according to specific objectives. These tools were chosen for their

flexibility in handling and the quality of the expected results. Figure 3 below shows the tools used during the various research phases.

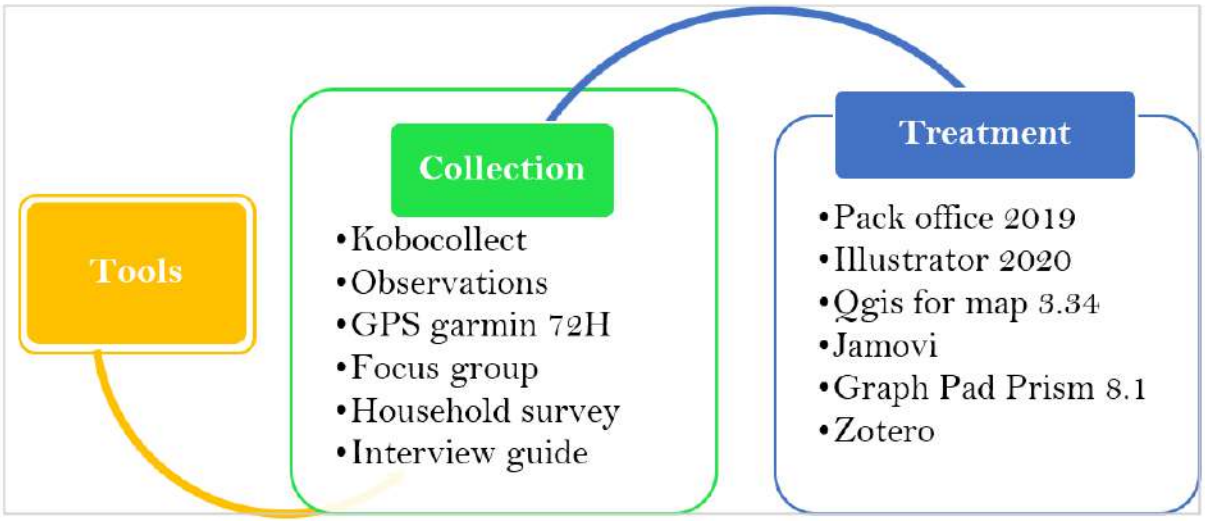

Figure 3.
Tools used.

3.5. The Formulas Used

- Rate of access to drinking water (General formula)

To calculate the rate of access to drinking water in Pala, we used a more general formula.

$$\alpha = \frac{\sum_{i=1}^{n} \sum_{j=1}^{pi} I(xij)}{\sum_{i=1}^{n} Pi} X100 \qquad (2)$$

With α: rate of access to drinking water (as a percentage), n: Number of groups or categories in the population, I(xij): Indicator function, worth 1 if person j in group i has access to drinking water, otherwise 0 and Pi: Total population of group i.

- Electricity access rate (weighting method)

The weighting method you mention is used to calculate an overall score (or index) α from several indicators that have been measured. The most common formula is as follows:

$$\beta = \frac{\sum_{i=1}^{n} wi.Ti}{\sum_{i=1}^{n} wi} X100 \qquad (3)$$

With β, the calculated global index or score. This score is often expressed on a scale of 0 to 100 for ease of interpretation, n the total number of indicators or variables included in the study (in our case, we retained 3 variables), wi: The weight associated with indicator i. These weights are coefficients representing the relative importance of each indicator in relation to the others. They should be assigned according to the relevance or significance of each indicator in the context of the analysis. Ti: the value of indicator i. This is the measure we have for this indicator, which can be a score, a percentage, a numerical figure, etc. To reduce complex analyses, we have considered the following indicators: indicator 1 (service): T1= X, Weight w1=0.5, indicator 2 (quality): T2=Y, Weight w2=0.3, indicator 3 (price) : T3=Z, Weight w3=0.2. The weighting method allows you to integrate multiple indicators with varying levels of importance to obtain a composite score that summarizes all the data.

- Rate of access to sanitation and wastewater treatment services

To calculate this rate, we considered socio-economic parameters and other external factors. The formula below gives further details on these factors.

$$\Omega = \left(\frac{1}{p} \sum_{i=1}^{n} (wi.ai)\right) X100 \qquad (4)$$

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With ai: the number of people with access to sanitation facilities in category i (i.e. the values of A distributed across the categories), Ω: Sanitation access rate expressed as a percentage, Wi: A weight coefficient for each socio-economic category i (e.g. income, education level) that could influence sanitation access, P: Total population of the city and n: the number of socio-economic categories considered.

- Access to education

Using logistic regression to model access to education is also a very valid approach, especially when it comes to predicting a binary dependent variable, for example, whether an individual has access to education or not (1 for yes, 0 for no). The formula below gives an overview of the different parameters used.

$$P(Y=1)=\frac{1}{1+e^{-(\beta 0+\beta 1X1+\beta 2X2+\beta 3X3)}} \quad (5)$$

With P(Y=1) the probability that the individual has access to education, β0 is the intercept, β1, β2 and β3 are the coefficients associated with the indicators X1, X2 and X3 are independent variables such as enrolment rate, completion rate and infrastructure quality.

Logistic regression is therefore a robust and suitable method for modeling phenomena where the answer is binary, as in the case of access to education.

- Access to health services

To calculate the rate of access to healthcare services, we took into account the number of patients served and the total population, while including other comfort parameters such as post-service satisfaction, accessibility in terms of distance and other factors.

$$\partial=\frac{Npatients.Q+(\sum_{j=1}^{m} Aj)\, x(\sum_{i=1}^{n} Xi)}{N\ habitants}\ X100 \quad (6)$$

With ∂: Health Access Rate, Npatients: Number of patients, Q: Quality of access to healthcare, Aj: Accessibility-related indicators, Xi: Determinants of health, Nhabitants: Total number of inhabitants. A Health Access Rate that combines various measurable elements, including number of patients and quality of care, as well as accessibility indices and health determinants.

- Improved access to mobility services.

For this rate, parameters such as accessibility, transport cost, infrastructure density and quality, as well as the socio-economic indicator. The formula below gives an overview of this complex function.

$$\mu=\frac{\sum_{i=1}^{n} Wi\ x\ f(Xi)}{N\ habitants}\ X100 \quad (7)$$

With μ the rate of access to mobility, N the total number of inhabitants in the study area, the function f(Xi) for each variable Xi takes into account the accessibility indicator, the quality of mobility services, the cost of transport, the density of infrastructures and finally the socio-economic indicator.

3.6. Standardisation

3.6.1. The Evaluation Grids

In the absence of a local grid in force, we have used a general grid from studies carried out in Sahelian countries, with similarities to Chad. Because of its history, Burkina Faso experiences almost the same realities as Chad, which justifies the use of this grid. The table below gives an overview of the grid used to draw conclusions.

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Table 3.
Service standards.

Parameters	Urban area	
	Typology of cities	
	Major cities	**Other towns and cities**
Quality	Nitrate content ≤ 50 mg/l and Conductivity ≤ 1000µS/cm	Nitrate content ≤ 50 mg/l and Conductivity ≤ 1000µS/cm
Specific water consumption	40l/day/person	40l/day/person
Distance from	BF and PEA within 500m from the habitat cluster center	BF and PEA within 500m from the habitat cluster center
Accessibility	1 BF/250 inhabitants 1 PEA/250 inhabitants 1 BP/9 inhabitants	1 BF/300 inhabitants 1PEA/300 inhabitants1 BP/10 inhabitants

Source: West Africa Water Supply, Sanitation and Hygiene Program (USAID WA-WASH), 2013. PEM: Modern water point; PEA: Autonomous water station; BF: Fountain; BP: Private connection.

