

Assessment of Water Poverty Index in Lokoja and its Environs, North Central Nigeria

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ABSTRACT

Lokoja, despite being a town situated at the confluence of Rivers Niger and Benue, experiences severe water shortages. Hence, the study aimed at assessing water poverty index in Lokoja and its environs, using the Balanced Approach. A multistage method of data collection was used to obtain data for the study through the use of a structured questionnaire. A total of 203 respondents were selected for the study. Descriptive statistics was used to summarize the data obtained. The results show that traditional Lokoja neighbourhoods have the highest WPI of 84% which indicate low water poverty. However, WPI scores for Felele and Ganaja (40% each), Zango (9%), Chari Megumeri Barracks neighbourhood (16%), Adankolo (15%), and Lokongoma (22%) indicated severe water stress. The study recommends expansion of available water treatment plant to reflect the increasing demand for improved water supply, enforcement of environmental laws to improve environmental integrity, public enlightenment against vandalization of pipe borne water facilities. In addition, the use of rain water harvesting, water storage tanks as well as water cycling is encouraged.

Keywords: Confluence, data, Lokoja, Water Poverty Index.

1. INTRODUCTION

The current world population of 7.6 billion is expected to reach 8.6 billion in 2030 and will rise up to 9.8 billion in 2050, and 11.2 billion in 2100 with roughly 83 million people being added every year (Makarigakis and Cisneros, 2019). The ascending trend in the world population along with an improved quality of life is expected to continue and with them the demand for water globally (Makarigakis and Cisneros, 2019). Water use is expected to rise as the rate of population increases. For example, agriculture accounts for 70% of the fresh water withdrawals as food production increased by 100% and more food will be needed by 2050 to meet the requirements of the growing population (Food and Agriculture Organisation, 2017). This will increase the production of irrigated food by

more than 50% in 2050 and thus, the amount of water usage by agriculture will be increased by 10% (FAO, 2017). Additionally, global water demand for the manufacturing industry is expected to increase by 400% from 2000 to 2050 leading all other sectors with the bulk of this increase occurring in developing countries (United Nations Educational Scientific and Cultural Organization, 2015).

Over the past several decades, the ever growing demands for, and misuse of water resources have increased the risk of pollution and severe water stress in many parts of the world. This has serious implication for public health, environmental sustainability, food and energy security, and economic development. Water scarcity is believed to be one of the most remarkable problems of

global concern in the 21st century. Globally, it is estimated that about 1.1 billion people lack access to improved and sanitised water supply with the lowest coverage in Sub-Saharan Africa and Asia and thus posing a privation to human dignity and lives (United Nations, 2006; UNISDR, 2015). Moreover, poor access to improved water supply remains the genesis of high morbidity and mortality (among children under five) and other water related health diseases. UN (2018) reported that in Nigeria, lack of access to improved water and sanitary conditions increased the risk of waterborne diseases such as diarrhoea which causes the death of more than 7000 children under the age of five annually.

Furthermore, the continuous deterioration and destruction of water infrastructure is increasingly posing a serious threat to improved water supply and sanitation. Kingdom *et al.*, (2006) found that about 45million cubic litres of portable water are lost daily in developing countries through water leakages in the distribution networks. In addition, Guppy and Anderson (2017) reported that the world economic forum ranked the water crises in the top three of global risks for three consecutive years and thus, failing to respond to these challenges will have a devastating effect on public health. Against this background, water related development challenges have received increasing global attention and therefore formed the centre of recent landmark agreements of numerous international symposiums such as the United Nations Millennium Summit (2000), United Nations World summit in the year 2002 in Johannesburg, Sustainable Development Goals (UN, 2015), the Sundai Framework for Disaster Risk Reduction (UN, 2015) and the Paris Agreement.

