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Original Article

Geospatial Distribution and Assessment of Filling Stations and Environmental Health Risks in Part of Urban Core Area of Ibadan Metropolis, Oyo State, Southwest Nigeria

Adewuyi Gbola Kehinde[1], Sanni Tawakalitu Bolanle [2], Abudulawal Kaothar Ayomide[3]

[1]*Department of Surveying and Geoinformatics, Faculty of Environmental Studies, The Polytechnic, Ibadan, Nigeria.*
[2]*Industrial Liaison and Placement Office, The Polytechnic, Ibadan, Nigeria.*
[3]*Department of Arts and Social Sciences Education, Faculty of Education, University of Ibadan, Nigeria.*

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Abstract - *This study examines the geospatial distribution of filling stations and assesses the relative distances between one station to another, closeness to the Residential houses/Public institutions, and the environmental health risks associated with the siting and operation of these filling stations in parts of the urban core area of Ibadan metropolis. eTrex Garmin 30x was used to determine the spatial coordinates (x, y) of all the filling stations and Quickbird satellite image with a resolution of 30m was used to show the position/location of the filling stations and as well as the existing features within the study area. Seventy (70) functioning filling stations were examined. However, two (2) hypotheses consisting of three (3) questions were formulated for this study. Questionnaires were administered to a sample of 250 respondents which was randomly selected from the study area. The data were analyzed using the non-parametric method of Chi-square. ArcGIS 10.4 (Arcmap 10.4) was used for image processing and field data analysis. The result shows that twenty-three (23) 32.86% filling stations comply with the International Standard of 1km distance to one another and the rest forty-seven (47) 67.14% did not comply. Also only five (5) 7.14% out of seventy (70) comply with 50m distance stipulated by Energy Regulation Board (ERB) to Residential houses/Public institutions such as churches, schools, public libraries, bus stops, markets, auditoriums, stadiums, hospitals around the filling stations while the remaining sixty-five (65) 92.86% does not comply within the study area. Also from the result, the three (3) hypotheses formulated for the study was null and rejected, as this shows that siting of filling station in the study area was not in conformity with the International Standard and as well as Energy Regulation Board and also had significant effects on the residential houses and public institutions and people's health*

Keywords — *Environmental health risks, Geospatial distribution, Hypotheses, Relative distances, , Significant effects.*

I. INTRODUCTION

Premium motor spirit (PMS) or fuel as it is normally called in Nigeria is the second most used product after food in Nigeria. Petroleum is no doubt a predominant source of Nigeria's revenue and foreign exchange ([1], [2]),.

It has occupied strategic importance in the Nigerian economy, accounting for as high as 78 percent of gross domestic product and up to 90 percent of the country's total annual revenue and foreign exchange earnings [3]. In siting, a petrol station, accessibility, traffic impact, and environmental safety should be given due consideration [4]. According to Ayodele (2011) [5], in highly urbanized areas, filling stations is a significant contributor to traffic problems such as traffic congestion, pollution, fire, and explosion.

Several studies ([5], [6], [7]) have looked into the location of filling station and its impact on the environment in different regions of Nigeria. Ayodele (2011) [5] examined the spatial distribution of filling stations in Kaduna North where the study identified the pattern and distribution problem in the area and found that there were about 22 filling stations in the area and the distribution is uneven as the stations are mostly concentrated along major roads. Also, the study looked at the setbacks and locational situation of these stations and concluded that 69.5% did not conform to the standard. Samuel et al. (2015) [7] carried out a study on the proliferation of petrol filling stations about the minimum environmental safety requirements by the Department of Petroleum Resources (DPR) that 'distance from the edge of the road to the nearest pump and the next petrol filling station should not be less than 15 and 400 meters

respectively. Findings from the z ratio analysis revealed that at 152 degrees of freedom and 95% confidence level, the petrol filling stations in the study area neither conform to the required distance of 400m apart nor conform to the required distance of 15m from the road.

Afolabi, et al., (2011) [8] assessed safety practices in filling stations in Ile-Ife, South-Western Nigeria. Assessment of the location and spatial distribution of petrol filling stations in Ilaro, Ogun State was carried out by [9]. Locational analysis of fuel stations, in Ilesa, Osun State, Nigeria was examined by [10]. Research has shown that there are pressing concerns about the health and safety and environmental quality emanating from filling stations ([11], [12]) and the negative sides of petroleum (especially, fuel for refuelling vehicles) on the ecosystem.

