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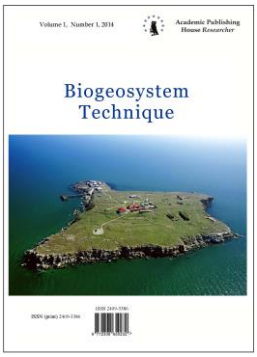

Spatial Distribution of Petrol Filling Stations in Bauchi Town, Bauchi State, Nigeria

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Abstract

The locations of petrol retail stations in Bauchi Town does not seem to be in compliance with the requirement of the Department of Petroleum Resources (DPR) that distance between any two stations should not be less than four hundred (400 m). This study evaluated the compliance of the filling stations with this requirement. This was achieved by obtaining, from the DPR, a list of all the approved stations in the Town and their non-spatial attributes, measuring and mapping their coordinates, and appraising the spatial distribution of the stations. Garmin Handheld GPS receiver was used to obtain required coordinates. The Google Earth satellite image of the Town (downloaded using Terra Incognita 2.4 Software) was georeferenced and overlaid on the scanned analogue map of the Town that was similarly georeferenced. On screen digitization for the update of the township roads, plotting of the locations in the stations, buffering, and the Average Nearest Neighborhood analysis were undertaken with ArcGis 10.1 Software. The results suggest that there are 73 filing stations in the Town. Out of these, 60 % were clustered along out bound roads while 58 % violated the 400m requirement by the DPR. Better synergy between the DPR, the Ministry of Lands and Survey, and the State Development Board is suggested to ensure total compliance with DPR regulations in the future. Physical development control and location allocation should be enhanced by migrating from analogue GIS guided operations. Existing stations should be compelled to comply with all public safety regulations at all times to forestall any negative consequence of the already violated regulation.

Keywords: spatial, distribution, petrol, station, GIS, location, proximity, neighborhood, comply, cluster.

1. Introduction

Virtually all aspects of contemporary daily life activities of individuals and nations, including environmental health depend on machines powered by petroleum products. The most popular among these products are Premium Motor Spirit (PMS, petrol), Automotive Gas Oil (AGO, gas) and Dual-Purpose Kerosene (DPK, kerosene). Among other uses, the products power and lubricate all types of transport vehicles and industrial machines. In homes, the products power machines that generate electricity for lighting, heating, and cooling, and cooking. Kerosene is particularly useful as a source of energy for cooking in most Nigerian homes.

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The universal utility of petroleum products has translated into universal demand for them. This made it imperative for institutional arrangements to avail the products to those in need. In view of the inherent highly combustible characteristic of the products, such institutional arrangements require to be structured to ensure public safety in all stages of its production, conveyance, and retail.

Filling Station, Petrol station, gas station or petroleum outlet is defined as any land, building or equipment used for the sale or dispensing of petrol or oil for motor vehicles or incidental thereto and includes the whole of the land, building or equipment whether or not the use as a petrol station is the predominant use or is only a part thereof. Most filling stations sell petrol or diesel, some carry specialty fuels such as liquefied petroleum gas (LPG), natural gas, hydrogen, biodiesel, kerosene, or butane while the rest add shops to their primary business (Ayodele, 2010).

In Nigeria, the outlets used for retailing of the products are called petrol filling stations. By virtue of provisions of the Petroleum Amendment Decree No 37 of 1997, the licensing and oversight of the operations of the filling stations are among the statutory mandates of the Department of Petroleum Resources (DPR).

In recent times, there has been a sustained increase in the number of petrol stations established in different parts of the country particularly Bauch. The reasons for such unprecedented increase are not far-fetched. Firstly, the increasing population in the country and the attendant increase in the purchase of vehicle; Secondly, the attractive price of petrol both at control price and black-market price which made more people to go into petrol retailing business (Uchegbu, 2002).

As safeguards against the risks to public and environmental safety, the DPR require sites that are intended for the construction of petrol filling stations to satisfy some physical requirements. Among these requirements are that the site should not: lie within pipeline or electricity high tension cable Right of Way (ROW); be less than fifteen (15) meters from the edge of the road to the nearest pump; The distance be less than 400 (four hundred) meters between an existing station and the proposed one and The drainage from the site will not go into a stream or river and finally the DPR guided/supervised environmental impact assessment (EIA) study of the site should be provided by DPR accredited consultant.