Tools advanced for assessment of water resources development include Water Poverty Index (Sullivan, 2002) and water

accounting and auditing (Batchelor *et al.*, 2017). Water Poverty Index (WPI) is an interdisciplinary decision making tool which incorporates output from both physical and social sciences within an integrated model. It advances the existing frame work explicitly by linking the socio-economic indicators of poverty with water resources assessments to enable identification of those communities where poverty may be closely connected to water stress (Sullivan *et al.*, 2002).

Although Lokoja is a confluence city situated on the bank of River Niger, the town experiences chronic water shortages. Yusuf and Agabe (2010) found that water supply and distribution in Lokoja Township is inadequate. Additionally, Lokoja being the state capital and administrative town witnessed massive population influx since 1991 when Kogi State was created. This massive and rapid population influx has placed more pressure on the existing water distribution system as Abenu *et al.*, (2016) noted that, even with the introduction of Lokoja Greater Water Scheme in 2011, access to portable water supply was unequal with planned neighbourhoods having greater access than unplanned neighbourhoods. A reconnaissance survey revealed various forms of environmental degradation within the study area, with refuse being dumped in gutters, backyards, rivers, open defecation in rivers and discharge of sewerage into water bodies which increase the risk of water pollution in the area. A water quality assessment, conducted in Ganaja village within the study area by Chiazor *et al.*, (2016) revealed that the hardness of the water sampled from river, hand dug well and borehole were above the threshold level of the World Health Organisation. Furthermore, rapid increase in the number and growth of slum areas coupled with inadequate infrastructural facilities in the town pose a serious threat to water resource management. These slum communities tend to poor, less

educated and worse affected by water scarcity and sanitation problems (Zahra *et al.*, 2012).

Several studies have been carried out on water resource management in the study area. However, they are limited to ground water and surface flow characteristics (Apeh, 2014), water supply and distribution (Abenu *et al.*, 2016; Yusuf and Agabe, 2010), water quality assessment (Ayuba *et al.*, 2013; Jacob, 2015; Saidu, 2015; Chiazor *et al.*, 2016), and domestic water consumption pattern (Oyesanmi, 2017). This means, knowledge on the connection between physical estimates of water quantity, quality and variability as well as socio-economic variables is grossly inadequate. It is against this backdrop that, this paper aimed at assessing water poverty index in Lokoja and its environs, with a view to providing a framework water resource management in the study area.

2. MATERIALS AND METHODS

2.1 Study Area

Lokoja is located between latitudes 7° 45'N - 7° 51' North and longitudes 6° 41'E – 6° 45' East (Figure 1). The climate is tropical wet and dry of the Koppen's classification (Alabi, 2012). It is characterised by distinct wet and dry seasons. The mean annual rainfall is about 1213.22mm (Audu *et al.*, 2018) the rain begins on average in March and peak in June to September. The annual mean temperature scarcely falls below 27.7°C with the hottest temperature of 34 – 40°C occurring in March, just before the onset of the rains in April. Relative humidity of over 95% at 0600 hours to 70% at 1200 hours is typical in the rainy season.

The relief of the area is that of undulating plains and pockets of lofty hills while the

geology consists of cretaceous sediments capped by lateritic iron stones resting on the floor of uneven basement complex rocks (Ologe, 1985). The city is drained by river Niger and river Meme which is a tributary to the former. The soil in the study area is hydromorphic with a poor drainage system (Jaiyeoba, 2015). The vegetation is Guinea Savannah with the presence of gallery forest by water courses which has been severely altered by man. The town has a population figure of about 45,122 in 1991 (National Population Commission NPC, 1991) which sharply rose to 181,369 in 2017 as projected by National Population Commission (2017).

2.2 Sampling Procedure and Methodology

A multistage sampling technique was employed in this study. The first stage involved a purposeful selection of traditional Lokoja neighbourhoods (Adankolo, Lokongoma, Felele, Zango, Chari Megumeri Barracks neighbourhoods and Ganaja). The simple random sampling method was used to select respondents for the study, using Yamane (1967) formula, which is given as;

$$n = \frac{N}{1+N(e)^2} \dots\dots\dots 1$$

Where; n = sample size, N = study population, e = the margin error (0.07), 1 = constant.