Hence, the location points of petrol stations must be strategically and consciously done to minimise their impacts on both human and their immediate environs [13]. Research has further shown that one of such environmental impacts on the earth's biosphere is the release of pollutants and greenhouse gases into the environment and the damage of ecosystems through oil spillage [14], gasoline delivery to stations, vehicle refuelling, combustion products from vehicle engines within fuel stations [15]. According to Sergio (2008) [16], these emitted gases are hazardous to human health.

According to WHO report (2004) [17], more than 2.3 million lives and properties worth about 4.5 billion are lost to fire outbreaks emanating from mishandled petroleum product ([6]). Hence, considering the high risk and dangers associated with petroleum product as a highly inflammable product, its exploration, transportation, offloading, storage and sale points and facilities must be handled carefully [6]. Therefore, this study examines the geospatial distribution of filling stations and assesses the relative distances between one station to another, closeness to the residential house/public institutions, and the environmental health risks associated with the siting and operation of these filling stations in parts of the core area of Ibadan metropolis, Oyo state, Nigeria

II. RESEARCH HYPOTHESES

A. Research hypotheses formulated for the study

The two hypotheses formulated to guide this study are as follows;

a) Location filling stations has no significant effect on Residential houses and Public institutions

H_1**.** Location of filling station at nearby residential houses and public institutions is dangerous as insurgence of tanker explosion lead to loss of lives and properties.

H_2 Location of filling station improves the standard of living of people in your area.

H_3: Location of filling station contributes positively to your environment in terms of development.

b) Location of filling stations has no significant effect on People's Health

H_1: Location of filling stations causes several physical, chemical and human interaction risks (ergonomic hazards).

H_2: Location of filling stations from exposure to diesel, petroleum fumes and fuel components such as benzene and formaldehyde contributes to tiredness leading to vomiting, cancers and acute myeloid leukemia and acute non-lymphocytic leukemia.

H_3: Location of filling stations at nearby hospital can endanger patient mental ability.

III. MATERIALS AND METHODS

A. The study area

The study area is parts of the core area of Ibadan metropolis consisting of Ibadan North, Ibadan Northeast, Ibadan Southwest, Ibadan Northwest and Southeast Local Government Areas of Oyo state, Southwest Nigeria. The study area lies at approximately latitude 7° 23′ 54.5″N to 7° 23′ 55.6″N and longitude 3° 53′ 7.3″E to 3° 53′ 7.6″E. It covers boundary area of about 5,266.255 hectares. It is majorly an urban centre of the Ibadan metropolis, Oyo State, Nigeria.

B. Methods of Data Acquisition

For the purpose of this study, both primary and secondary data were employed. Primary data are data that are obtained during the field survey while the secondary data are existing data that can be use to support and explain the primary information. Secondary data assist readers and academician to gain more understanding about topic under investigation was demonstrated by [18]. The primary data was sourced through the field observation by determining the spatial coordinates of each filling station and as well as questionnaire administered to sample people's opinion on the environment, and health risks of siting filling stations within the study area. Secondary data was sourced from the Quickbird satellite image obtained from the Federal Research Institute of Nigeria Jericho, Ibadan and related journals, books, conference proceedings, seminars etc.

C. Field and image data collection

The location of all the functioning filling stations consisting of petrol, oil and gas stations were visited across the study area. Handheld Global Positioning System (GPS) (eTrex Garmin 30x) was used to determine the spatial location of filling stations. A purposively sampling method and global positioning system (GPS) to assess all the surviving filling stations was used by [19]. Seventy (70) functioning filling station were visited and their spatial locations were examine if it is line with the International Standard of 1000m (1km) distance to one another. Questionnaires were administered to a sample of 250 respondents which was randomly selected from the study area of the metropolis based on closeness of residential houses/public institutions around the filling stations and

environmental health risk associated with sitting if filling stations.