Thomas, Chanda & Blessings (2016) stated that in locating petrol filling stations, it is important to take some precautionary measures like locating them at a required distance from buildings; places of public assembly such as markets, hospitals and schools and areas of high traffic congestions and residential buildings. Unfortunately, this seems not to be the practice and as a result, there have been proliferations of filling stations that are located close to residential buildings and public places. This might have constituted serious hazards to residents in close proximity to filling stations and to the environment at large.

A contemporary trend in most Nigerian cities is the proliferation of petrol filling stations (Afolabi et al., 2011). The proliferation is the consequence of the fast growth of urban population that is accompanied with similar growth in the demand for petroleum products to fuel increasing quantum of vehicles and cooking. In addition, epileptic public electricity supply has necessitated the use of petrol-powered generators in many public and private buildings to generate their electricity needs. Noteworthy is the observation that the proliferation has become haphazard and potentially risky. For instance, Mshelia, Abdullahi & Dawha (2015) reported the location of the stations close to residential and commercial buildings. With Geographic Information System (GIS), it is possible to graphically capture, display and analyze the compliance of the distribution of the filling stations with the guidelines for their location as specified by the DPR. This has been undertaken for several Nigerian cities that include Kano (Mohammed et al., 2014), Ilorin (Oloko-oba et al., 2016), Ilaro (Olapeju, 2017), Kaduna (Tah, 2017), Karo (Vivian et al., 2013), Alesha (Ogundahunsi, 2014), Umuahia (Okonko et al., 2014), Oyo town (Njoka, Alagbe, 2015), Obior-Akpo (Samuel et al., 2015) and other. All these studies reported violations of the spatial regulations of the DPR. This write up covers the same theme in Bauchi town in the hope that it will guide concerned agencies in taking appropriate decisions.

2. Aim and objectives

The aim of this study is to map the distribution of filling stations in Bauchi town. The objectives were to:

- Obtain a list of all petrol filling stations in the town;
- Measure the GPS coordinates of the petrol filling stations;
- Plot the coordinates and attribute data;
- Evaluate the spatial pattern of distribution of the filling stations.

3. Study area

The locale of the study is Bauchi town, north eastern Nigeria. It is located between latitudes 10°19′5″ and 10°20′58″ N and longitudes 9°50′50″ and 9°51′29″ E (Figure 1).

