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SPATIAL DISTRIBUTION OF SACHET WATER BRANDS IN KADUNA METROPOLIS, KADUNA STATE, NIGERIA

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ABSTRACT

The sachet water industry has become a major source of drinking water in Nigeria due to the inadequacy of public water supply systems. This study investigates the spatial distribution of registered sachet water factories in Kaduna Metropolis, Kaduna State, Nigeria. Using data from the Standards Organization of Nigeria (SON) and the National Agency for Food, Drug Administration and Control (NAFDAC), the 554 registered sachet water brands were captured combined with a field survey method was used to collect data of geographic coordinates of these brands using a hand-held Garmin Global Positioning System (GPS) device, these points were plotted in the geographic information systems (GIS) environment employing the 10.5 version of the software., Nearest Neighbor Analysis (NNA) statistical tool was used for the analysis. The results revealed a highly clustered distribution pattern (z-score = -19.101, Nearest Neighbor Ratio = 0.57, p-value = 0.00), indicating that brands are concentrated in specific areas rather than evenly distributed. This clustering is attributed to, economic efficiencies, and high demand in densely populated urban areas. The study recommends targeted monitoring of production areas to ensure water quality standards are met.

Keywords: Sachet water, Spatial distribution, Kaduna Metropolis

INTRODUCTION

The provision of safe drinking water is a fundamental necessity for human health and development. In Nigeria, as in many developing countries, the public water supply system has struggled to meet the growing demand, particularly in urban areas. This shortfall has led to the proliferation of alternative water sources, most notably the sachet water industry, which has become a vital component of the country's water supply chain (Addo, Amponsah, & Asamoah, 2020; Asishana, Ogunleye& Adebayo, 2024).

Sachet water, often referred to as "pure water," is packaged in small, sealed plastic bags and is widely consumed across Nigeria, due to its affordability and perceived purity. The industry has grown exponentially since its inception in the 1990s, driven by factors such as population growth, urbanization, and the inadequacy of public water infrastructure (Abdulrazak, Mahmood, & Mohammed, 2023). However, the rapid expansion of this sector has raised concerns about the quality of the water, the environmental impact of plastic waste, and the spatial distribution of production facilities (Gyang, Musa & Okeke, 2004; Dada, 2015).

Understanding the spatial distribution of sachet water factories is essential for various reasons. First, it aids regulatory bodies in determining where to concentrate their monitoring and enforcement efforts to uphold water quality standards. Second, it contributes to urban development and infrastructure planning, either to support or mitigate the industries' presence. Third, it sheds light on the economic geography of the sector, revealing concentration areas that may connect to resource availability, market demand, or other locational benefits.

Previous research on sachet water in Nigeria has primarily focused on the microbiological and physicochemical quality of the water (Asishana *et al*., 2024; Addo *et al*., 2020; Olaoye & Onilude, 2009). These studies have revealed varying levels of contamination, highlighting the need for stricter regulation and quality control measures. For instance, a recent study in Wukari, Nigeria, found that some sachet water brands exceeded acceptable limits for certain parameters, posing potential health risks (Ezeamaka, 2020). Similarly, studies in other regions have identified contaminants such as bacteria, heavy metals, and radiological elements, underscoring the importance of regular monitoring (Gyang *et al*., 2004; Obiri-Danso, Adjei, & Stanley, 2017).

However, there is a paucity of literature on the spatial aspects of the sachet water industry. Studies on the spatial distribution of industries in Nigeria have been conducted, particularly in the context of manufacturing (Ayeni, 1976; Abiodun & Aguda, 1987). These studies have shown that industrial locations are often influenced by factors such as proximity to raw materials, transportation networks, and market demand. The sachet water industry, being a manufacturing sector that relies on water sources and distribution networks, may exhibit similar spatial patterns.

In neighboring Ghana, research has been conducted on the geographic distribution of packaged water production (Obiri-Danso *et al*., 2017). This study found that sachet water production is concentrated in certain regions, often near urban centers, and that the industry plays a significant role in local economies. Similar patterns may exist in Nigeria, where urban areas like Kaduna Metropolis experience high demand for sachet water.