- Evaluation grids used in the water sector for the Sahel zone

The grid in Table 4 is generally used in the Sahel zone to better assess access to certain essential needs.

Table 4.
Standards in force in the Sahel zone.

Water quantity	**Distance from water point**	**Coverage of needs**	**Health risks**
No access <5l/person/day	>1000 m or 30 minutes	Consumption cannot be guaranteed. Hygiene practices are impossible (unless practised at source).	Very high
Minimum access: ≤20l/person/day	From 100m to 1000m Or from 5 to 30 minutes	Consumption can be assured: -Hand washing and hygiene for basic foodstuffs possible -Showers and laundry difficult to ensure, unless taken at source	High
Intermediate access: 50l/person/day on average	Tap in the plot or less than 100m or 5 minutes away	Consumption and hygiene are assured: food hygiene and all aspects of personal hygiene (WC, shower, laundry) are assured.	Low
Optimum access: 100l/person/day	Continuous supply, thanks to numerous taps	Consumption: all needs covered Hygiene: all needs covered	Very low
The intermittent nature of the water supply generally reduces consumption and increases health risks.			

Source: Domestic Water Qauntity, Service, level and health-WHO/SDE/WSH/03.02-Guy Howard et Jamie Bartram, 2018.

- The service scale concept

Beyond this simple classification, it is interesting to be able to qualify the level of service received by each inhabitant. This is why a service level assessment tool has been developed, based on the concept of a service scale. The Joint Monitoring Program (JMP) used this concept to qualify access to sanitation in 2008 [35].

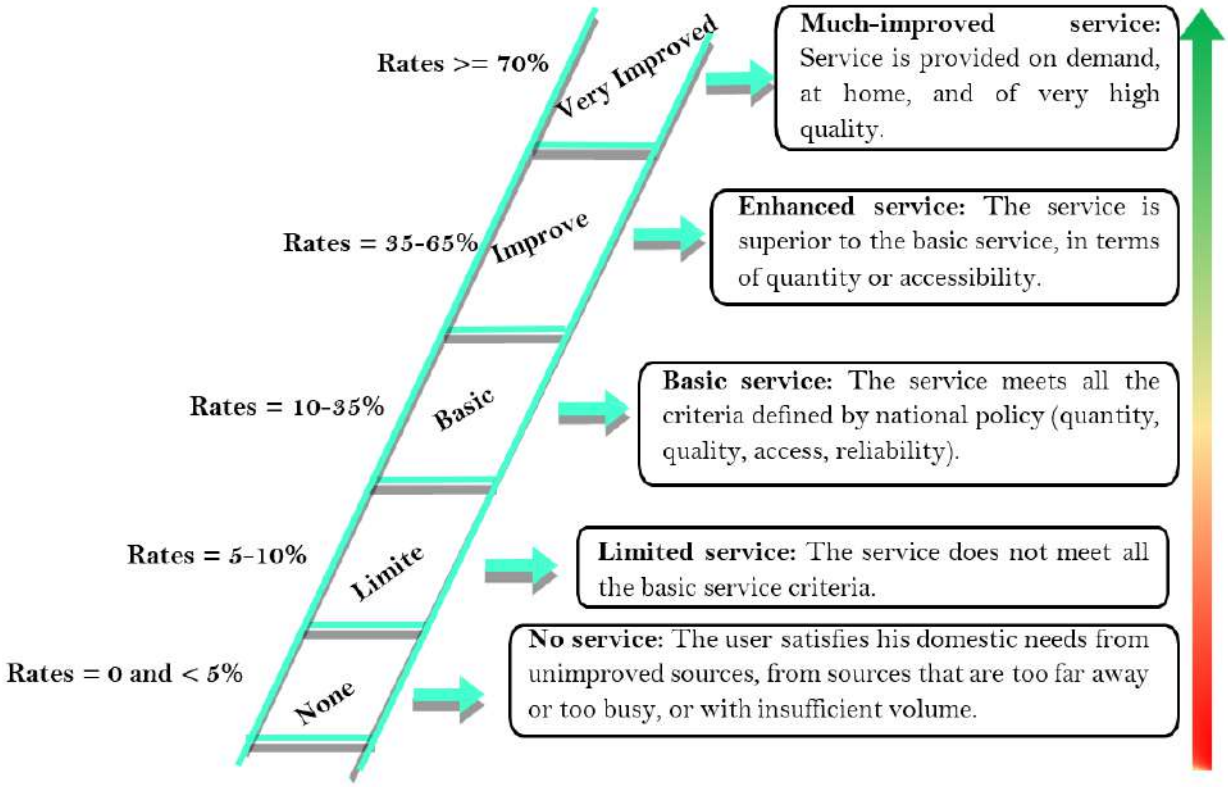

Figure 4.
Service level scale.
Source: West Africa Water Supply, Sanitation and Hygiene Program (USAID WA-WASH), WB, USAID, 2018.

This grid is used to classify the level of service provided on the basis of access rates, in order to draw more accurate conclusions. It highlights the number of users and also the distance to be covered to measure the type of comfort of the population. This grid is a guideline because, depending on the rate calculated, it enables a more or less general classification to be made, but can already serve as a basis for making a decision as to whether the access rate is limited, basic or much improved, for example. It is supported by the grid in Figure 5 below.