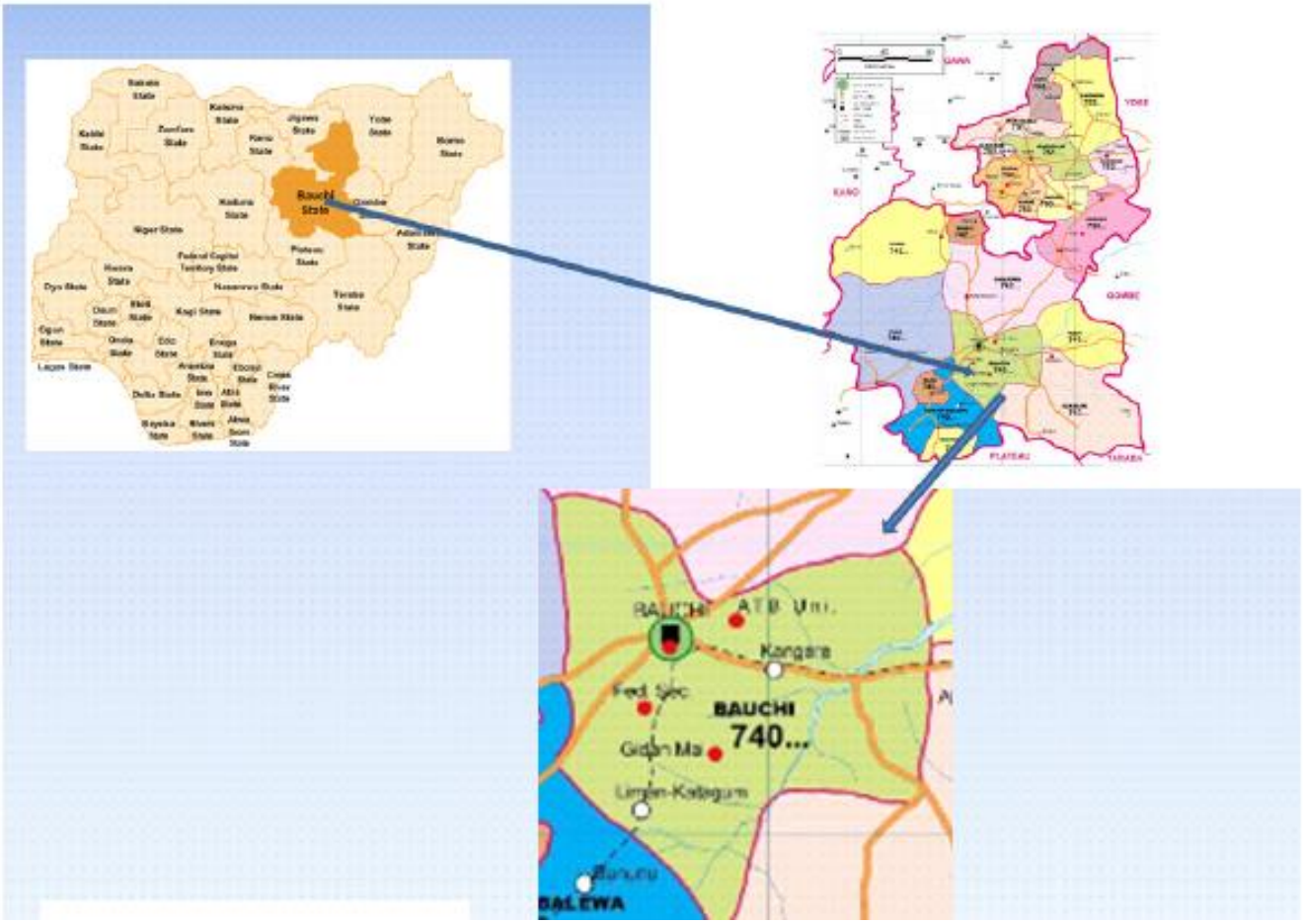

Fig. 1. The Study Area
Source: Bauchi State Ministry of Lands, 2015

The town has been the administrative headquarter of Bauchi emirate (since 1805), Bauchi State and Local Government (since 1976). The last population census (conducted in 2006) gave the population of Bauchi Local Government as 493,810 (the census figures were not disaggregated to town and village levels). It is expected that the bulk of this population reside in Bauchi town. At the national population growth rate of 2.79 %, the projected population of the town is about 707,300 in 2019. Between 2006 and 2015, the town expanded physically at an annual average of 4.40 km². As at 2015, the spatial extent of the town was estimated at 89.23 km² (Modibbo et al., 2017). Using the annual average physical growth of the town (4.40 km²), the estimated size of the town will be 106.83 km² in 2019.

The institutional framework for statutory land administration in the town consists of the Ministry of Works, Lands, and Housing, and the State Development Board. The Ministry of Works, Lands and Housing has the statutory responsibility for general land administration, surveying, mapping, and urban and regional planning. The Bauchi State Development Board, through land use zoning regulations, layout/subdivision regulations and building byelaw, has the statutory mandate to control land development to ensure conformity with safety standards. In line with this, all prospective land developers (inclusive of petrol filling stations) are expected to obtain approval

for their intended developments from the board. The detailed plan of intended developments and proof of ownership of the plot of land are required while applying for development permits. In addition, the Board is mandated to ensure compliance with approved building plans during their construction.

4. Methods

Two types of data were collected: primary and secondary. The primary data were the coordinates of filling stations in the study area that were acquired with a handheld Garmin Global Positioning System (GPS) receiver for the purpose of locating the stations. The secondary data were the high-resolution satellite image of the study area, the analogue map of the town and the attribute data of the filling stations. The satellite image, required to update the road network of the town was sourced from Google Earth using the Terra Incognita software. The analogue map was obtained from the Bauchi State Bureau of Lands to serve as a base map for adding the locations of the filling stations. The attribute data, essentially, names of the filling stations and category of marketer (independent or major) were collected from the DPR.