This paper investigates the spatial distribution of registered sachet water brands in Kaduna Metropolis, Kaduna State, Nigeria. By employing geographic information systems (GIS) and spatial analysis techniques, so as to determine whether the distribution of these factories is random, clustered, or dispersed, as well as to identify the factors that influence their location.

MATERIALS AND METHODS

Study Area

Kaduna Metropolis is located between Latitudes 10° 24' 39" N, and 10° 36' 40" N and Longitude 7° 21' 26" E and 7° 30' 3" E of the Greenwich Meridian (Fig. 1). It is located on the high plains of the North Central Highlands of Nigeria. Kaduna Metropolis is the headquarters of Kaduna State. It covers more than 355 square kilometers and is approximately 250 meters above sea level. Kaduna Metropolis is about 912 Km north of the Gulf of Guinea (Atlantic Ocean), about 930 Km from Nigeria's northern border and 180 Km from the nation's capital city, Abuja (Ezeamaka, 2020). As shown in Fig. 1.

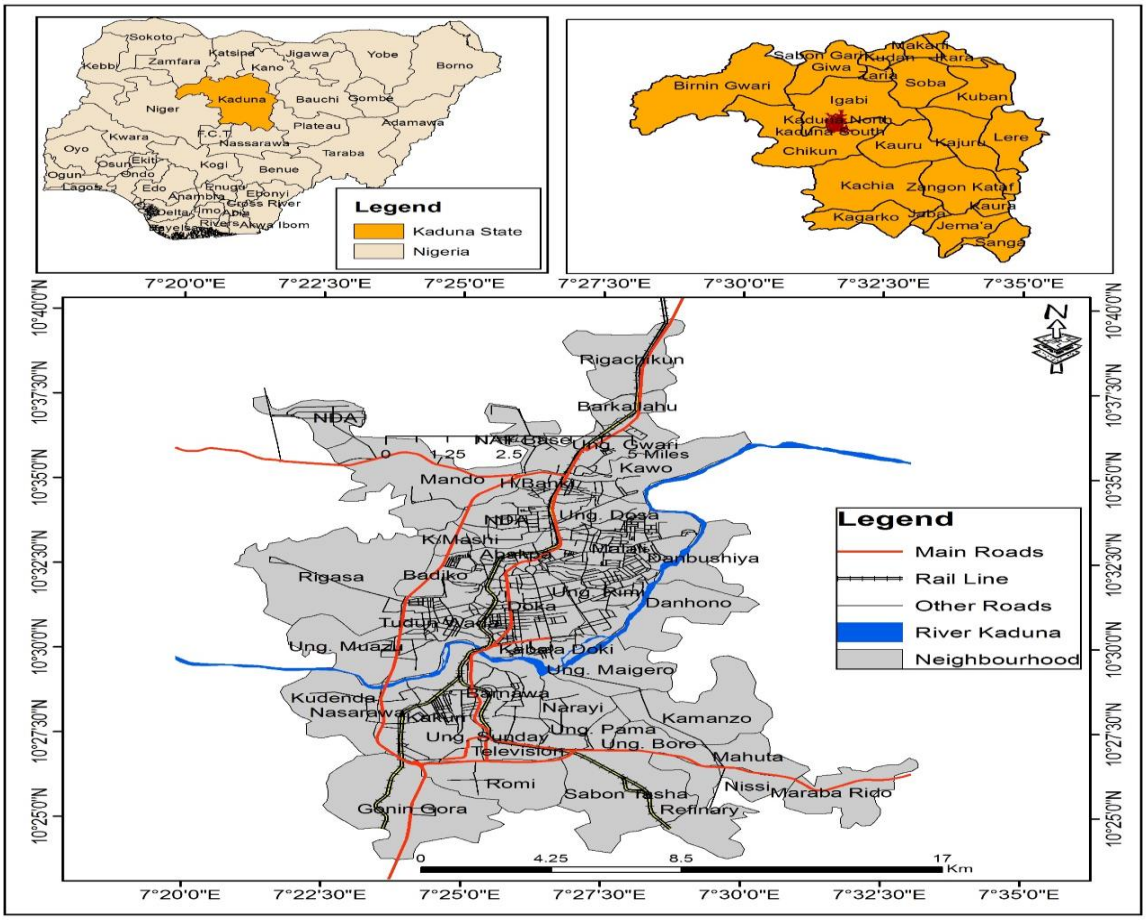

Figure 1: Kaduna Metropolis (The Study Area)
Source: Google Maps (2017)