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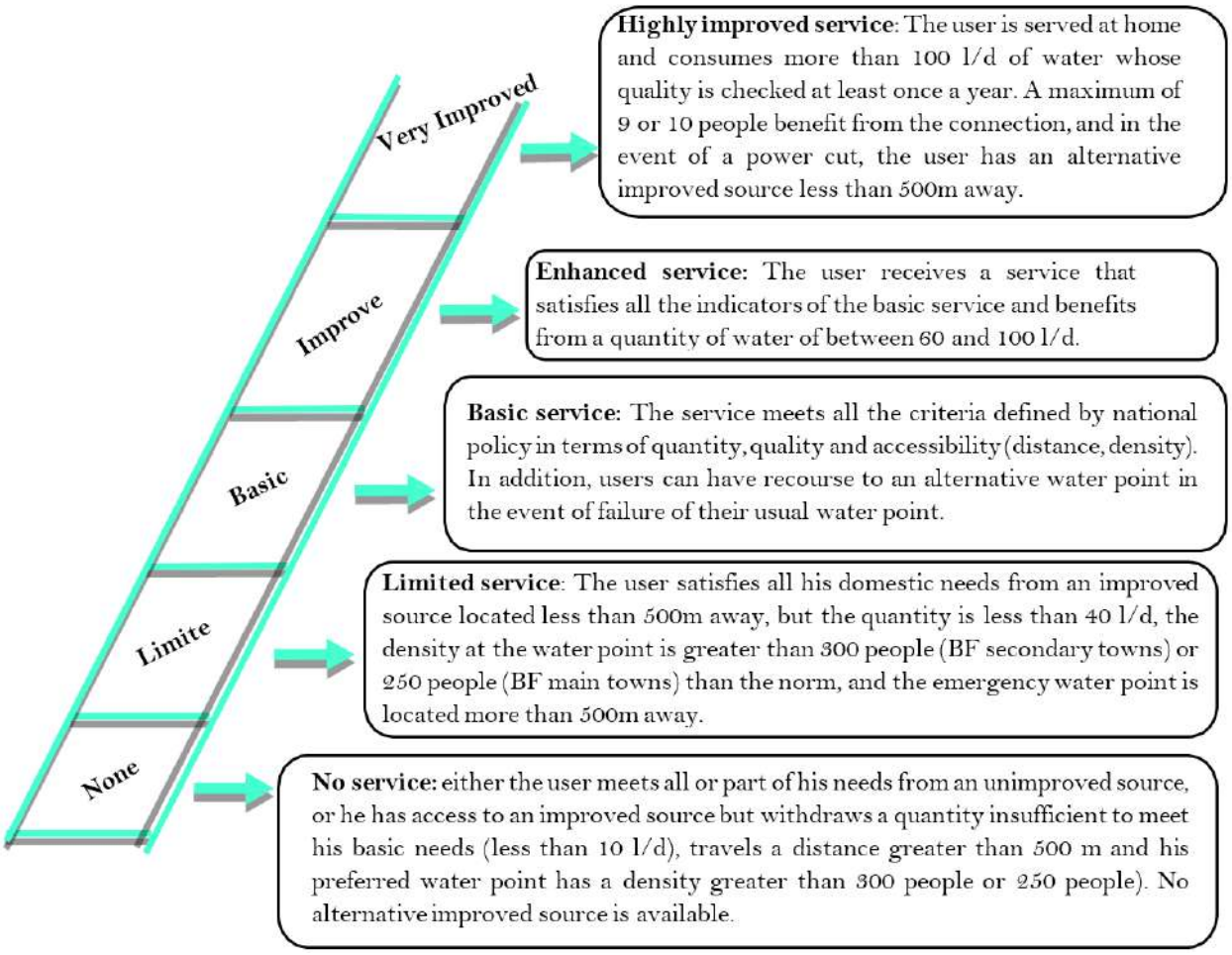

Figure 5.
Urban drinking water service scale.

These two grids in figure 4 and figure 5 are used in the Sahel zone to highlight access to different levels of service, taking into account the users, the distance to be covered, the type of convenience and the availability of these services in the vicinity. They also address the question of the quality of these services provided, in order to obtain the perceptions of the various users. In our study, after calculating access rates, these grids will be used to measure the degree of vulnerability to which users are exposed.

4. Results

4.1. Access to Water

Along with food and housing, drinking water is an essential pillar of quality of life. Access to drinking water can take two forms, according to the WHO definition. 5.8 billion people, or 73% of the world's population, have access to tap water for at least twelve hours a day, with the assurance that this water is - in principle - uncontaminated [40]. As the city of Pala lies on the Precambrian bedrock, it is difficult to reach the water table by traditional means. As a result, the borehole supplying the town's water tower is more than 20 km away. This situation means that the drinking water problem is the most recurrent in this town [41]. The results of our research show that only 15% of Pala's population has access to drinking water, compared with 70% who rely on traditional open wells, exposing them to the

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risk of water-borne diseases. The remaining 15% use sources such as rivers, temporary streams and other springs to meet their various needs.

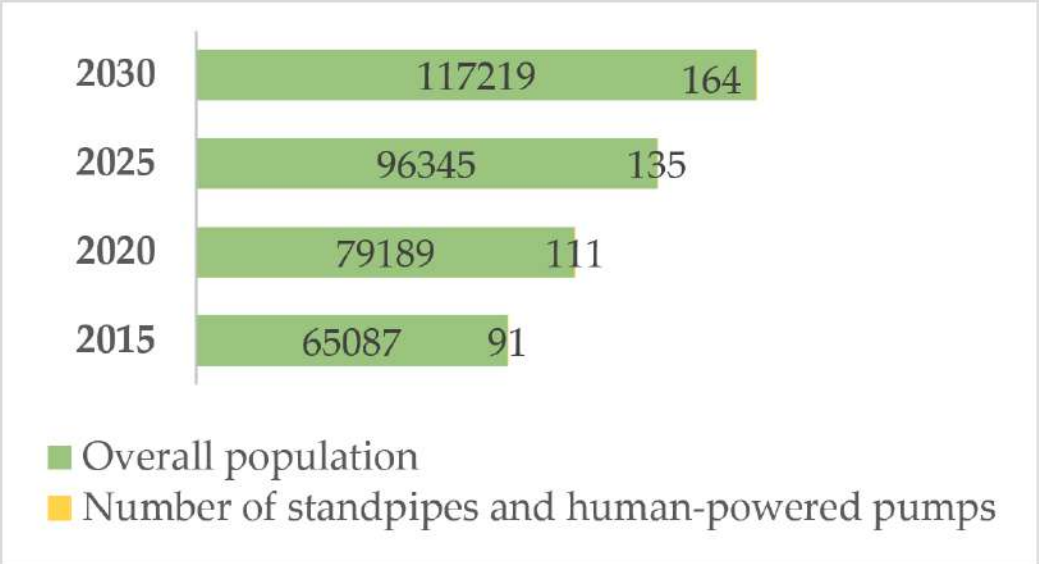

Figure 6.
PDC projection.

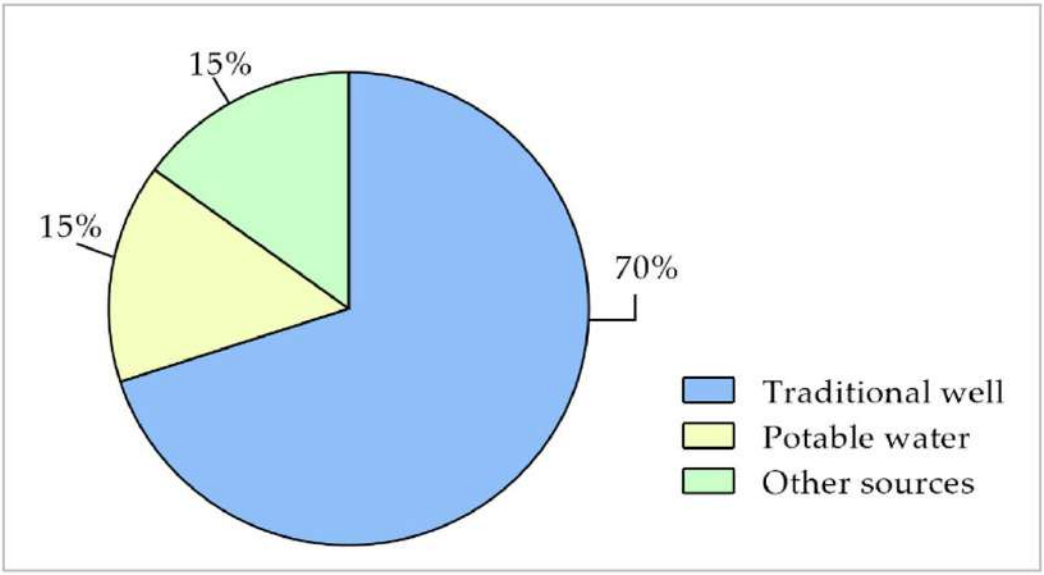

Figure 7.
Level of water service provided in Pala.