The analogue map of the town was scanned and along with its satellite image, they were georeferenced. Onscreen digitization of the map and the roads in the satellite image was undertaken using ArcGIS 10.1 software. The digitized roads were overlaid on the digitized base map. The GPS coordinates of the filling stations and other related dataset (Names, Address and Type) were further geo-coded and integrated into an ArcGIS database. To locate the filling stations on the digitized base map, their coordinates were plotted on the map. Four-hundred-meter buffer zones were created around each of the filling stations. The Average Nearest Neighborhood (ANN) tool for analyzing spatial distribution patterns was employed to evaluate the spatial pattern (clustered, dispersed, or random) of the distribution of the filling stations.

5. Results and discussion

There are seventy three filling stations in the town among which fourteen (14) were owned by major marketers, fifty two by independent marketers while seven were operated by the Nigeria National Petroleum Corporation. Figure 2 shows the distribution pattern of the filling stations in the study area. From the Figure 2, it is discernible that all the stations are sited in a linear pattern along the roads (especially out bound) in the town. Sixty (60 %) of the stations are located along the out bound roads, a trend similar to what was reported for Kaduna (Tah, 2017) and Kano (Mohammed et al., 2014).

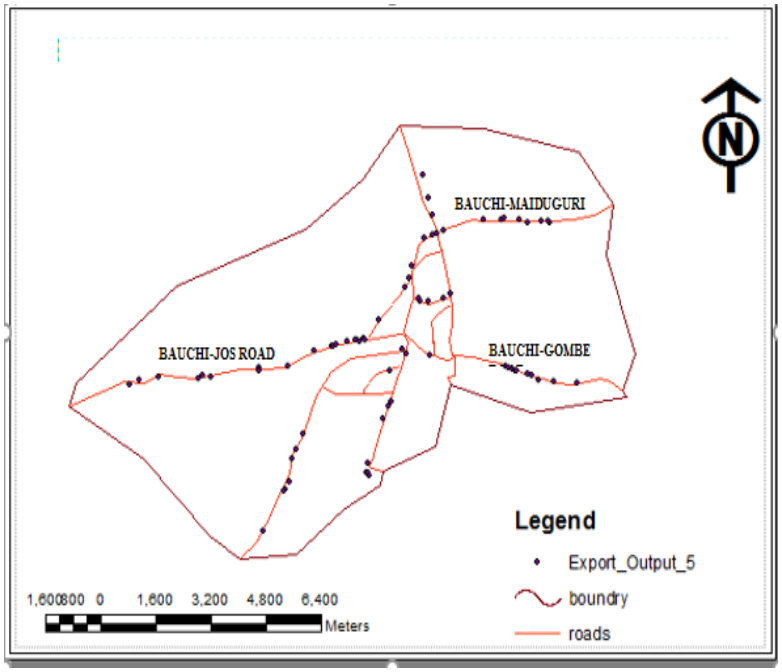

Fig. 2. Distribution of Filling Stations in Bauchi Town Source: Field Survey, 2019

The result of spatial pattern of distribution of the filling stations, represented in Figure 3, shows a clustered pattern of distribution with Nearest Neighbor Ratio (NNR) of 0.43 and a Z-Score of −9.06349090717. This means that majority of the stations are in close proximity to each other rather than being spread across the town.