The Water Poverty Index consists of five major components of Resource (R), Access (A), Capacity (C) Use (U) and Environment (E) and a subcomponent as outlined by (Sullivan, *et al.*, 2002). The scores of each component were generated using the following formula as presented in Table 1.

Balanced approach was adopted in this study because it gives equal weight to every aspect of the index and to all the subcomponents.

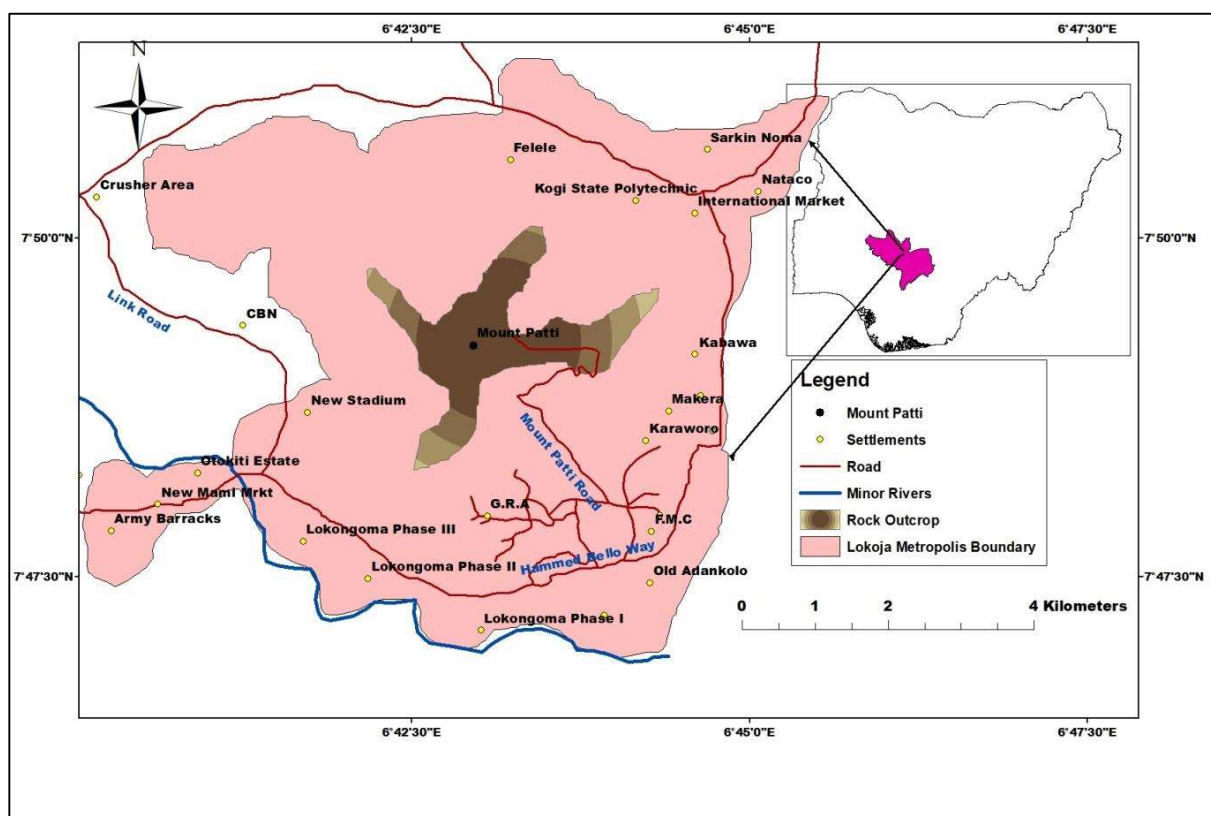


Figure 1: Geographical Location of the Study Area
Source: Adapted and Geoprocessed from Oyesanmi (2017)