Figure 6 shows the projections contained in the urban planning documents in terms of years and population size, which are subject to change. Between now and 2030, some 164 standpipes, public fountains and/or human-powered pumps will be needed to satisfy a population of 117,219, excluding individual or household connections. Figure 7 shows the actual rates of access to drinking water in the study area, based on the data collected. It highlights the difficulties experienced by the State and its decentralized local authorities in implementing certain planning documents. This gap can be explained by limited resources and the economic situation in 2016 due to the fall in the price of a barrel of oil on

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the international market, thus weakening the national economy and slowing down the realization of certain projects. The photos below, on the other hand, give an overview of the water supply methods, ranging from human-powered pumps to other temporary sources, via traditional open wells. The photos below give an idea of the different ways in which drinking water is supplied in the town of Pala.

Figure 8.
Photo (a) shows a breakdown of a human-powered pump in an elementary school. Photo (b) shows a traditional open-air well used by the local population as a source of water. Lastly, photo (c) shows a non-functional standpipe threatened by water erosion in the town center.

4.2. Access to Sanitation

The results show that around 60% of the population of Pala uses the predominantly traditional type of toilet (sunken pit), compared with less than 10% who use modern septic tank latrines. As far as liquid sanitation is concerned, wastewater of all kinds is discharged directly into the street, due to the lack of a wastewater collection network. Only 5% of the population use cesspools to collect water. As far as water, hygiene and sanitation are concerned, the town of Pala is served by 24 boreholes and fountains and 5 traditional wells [41]. This is highly inadequate for the size of the population. In terms of rainwater drainage, only 2 canals have been built. As for hygiene, there are only 26 public toilets, which are less frequented as the majority of the population continues to defecate in the open air. This demonstrates the deplorable sanitation situation in this town [42]. The figures below further illustrate the situation.

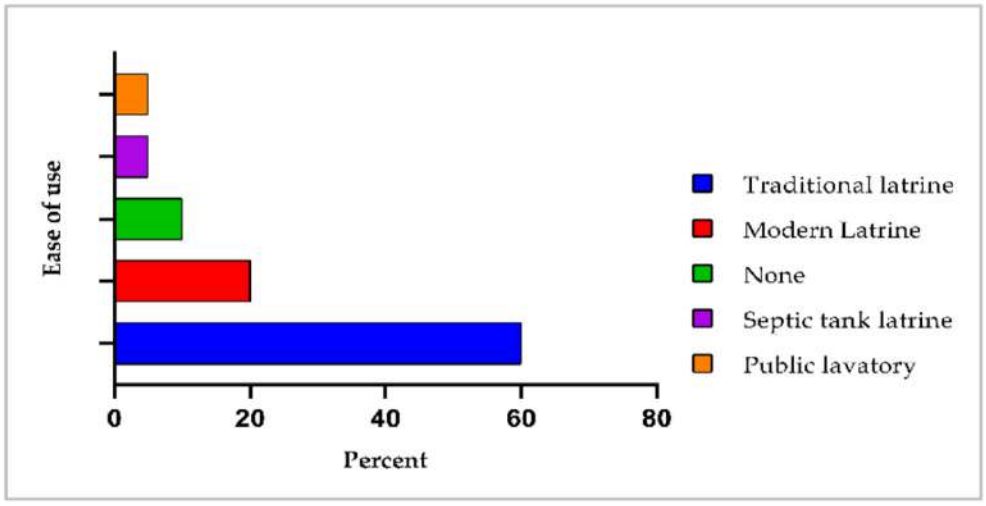

Figure 9.
View of the sanitation system.

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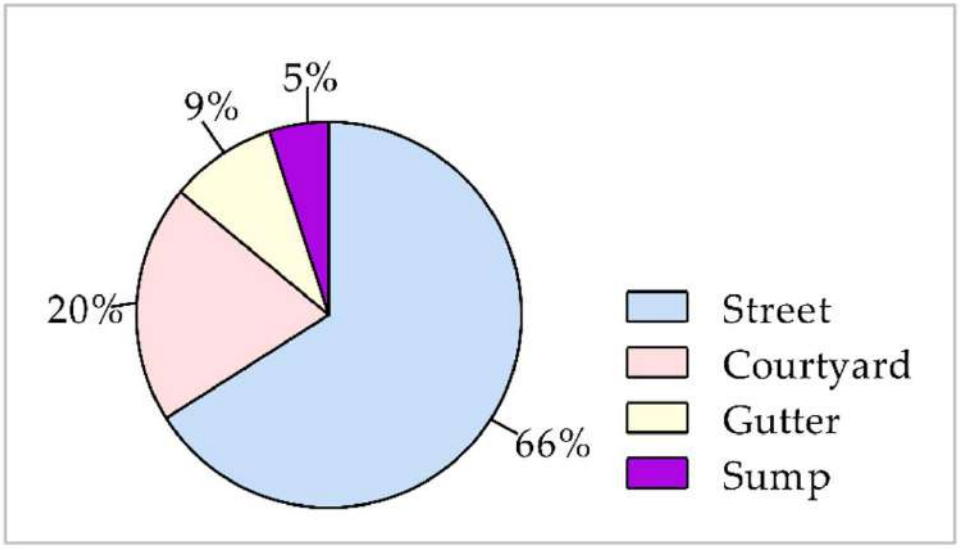

Figure 10.
Overview of the collective sanitation.

To illustrate the serious impact of landfills on the environment, the photos below show the discharge of all kinds of waste into the environment, as well as an authorized but poorly maintained landfill where incineration is still the method of disposal.

Figure 11.
Photo (a) shows an authorized dump, not maintained by the local authority, which finds it difficult to remove the waste and instead incinerates it on site. Photo (b) shows an unauthorized dump, a source of environmental pollution.

These unauthorized dumps are everywhere in the city, especially on the outskirts. Waste collected in the city around structuring facilities is transported and dumped in the wild, in less densely populated areas, without any precautions whatsoever.

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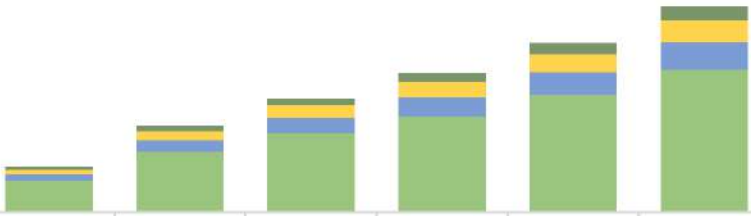
4.3. Access to Education

The results show that only 33% of Pala's population has access to quality education. Educational infrastructures are also in an advanced state of deterioration. 10% of Pala's educational infrastructure is in good condition, while 60% no longer meets needs effectively. Figure N°11 below highlights the projections made by experts in the field of education, taking into account UNESCO standards for class size in developing countries, which set this number at 50 pupils per class. The analytical Chi² test, with a degree of freedom of 15, gives a result of 9.35 and a P-value > 0.99 and therefore not significant. On the other hand, the ANOVA tests of Anderson-Darling (P-Value =0.47), Agostino-Pearson omnibus (P-Value= 3.51), shapiro-Wilk (P-Value= 0.96) and Kolmogorov-Smirnov (P-Value= 0.08) show increasingly significant results. All these normality tests have a P-value greater than 0.05. In other words, as the population increases, the frequency or fringe of the population to be enrolled increases according to the classes represented. The situation in 2023, however, is as follows, according.