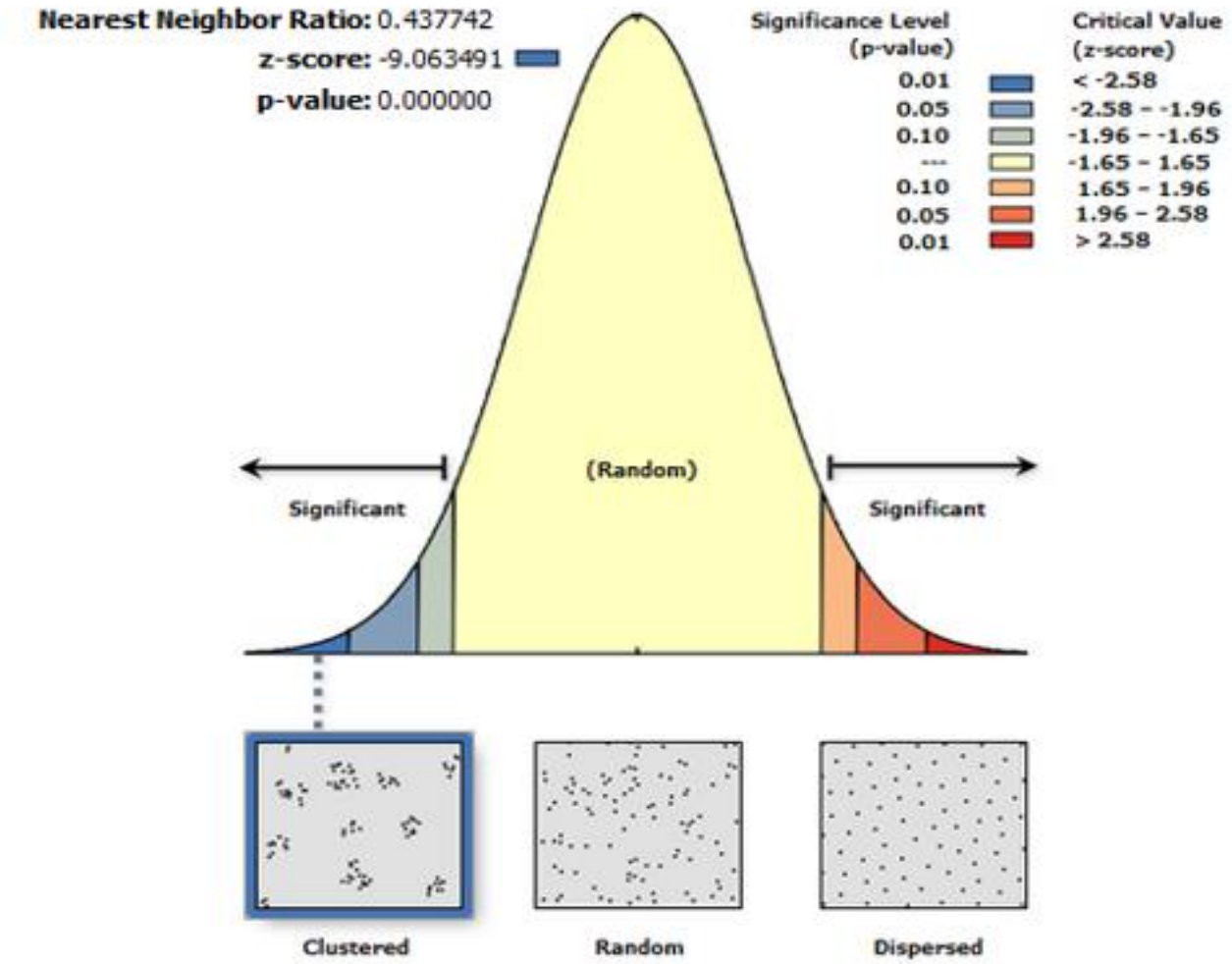

Fig. 3. Average Nearest Neighbor of Filling Stations. Source: Field Survey, 2019

Figure 4 represents the proximity analysis of the filling stations. The analysis reveals that the proximity of fifty-eight (58) of the stations, representing eighty percent (80 %) is less than 400 m.