Data Collection

Data for this study were obtained from the Standards Organization of Nigeria (SON) and the National Agency for Food, Drug Administration and Control (NAFDAC) in Kaduna State. These agencies provided lists of registered sachet water brands and their factory locations. Additionally, the needed data on geographic coordinates of registered sachet water brands in the study area were obtained through field survey conducted to verify and geocode the locations using Garmin Global Positioning System (GPS) device.

A total of all the 554 SON/NAFDAC-registered sachet water brands in the study area were used in this study to provide an overview of the geographic spread and distribution pattern of brands within Kaduna Metropolis. The locational coordinates, including longitude (x-coordinate) and latitude (y-coordinate), of each brand's geographic location was recorded in Microsoft Excel using CSV (comma-delimited) format. The Excel spreadsheet was then imported into the ArcGIS 10.5 environment, plotted as a point map, and converted into a shapefile for analysis. Attribute data were subsequently assigned to the spatial objects, making the system ready for spatial analysis. These points were plotted within a GIS environment using ArcGIS 10.5. To evaluate the spatial distribution pattern, the Nearest Neighbor Analysis (NNA) was employed. NNA is a statistical method used to determine if the point distribution (in this case, the locations of brands/factories) is clustered, dispersed, or random. The analysis computes the average distance between each point and its nearest neighbour, and compares it to the expected distance in a random distribution.

RESULTS AND DISCUSSION

Results

A total of 554 registered SON/NAFDAC sachet water brands/factories were identified in Kaduna Metropolis, distributed across four local government areas (LGAs), as shown in Table 1. Some of the communities include; Narayi, Sabon Tasha, Unguwan Boro, Unguwan Pama, Gonin-gora, Unguwan Romi (Chikun), Hayin Danmani, Mando, Hayin Rigassa, Farin Gida, (Igabi),Hayin Banki, Badarawa, Old NDA barracks, Malali, Unguwan Rimi, Unguwan Sarki (Kaduna North LGA), Kurmin-Mashi, Barnawa, Unguwan Television, Television Garage, Kakuri, and Tudun Wada, Kudenda (Kaduna South)

Table 1: Distribution of Factories in LGAs

Local Government Area	Number of Factories
Chikun	135
Igabi	161
Kaduna North	115
Kaduna South	143
Total	554

The NNA revealed a z-score of -19.101, with a Nearest Neighbour Ratio of 0.57 and a p-value of 0.00, indicating a highly clustered distribution pattern. This suggests that the factories are not evenly spread but are concentrated in specific areas within the metropolis (Fig. 2).