	1993	2010	2015	2020	2025	2030
School-age population for higher education	2481	4699	6183	7523	9153	11136
Secondary school-age population	3891	7370	9698	11799	14355	17466
Primary school-age population	5092	9645	12692	15442	18787	22858
Total population	26115	49461	65087	79189	96345	117219

Figure 12.
Projection according to the municipal development plan.

The figure 12 shows a rapid and continuous increase in the total population as well as in school-age groups (primary, secondary, tertiary) between 1993 and 2030, reflecting strong demographic dynamics. This growth implies increasing pressure on education systems at all levels. These demographic trends indicate an urgent need for decision-makers to anticipate and strengthen the capacity of the education system. If no significant measures are taken, there is a great risk of seeing inequalities in access to education, the overloading of existing infrastructures, and the exclusion of a growing proportion of school-age young people.

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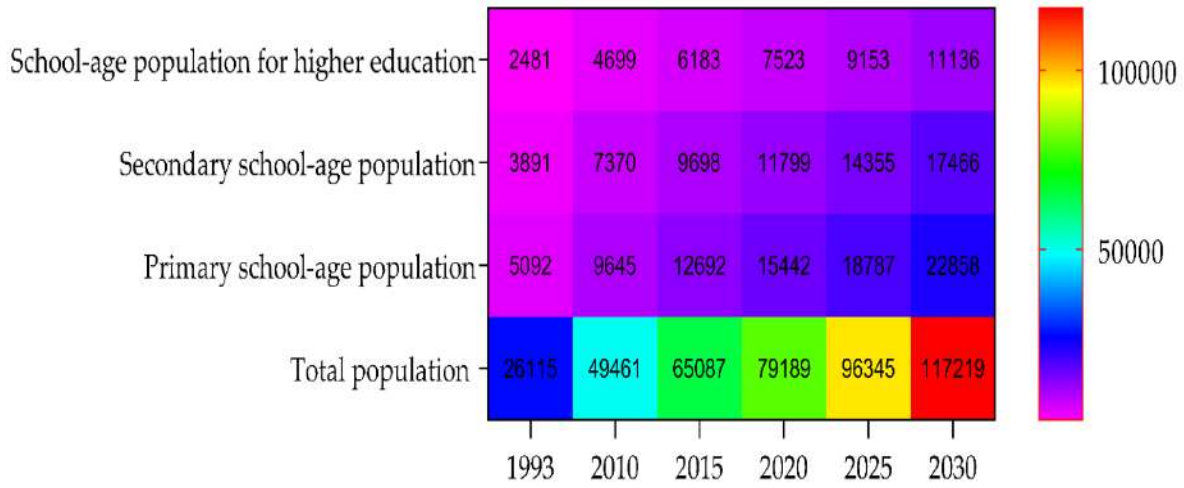

Figure 13.
Results of Chi² normality tests under heat map.

Despite these projections by the experts, UNESCO presents the educational results in Chad as unsatisfactory, and very glaring in the secondary towns. Particular emphasis is placed on the thematic areas of the KIX (Knowledge and Innovation eXchange) initiative for Africa. Educational poverty, i.e. the proportion of children unable to read and understand age-appropriate text by the age of 10, is estimated by the World Bank, UNESCO and other organizations at 94% [34]. The figures below show the proportion of the school-age population with or without access to adequate education (figure 14). Figure 13 gives an assessment of the buildings housing classrooms, which can be in good, average, poor or advanced disrepair (Figure 15).

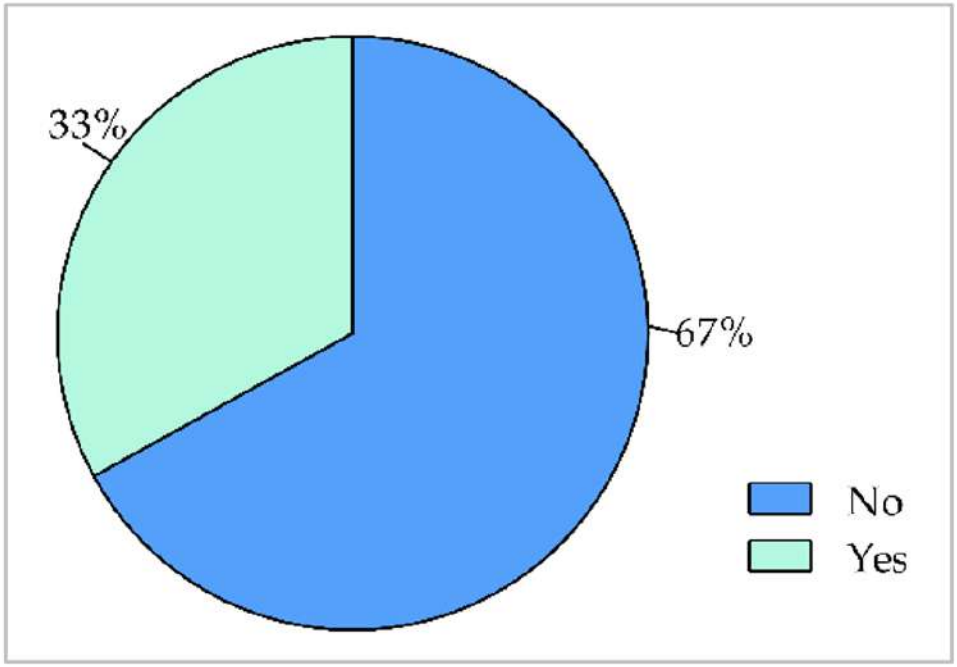

Figure 14.
Access to education.

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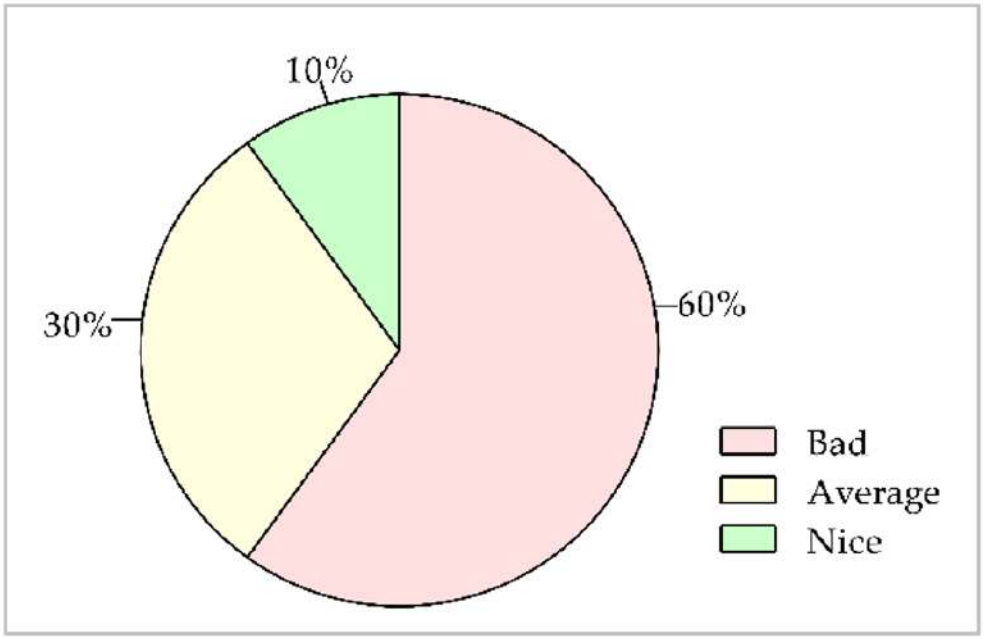

Figure 15.
State of infrastructure.