Table 1: Components and Subcomponents of Water Poverty Index

Components	Subcomponents
Resources	$R = \frac{X_a - X_{min}}{X_{max} - X_{min}} \times 100 \dots\dots\dots 2$ <p>Where: X_a = annual average rainfall X_{min} = average minimum X_{max} = average maximum</p> $T_i = \frac{X_t}{X} \times 100 \dots\dots\dots 3$ <p>Where: T_i = population who treat their water supply X_t = population who treat their water X = sample population</p>
Access	$A_1 = \frac{X_w}{X} \times 100 \dots\dots\dots 4$ <p>Where: A_1 = access to safe water X_w = population with water supply</p>

	<p>X = sample population</p> <p>$A_2 = \frac{X_p}{X} \times 100$.....5</p> <p>Where:</p> <p>A_2= proportion. of people with piped water throughout home</p> <p>X_p= population with piped water supply throughout home</p> <p>X = sample population</p> <p>$A_3 = \frac{X_s}{X} \times 100$.....6</p> <p>Where:</p> <p>A_3= access to sanitation</p> <p>X_s= population with sanitation facilities</p> <p>X = sample population</p> <p>$A_4 = \frac{X_{is}}{X} \times 100$.....7</p> <p>Where:</p> <p>A_4= proportion of people with indoor sanitation</p> <p>X_{is}=population with indoor sanitation facilities</p> <p>X = sample population</p>
Capacity	<p>$C_1 = \frac{X_{di}}{X} \times 100$.....8</p> <p>Where:</p> <p>C_1= proportion of people who own durable item</p> <p>X_{di}= population who own durable items</p> <p>X = sample population</p> <p>$C_2 = \frac{X_l}{X} \times 100$.....9</p> <p>Where:</p> <p>C_2= population of people who own their own land</p> <p>X_l= population with ownership of land</p> <p>X = sample population</p> <p>$C_3 = \frac{X_{hc}}{X} \times 100$.....10</p> <p>Where:</p> <p>C_3= proportion of population with access to health care</p> <p>X_{hc}= population with access to health care services</p> <p>X= sample population</p> <p>$C_4 = \frac{X_e}{X} \times 100$.....11</p> <p>Where:</p> <p>C_4= proportion of people with at least primary school education</p>

	X_e = population of people with at least primary school education X = sample population
Use	$U_1 = \frac{X_{wc}}{X} X 100 \dots\dots\dots 12$ <p>Where: U_1= proportion of population who conserve water X_{wc}= population who conserve water X= sample population</p> $U_2 = \frac{X_c}{X} X 100 \dots\dots\dots 13$ <p>Where: U_2= proportion of population reporting conflict X_c= reports of conflict X = sample population</p> $U_3 = \frac{X_{ir}}{X} X 100 \dots\dots\dots 14$ <p>Where: U_3 = proportion of people who practice irrigation X_{ir}= population who practice irrigation X = sample population</p>
Environment	$E_1 = \frac{X_d}{X} X 100 \dots\dots\dots 15$ <p>Where: E_1= proportion of people reporting deforestation X_d = population of people reporting deforestation X= sample population</p> $E_2 = \frac{X_{se}}{X} X 100 \dots\dots\dots 16$ <p>Where: E_2= proportion of people reporting soil erosion X_{se}=population reporting soil erosion X = sample population</p> $E_3 = \frac{X_{cl}}{X} X 100 \dots\dots\dots 17$ <p>Where: E_3= proportion of people reporting crop losses X_{cl}= population of people reporting crop losses X = sample population</p> $E_4 = \frac{X_{ew}}{X} X 100 \dots\dots\dots 18$ <p>Where:</p>

	E_4 = proportion of people who believe that water is important to themselves as it is to the environment X_{ew} = population who believe that water is important to themselves as it is to the environment X = sample population
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The final value of the WPI value was determined using Sullivan *et al.*, (2002) formula with a little modification to ensure that all the five components and subcomponents were captured.