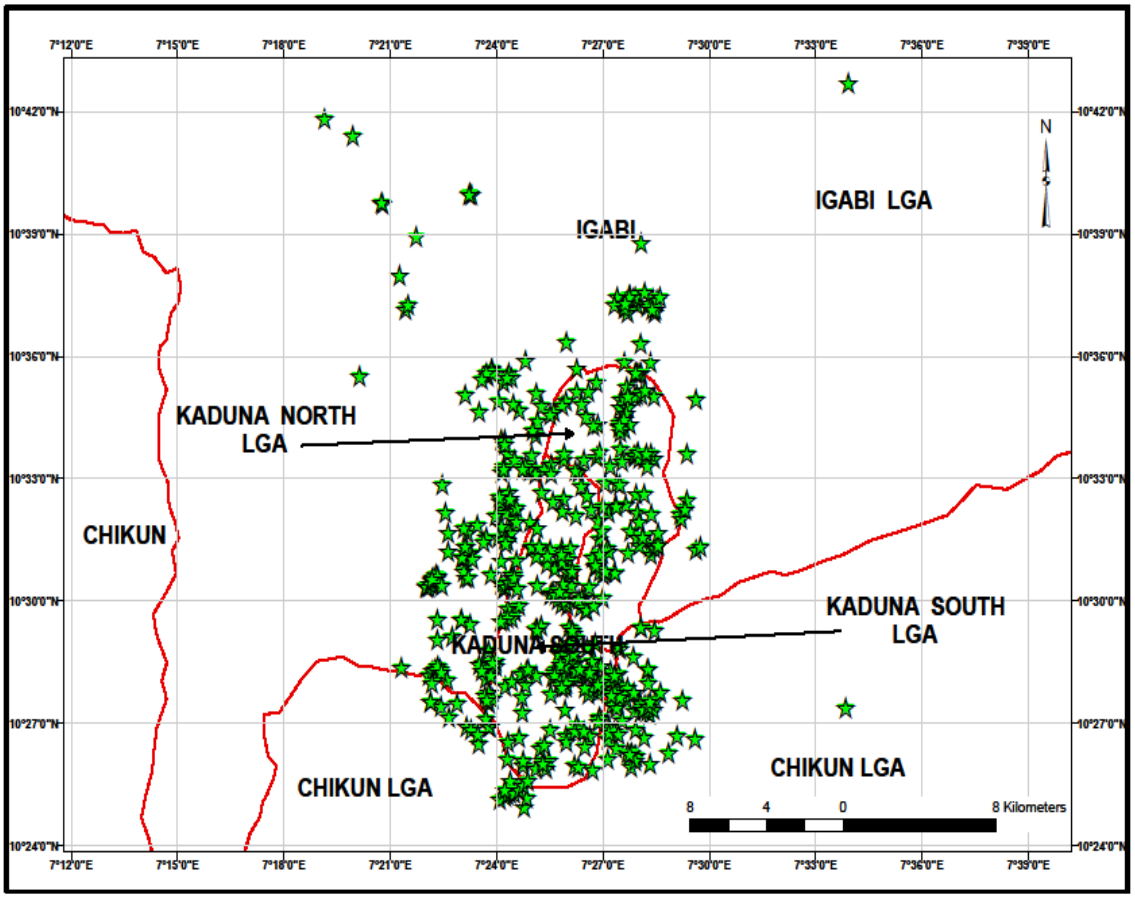

Figure 2: Spatial Distribution of Sachet Water Brands in Kaduna Metropolis
Source: Authors' Fieldwork (2024)

Discussion

The clustered distribution of sachet water factories in Kaduna Metropolis can be attributed to several factors. , First, economic considerations such as shared resources and cost efficiencies may encourage clustering, as seen in other industrial sectors (Wudu, Singh & Kassahun 2024), Second, the high population density and socio-economic activity in certain areas of Kaduna Metropolis create pockets of high demand, making it advantageous for factories to be located nearby to meet market needs efficiently.

This clustering has implications for regulation and public health. Concentrated production areas may be easier to monitor and regulate, but they also pose risks if quality control lapses occur, as contaminated water from one factory could affect a large number of consumers. Furthermore, the environmental impact of plastic waste from sachets may be more pronounced in areas with high factory density. Studies on sachet water quality have highlighted the presence of contaminants such as bacteria, heavy metals, and radiological elements (Ezeamaka, 2020; Obiri-Danso *et al*., 2017), emphasizing the need for stringent regulatory oversight in these clusters.

CONCLUSION

This study has demonstrated that the spatial distribution of sachet water factories in Kaduna Metropolis is clustered, influenced by factors such as resource availability, economic efficiency, and market demand. This implies that, residents of Kaduna Metropolis can easily purchase the product without having to travel far distance since the factories are located within close proximity in the respective communities. The study recommends targeted monitoring of production areas to ensure water quality standards are met. Future research could expand this analysis to other urban centers in Nigeria or investigate temporal changes in distribution patterns. Additionally, integrating data on water quality and consumer health outcomes could provide a more comprehensive understanding of the industry's impact.

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