Based on other variables, the expected productivity of a child in adulthood is estimated in relation to the total productivity that could be expected from complete education and health. It is estimated that a child born in Chad and secondary towns today will only reach 30% of his or her potential. This figure is lower than the average for sub-Saharan Africa and low-income countries [43]. The photos below give an even clearer picture of the state of deterioration of the educational infrastructure in the town of Pala.

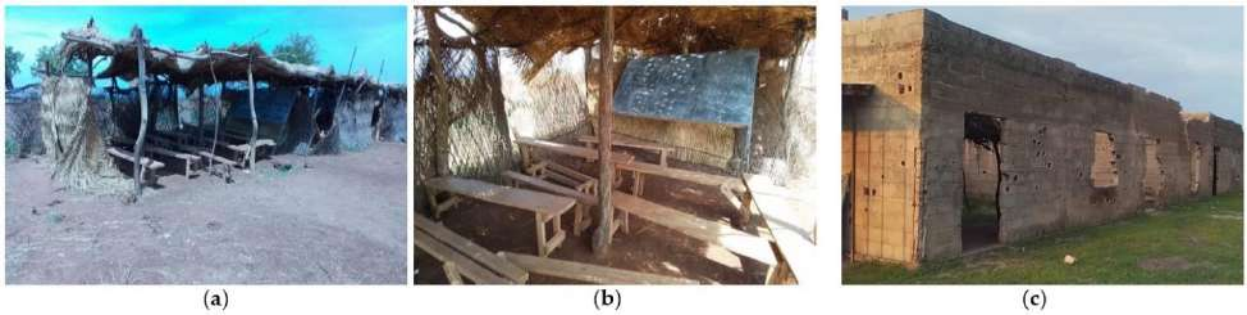

Figure 16.
Photos (a), (b) and (c) show the precarious state of the school infrastructure in Pala, which is no longer functional after the first rains.

These schools are also poorly equipped. Very few have latrines, boreholes or accommodation for teachers. Most of the existing infrastructure is dilapidated and in need of repair. Most of the commune's primary schools are under-equipped with furniture and suffer from a shortage of premises. Indeed, some classes are held in sheds [41]. The situation in this sub-sector can be summarized as follows: many older neighborhoods have no schools at all and community schools are almost all housed in straw sheds.

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4.4. Access to Healthcare

Access to health services in sub-Saharan Africa, and Chad in particular, is a complex issue that raises many questions about inequalities, the effectiveness of health systems and the role of social protection [44]. Our results show that around 25% of the population of the town of Pala has access to an adequate health service. The remaining 75% turn to traditional medical practices, due to lack of means or the distance from their homes to the hospital, which is more than 10 km from certain districts, such as Madagascar in the second arrondissement. The hospital has only two ambulances, one of which has broken down, and therefore does not have the capacity to offer a better quality of service to all users. Figure 17 below gives an overview of the bangs of the population that have access to an adequate health service, and on the other hand, a range that does not have access to the same service.

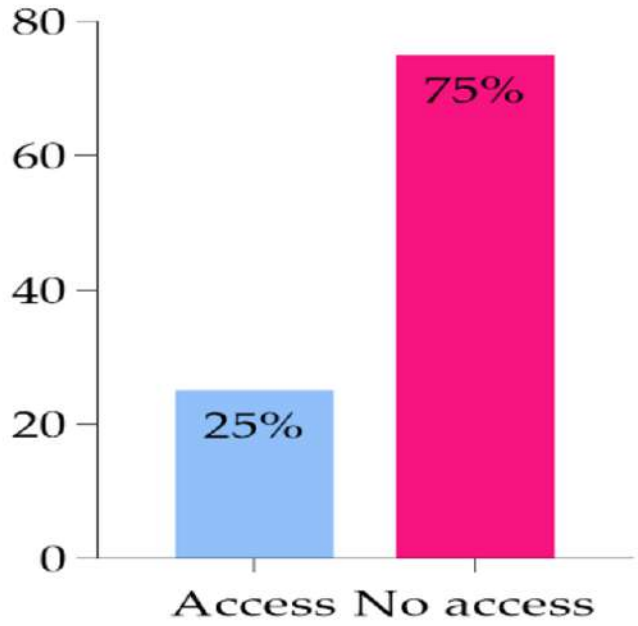

Figure 17.
Access to appropriate health care services.

4.5. Energy, Transport and Mobility

Chad has one of the lowest rates of access to electricity in the world. Around 11% of the population has access to electricity, and this figure is even lower in rural areas, where less than 5% of inhabitants have access to modern energy sources [45]. Most Chadians rely on traditional fuels, notably firewood and charcoal, for cooking and heating. This dependence has implications for public health and the environment, as the burning of these energy sources contributes to deforestation and air pollution [46]. Despite forecasts, the situation in the town of Pala remains critical. The city is not electrified, and efforts are focused on the use of solar energy, personal generators and other energy sources. Around 41% of the population use solar power, while 16% still use old-fashioned kerosene lamps. Torches and battery-powered lamps are used in outlying areas and new, fast-growing neighborhoods. Candles and wood fires are the old lighting methods, still used by 4% and 2% of the population respectively. However, figure 18 shows the breakdown of energy consumption by type of use in the city of Pala. According to the results, over 41% of this population uses solar lamps to compensate for the lack of electrical power in the city. This threshold is less than 5%, as there is neither electrification nor electricity poles in the town. This exacerbates or exposes the population to extreme vulnerability, which can reach a scale of 8/10.