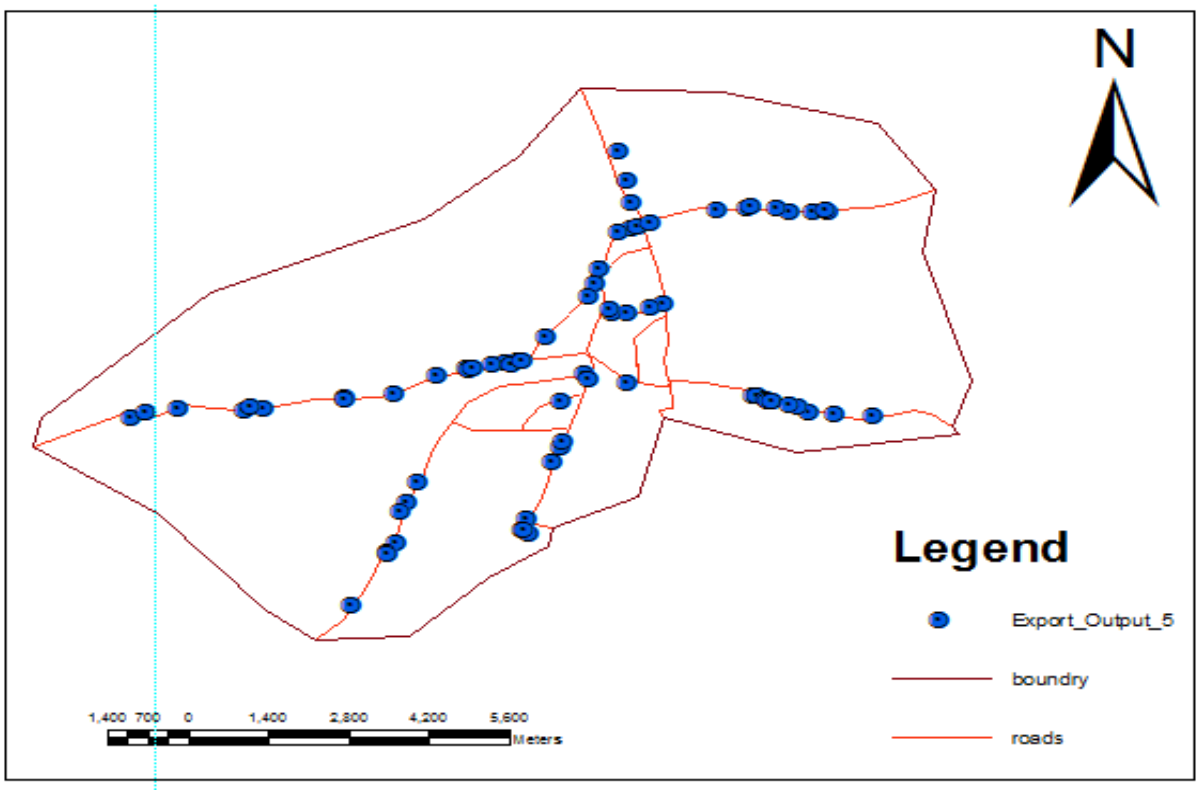

Fig. 4. Location of Filling

This suggests that there is significant non-compliance in terms of compliance with the DPR requirement of keeping a minimum distance of 400 m between them. This level of non-compliance is significantly higher than the 24 % percent reported by D.S. Tah (2017) for Kaduna, but much less than the 97 % in Ilorin. This situation can be attributed to the weakness in the physical development control effectiveness by the State Development Board that is overwhelmed by personnel, perception and funding problems (Bogoro, Nghalmi, 2014). Similarly, the collaboration between the DPR, the Ministry of Lands and Housing, and the State Development Board appears to be weak. This causes an environmental danger for the Bauchi Town geosystem.

6. Conclusion

The spatial distribution of the seventy three filling stations in Bauchi Town is clustered along the out bound roads. For more than half of them, the requirement for a minimum distance of 400 m between neighboring stations was violated. This suggests weakness in the enforcement of the requirement by the DPR and the State Development Board. In view of this, it is recommended that to stop future violations, the disconnect between the DPR, the Ministry of Lands and Survey, and the State Development Board that allowed the violation to happen should be addressed by better collaboration. The performance of physical development control and location allocation should be enhanced by migrating from analogue GIS guided operations and providing required funding, personnel, logistics, and political will. Existing stations should be compelled to comply with all public safety regulations at all times to forestall any negative consequences of the already violated regulation. This will help to mitigate the environment impact of the filling stations current spatial distribution which violates the DPR requirement.

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