Thus, WPI =

$$\sum_{i=1}^N wiSubC = \sum_{i=1}^{N_1} wiRi + \sum_{i=1}^{N_2} wiAi + \sum_{i=1}^{N_3} wiCi + \sum_{i=1}^{N_4} wiUi + \sum_{i=1}^{N_5} wiEi.....19$$

Where;

$SubC_i$ = are all the subcomponents used under resource, access, capacity, use and environment.

R_i = all the sub components used under resource

A_i = all the sub components used under access

C_i = all the sub components used under capacity

U_i = all the sub components used under use

E_i = all the sub components used under environment

N_2 = is the total number of sub components used in obtaining access

N_3 = is the total number of sub components used in obtaining capacity

N_4 = is the total number of sub components used in obtaining use

N_5 = is the total number of sub components used in obtaining environment

w_i = is the weight associated with each component which is subject to the following constraint.

Furthermore, WPI scores were conformed to Guppy (2014) classes of water poverty index of 0-47.9, 48.0-55.9, 56.0-61.9, 62.0-67.9, and 68.0-100.0 which represents severe, high, medium, medium low, and low water poverty respectively. Data collected were summarized using descriptive statistics.

3. RESULTS AND DISCUSSIONS

The results of WPI are summarized and presented in Table 2.

The result shows that traditional Lokoja has the highest WPI value of 84% followed by

Table 2: Water Poverty Index Values for Lokoja Town and its environs

Area	Resource	Access	Capacity	Use	Environment	WPI (%)
Traditional Lokoja Neighbourhood	45.4	137	87	64	87.8	84
Felele	21.4	50	53	29	44.4	40
Ganaja	13.4	88	22	27	50.3	40
Zango	2.4	15	11	03	11.9	09
Army Barracks neighbourhoods	1.4	35	14	12	17.7	16
Adankolo	7.4	30	14	07	14.8	15
Lokongoma	4.4	52	19	11	22.3	22

N_i = is the total number of subcomponents used in obtaining resource

Felele and Ganaja with 40% respectively. The result further shows that Lokongoma

community has 22% while Chari Megumeri Barracks neighbourhood has 16%, Adankolo has 15% and Zango has the least with only 9%.

3.1 Low Water Poverty

Traditional Lokoja neighbourhood (consisting of localities such NEPA site, Obasanjo Square, Madabo, Kabawa, Old Market, Galilee, and Nataco) is the only area which falls within the low water poverty category with the WPI score of 84%. This high score is as a result of the fact that except the resource base with 45.4%, all the other components had high scores. This is shown in capacity (87%), use (64%), access (137%), and environment (87.8%). High access may be due to the fact that the area is the commercial heart of the city where the two prominent markets (Old market and the new market, known also as Kasuwan Dole) as well as several shops and local industries like ceramics and shoe making industries are located. These are sources of income which potentially increase the livelihood of the residents in the study area. This corresponds with the findings of Paul and Oyebamiji (2014) that presence of economic activities suggest access to various sources of income that can improve people's livelihood. High scores for environment may be attributed to the presence of the floodplain areas of River Niger. This wet land is used for irrigation farming and grazing especially in the dry season, thereby increasing food sufficiency and sustainable livelihoods in the area.

3.2 Severely Water Poor

All other areas (Felele, Ganaja, Zango, Chari Megumeri Barracks neighbourhood, Lokongoma, and Adankolo) fall within this category. These areas are characterized by very weak resource base. For Felele, the severe water stress may be attributed to a weak resource base of 21.4%, use 29%, environment 44.4%, and high medium scores for capacity (53%) and access (50%). Low

water use in this area revealed low industrial and agricultural activities in the area and this indicate restricted sources of income and hence inability to lobby for and maintain water resource projects in the area. Field observations indicate that substantial parts of the area are occupied by students of Kogi State Polytechnic who depend on their parents for sources of livelihood.

In Ganaja village, even though access to water is as high as 88% and high medium environmental score of 50.3%, resource base, capacity and water use were low at 13.4%, 22% and 27% respectively. High access was attributed to the presence of the town's water treatment plant in the area. However, the low resource base, low capacity and low use are attributed to the nature of people living in this area being mostly agrarian living in the urban fringes with low level of income, and education and unable to maintain the infrastructure put in place which eventually confounded the water stress in the area.