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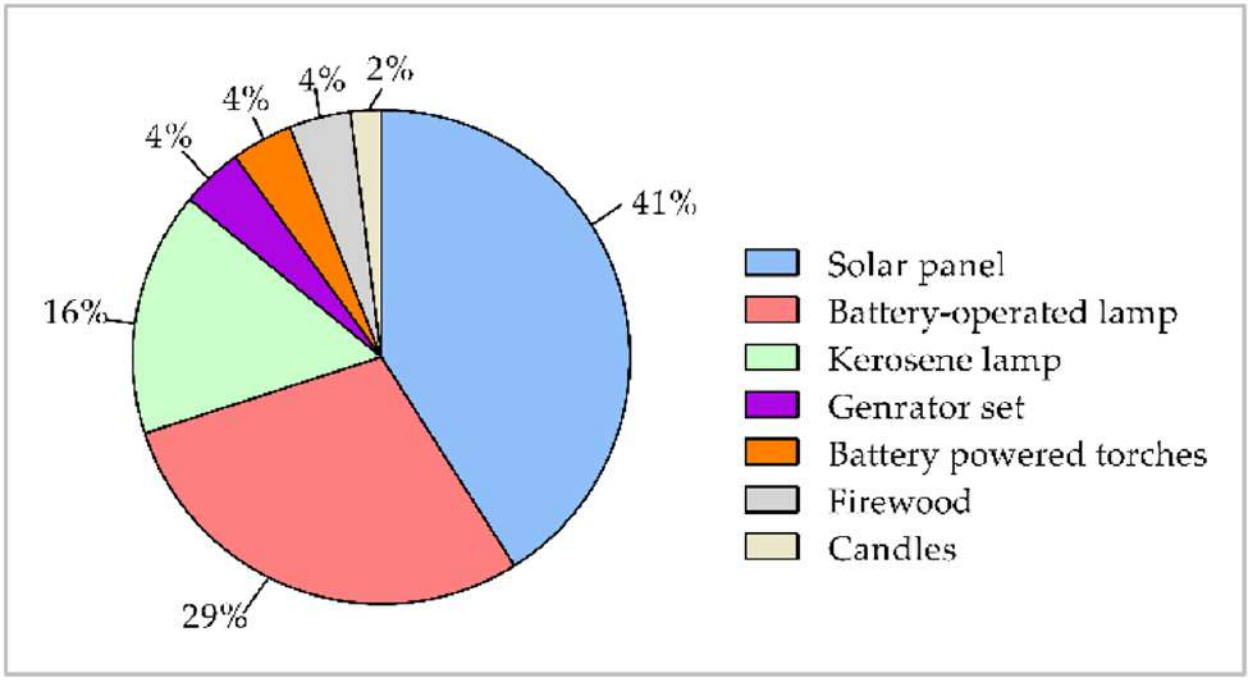

Figure 18.
Access to energy in Pala.

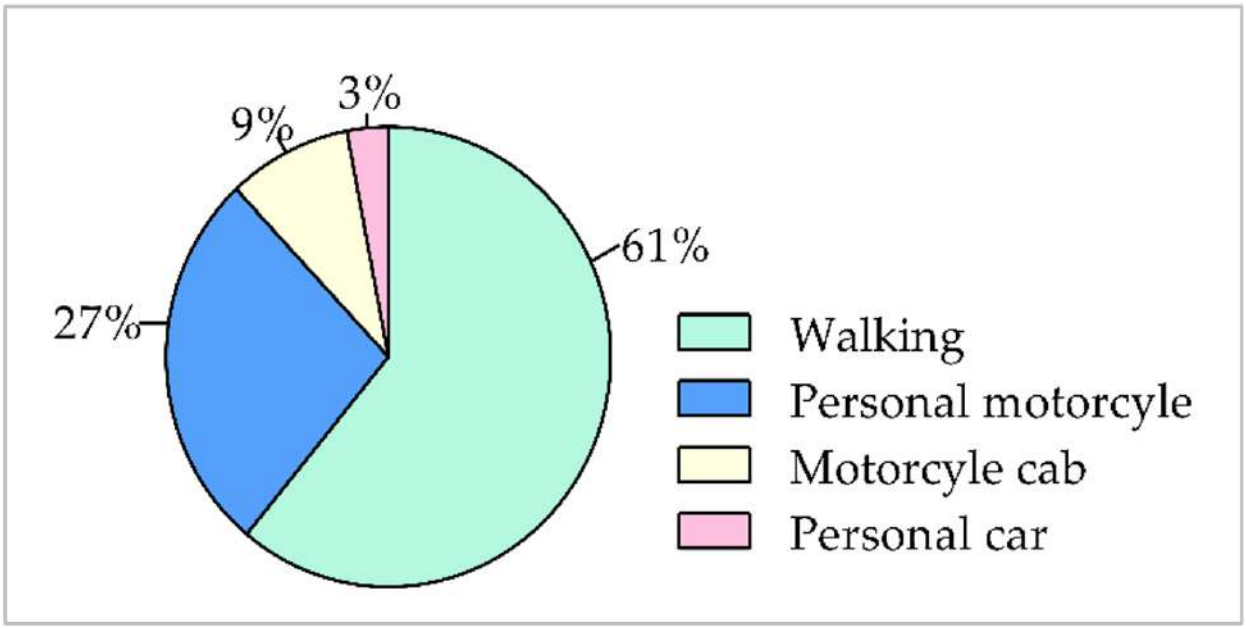

Figure 19.
Different modes of transport in Pala.

Apart from the main roads linking the capital to the towns of Sarh and Pala, in the south, and Abéché (in the east), overland communications are in poor condition throughout the country, and often impassable during the rainy season, particularly in the south. Flooding is frequent. The north of the country has no reliable land routes, and the presence of mines is a constant danger [25]. The results

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(figure 19) show that there is no public transport system of any kind, and the most common mode of transport is walking. In the absence of public transport, walking (61%) and the use of personal motorcycles (27%) remain the most common means of transport. Motorcycle cabs are little used due to their cost and the lack of security in the area.

4.6. Access to Road Infrastructure

The expansion of the road network has diversified Chad's options in terms of trade routes to neighboring countries and ports. As in other landlocked African countries, transport costs account for 50% of the value of exports; better roads will reduce this economic burden [47]. The town of Pala does not have an asphalted road network. Road infrastructures are often exposed to water erosion and impassable during the heavy rainy season [48]. The photos below further illustrate the state of these roads during the rainy season, forcing the local population to be absolutely resilient.

(a) (b) (c)

Figure 20.
The photos (a, b and c) show just how vulnerable the city's main thoroughfare is during the rainy season. Neighborhood roads are not spared either.

In most cases, this road malfunction results in longer travel times during the rainy season between Kelo and the town of Pala. The figure below gives a comparative overview of travel times between the dry and rainy seasons.

The situation remains critical between July and September, a period of heavy rain that makes travel difficult, taking up to five (5) hours to cover 109 km. The situation only returns to normal between October and December, after the heavy rains. At times, these disruptions impact on the local economy and even the safety of users.

5. Discussion

In 2030, according to data from the communal development plan, around 164 standpipes are needed to satisfy the 70% of the population of the town of Commune de Pala [41]. With a threshold of 15% of service provided, these results are in line with studies by Ayeb and Ruf [49] who conclude that people deprived of access to improved water and sanitation services are less likely to realize their potential and thus satisfy all their needs. According to the WHO, 700 million people have no access to drinking water, and 300 million have to walk more than 30 minutes round trip to reach a drinking water point. This is a very arduous task, most often carried out by women and girls. A similar number have access to a well or non-potable spring, and 115 million (1% of the world's population) have to drink surface water (rivers, ponds, etc.). In the latter two cases, the risk of illness is considerable, particularly for young children [50]. According to the UN water report, it takes around 40 L/day/person to satisfy the needs of populations living in Sahelian countries, yet in the town of Pala, only 3/10 have access to drinking water. The city's water distribution system is a so-called “sector system”, which involves distributing

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water to neighborhoods in turn. These results also correlate with the work of Kanyangarara, et al. [51] who point to migration as the accumulated pressure on existing infrastructures, which are often insufficient to meet the needs of the growing population. This point is also made by Jaglin [52] whose study distinguishes the critical situation in slums. Faced with this vulnerability in secondary towns, Diouf, et al. [40] point out that contaminated water is a major source of water-borne diseases, such as cholera and diarrhoea, which particularly affect children. Studies show that improving access to drinking water could significantly reduce the morbidity and mortality associated with these diseases [53]. The use of sustainable technologies, such as rainwater harvesting systems and wastewater treatment plants, is also essential [54].

Access to sanitation facilities is a persistent problem in many secondary towns in sub-Saharan Africa [21]. They develop that, in addition, medium-sized cities often suffer from greater deficits in infrastructure and services. Once again, these findings converge with our own. The city of Pala has no functional sewage disposal system, as the collection networks are outdated. Less than 2% of city dwellers have sanitary facilities with running water. There is no system for disposing of excreta and household waste, no solid waste treatment system, and no (or very few) rainwater drainage systems. Hospitals and health centers have no infrastructure in good working order (incinerator, treatment plant, etc.) [41]. All these studies converge to describe how important sanitation is in secondary towns in Chad. And despite this, we must highlight the efforts of World Vision, which has helped 29,000 people in Chad gain access to drinking water, and 34 communities have been certified free of open defecation in 2019 [35].

In Chad, access to education is limited, with relatively low enrolment rates, especially in rural areas. According to recent data, around 70% of school-age children are enrolled in primary education, but this rate declines as one moves up the educational ladder (secondary and higher education) [32]. There is a marked geographical disparity in access to education. Urban areas, such as the capital N'Djamena, generally have better school infrastructures and easier access to educational resources. In contrast, rural areas are often neglected, with a lack of schools and qualified teaching staff [55]. The quality of education suffers from a number of problems, including a lack of teaching materials, inadequate infrastructure and insufficiently trained teaching staff.

These analyses are in line with our findings that the main obstacles to access to basic education in Chad are political and legal challenges, poor infrastructure, weak institutions, culture, religion, ethics and corruption. These findings are also supported by the report on Chad's National Education Policy (CNEP). The priority given to education by Chad, and consequently to its teachers, is confirmed by the orientations of the National Development Plan (PND 2017-2021) and the Interim Education Plan (PIET 2018-2022), which recognize the impact of education on the country's development.

According to Patouki, et al. [48] inequalities between urban and rural areas are marked, with access to health services generally better in urban areas. Indeed, barriers to access to healthcare include physical distance to health facilities, cost of services and lack of qualified personnel. Health infrastructures often lack essential resources such as reliable electricity, limiting their ability to provide adequate care [36]. In addition, discriminatory attitudes and lack of awareness of available services are further obstacles. These findings converge with our own in terms of the equidistance that needs to be taken into account when programming spaces for public facilities.

Chad's Energy Pact aims to significantly increase electricity generation capacity from renewable sources (30% by 2030) and to accelerate the rate of access to electricity and clean cooking to 15% and 5%, respectively, by 2030 [56]. The private sector will play a key role in achieving these goals, with the ambition of mobilizing a contribution of US$650.3 million in private investment for electrification in power generation, transmission, distribution as well as decentralized renewable energy (DRE) and clean cooking solutions. The government is committed to implementing the action plan included in the Pact in order to eliminate bottlenecks in the energy value chain and help mobilize the financing needed to provide reliable, affordable, inclusive, sustainable and clean energy, and contribute to the economic growth and development of the country and the region [57].

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In Chad, as elsewhere in sub-Saharan Africa, governmental frameworks are struggling to implement effective transport policies that are accessible to a fast-growing population, largely affected by poverty and undergoing rapid urbanization [58]. In many sub-Saharan cities, transport infrastructure is inadequate and poorly planned, limiting mobility options for residents, particularly the poorest [59]. According to Satterthwaite [22] urban mobility is another crucial aspect of basic urban services. To make up for these shortcomings, the private sector is a reliable recourse thanks to the resources offered by artisanal transport. After the well-known success of mototaxis or "clandos", recent years have seen the rapid spread of another light means of transport, the rickshaw, which is now used in the majority of urban centers [11]. All these results converge with our studies when it comes to emphasizing the precariousness of the urban transport system in the city of Pala.

In terms of road infrastructure, the most glaring problem is that the town's streets are not laid out. The few streets that are laid out are not maintained and traffic in the city is very difficult [41]. Launched in January 2017, the project (construction of the town's main road), worth almost 71 billion francs (around 106 million USD) and co-financed by the Banque de Développement des États de l'Afrique Centrale (BDEAC) and the Chadian government, had been halted due to insufficient funding [60]. The 109-km road is intended to interconnect regions in the south-west of the country. It is also an integral part of the network linking Chad to Cameroon. In its current state, the road is mainly made of earth, which makes travel difficult for users, especially during the rainy season. The section is a major piece of infrastructure which, according to BDEAC, will help to open up the region, which has significant agricultural potential [42]. Completion of the road will also stimulate regional integration by intensifying trade between landlocked Chad and its neighbor Cameroon, a key player in its supply chain [60]. Added to this is the lack of housing in many districts. Many districts have no cadastral plan (9/24 districts) [48]. The few districts that do have a cadastral plan are not urbanized, and people are building without taking into account state reserves [47]. Linking Pala to other towns in Central Africa, it is clear that similar challenges exist in terms of access to road infrastructure. This underlines the importance of a regional approach to sustainable development and infrastructure management, where lessons learned from one city can be applied to others to improve living conditions for residents. Our results show that, in recent years of climate disruption, the situation is becoming increasingly worrying. These results correlate with the work of the African developpment bank group [42] which further explains the importance of roads for trade and other services.

6. Conclusion

Access to basic urban services in Chad's secondary cities, such as Pala, is fraught with complex challenges, illustrating the need for structural reforms. Studies carried out across sub-Saharan Africa show that the challenges of access to essential services are often similar and linked to the dynamics of uncontrolled urban growth and inadequate urban management. For example, in cities such as Accra in Ghana, poor urban planning has led to limited access to drinking water and basic sanitation. According to Agyeman, et al. [61] this exacerbates public health problems in urban areas. Similarly, in Nairobi, Kenya, informal settlements suffer from a lack of adequate services, underlining the importance of inclusivity in urban planning [62]. These examples illustrate that similar gaps exist in Pala's urban management, where services such as water, sanitation and health are often underdeveloped, contributing to precarious living conditions. In addition, studies such as those by Ullah, et al. [63] show that urban policies must be adapted to local contexts to be effective. This research indicates that initiatives that incorporate community participation and local knowledge are more likely to be sustainable. For example, the integrated water resource management program in Ouagadougou, Burkina Faso, has significantly improved access to water for vulnerable populations through a participatory approach. For Pala, this means learning from the successes and failures of other cities in sub-Saharan Africa. By implementing participatory strategies, building the capacity of local authorities, and mobilizing adequate financial resources, it is possible to transform Pala's urban landscape and improve access to basic urban services. The example of Pala, as well as those of other cities in sub-

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Saharan Africa, illustrates the need for an integrated and holistic approach to sustainable urban development, addressing the needs of all citizens and contributing to the reduction of poverty and inequality. Finally, this study underlines the urgent need for increased funding and coherent policies to strengthen infrastructure and improve access to essential services [64]. Investing in sustainable infrastructure projects, while taking into account the specific needs of vulnerable populations, is essential for developing urban resilience in line with contemporary challenges.

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Transparency:
The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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