Zango is severely water poor with low scores for resource score (2.4%), capacity (11%), use (03%), access (15%) and environment (9%). This situation is due to the fact that the area is located on the outskirts of the town and it is politically located under a different Local Government Area which deprived the area of all the urban infrastructural services enjoyed by the state capital including improved water supply. This has resulted in the provision of water by individuals through hand dug wells, bore holes and water vendors. This suggests that a part of the respondents' income is being expended on unimproved water supply, which makes the respondents vulnerable to poverty.

The Chari Megumeri Barracks neighbourhood is the area with the lowest resource base (1.4%) due to lack of pipe borne water supply in the area. The public water system in this area is from a single bore hole serving the entire area. Other sources of

water include hand dug wells and bore holes mainly provided by individuals in their respective compounds. This situation in addition to low capacity (14%), low water use (12%), low access (30%), and low environmental integrity (17.7%) indicate severe condition of water scarcity.

The water scarcity in Adankolo may be as a result of the fact that the resource base is 7.4%, which means improved water supply is not reliable. This is one of the areas which witnessed a massive influx of people when Kogi State was created and Lokoja became the administrative capital and the establishment of the Federal University, Lokoja. This is in addition to the large number of settled migrants. This surge in population and increased demand for water supply led to the breakdown of existing water facility, evidenced by exposed and broken pipes, illegal water connection and direct water withdrawal from pipes which cause leakages and water related diseases. WPI scores are low with capacity to manage water at 14%, use (7%) access to water (30%) and environmental integrity (14.8%). Low capacity to manage water in this area is attributed to low levels of education and income as most of the residents are migrants engaged in petty trading, farming and fishing for their livelihoods. This is in addition to the insufficient effort from the public and private institutions to expand the network coverage of the water facility to the unplanned neighbourhood. These result in low access because a substantial number of houses are not connected to pipe borne water facility. The environmental score in this area is low due to insufficient outdoor sanitation facilities, with residents disposing waste into the river and at their backyards, predisposing the area to unsanitary conditions and risks of diseases and water stress.

For Lokongoma, access to water in this area is high medium (52%), but the resource base is weak (4.4%), capacity is low (19%), water

use is also low (11%) and environmental score is also low (22.3%). High medium access to water in this area has to do with the nature of the respondents that are mostly civil servants with ability to pay for improved water supply. However, weak resource base, low capacity, use and environment can be attributed to rugged terrain of the area which makes the wider coverage of piped borne water facility very difficult and thus many houses in this area are not connected to water facility. Similarly, wealthy individuals spend heavily in order to drill boreholes in their respective compounds because access to underground water is limited by terrain.

4. CONCLUSION AND RECOMMENDATIONS

There is a growing body of literature documenting pollution of surface and underground water resources all over the globe. Insufficient water and sanitation services to the rich, poor, middle and low income earners suggests increase in expenditure on improved water supply, and thus reduction in income and potential health risks. To address the problem, Water Poverty Index has been provided as a decision making tool in water resources management. The five components examined include resource, access, capacity, use and environment. The WPI of the traditional Lokoja neighbourhood was found to be low, but for other areas specifically Ganaja village, Lokongoma, Chari Megumeri Barracks neighbourhood, Zango and Adankolo, the WPI showed them to be in severely water poor condition. The scores for the access component were generally much higher in all the areas whereas the scores for resource, capacity, use, and environment were generally much lower. The study recommends extension of pipe water borne facility to unplanned neighbourhoods, expansion of available water treatment plant to reflect the increasing demand for improved water supply, enforcement of environmental laws to

improve environmental integrity and enhancement of social intervention programmes. In addition, more water reservoirs should be constructed at strategic locations and there should be special annual budget for expansion and maintenance of water facilities, thus alleviating poverty and reducing the incidences of water borne diseases.

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