The Questionnaire was administered based on the data elicited from the respondents and were analyzed through non-parametric method of Chi-square. Two (2) research hypotheses consisting of three (3) questions were formulated for this study. The questionnaire was developed using the likert scale of Strongly Agreed (SD), Agreed (A), Strongly Disagreed (SD), and Disagreed (D). Data collected in the field were analyzed using frequency distribution tables and simple percentage technique. Chi-square (X^2) statistical tool was used in testing the hypotheses in order to achieve the objectives of the study. Chi-square formula used to test the hypotheses of the assessment of this study is as follows;

$$X^2 = \frac{\Sigma (O-E)^2}{E}$$

Where; X^2 = Chi-square, Σ = Summation, O = Observed frequency, E = Expected frequency.

D. Image Processing and Digitizing Procedures

The Quickbird image was processed using ArcGIS 10.4. The image was imported to ArcGIS 10.4 (Arcmap 10.4) for vectorization. Shapefile was created using the Arc catalog for each features contained on the image. After creating the shapefile, Line features was used to digitize line features consisting of major roads, minor roads, bridges, expressway, waterways, and rivers. Polygon features for buildings and reservoir and point features for all the functioning filling stations.

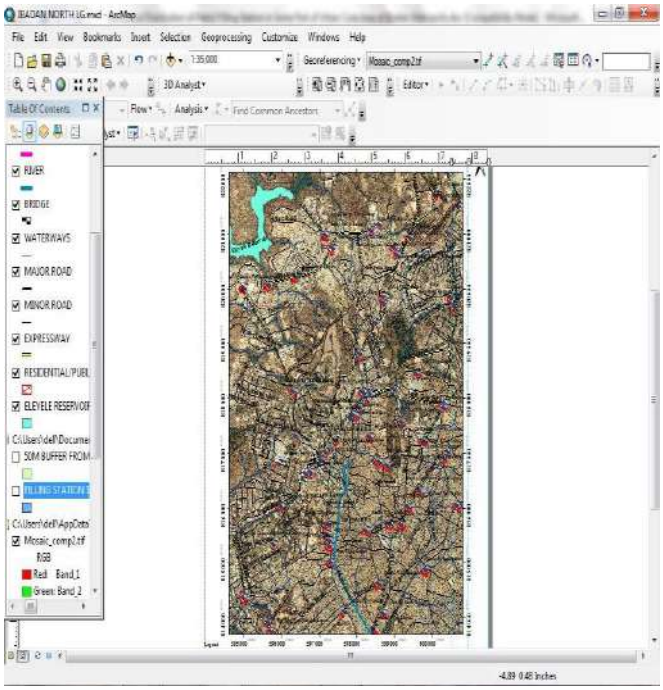

Fig. 1: Showing image processing procedures of filling stations and other features within the study area.

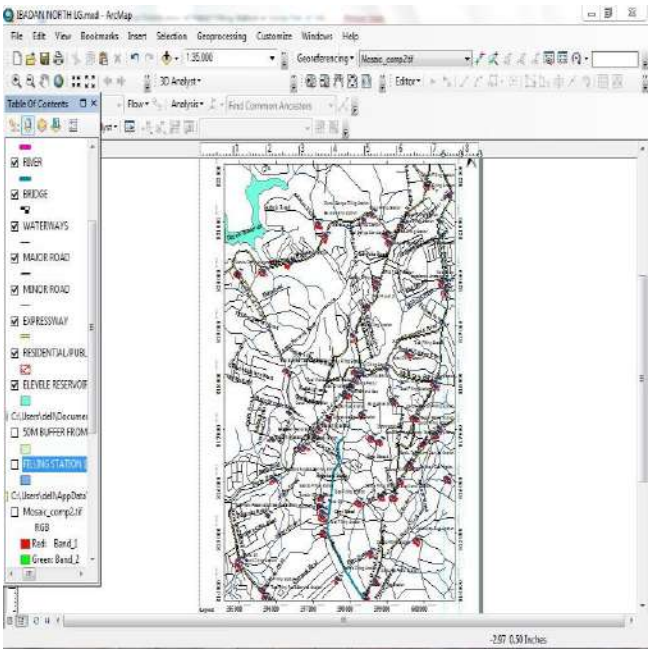

Fig. 2: Showing processed image of filling stations and other features within the study area

IV. RESULTS

Below are the results obtained from this study. The results are presented in form of maps and map queries (Fig. 3-9), frequencies and statistical tables (TABLE 1, 2, 3, 4a&b).

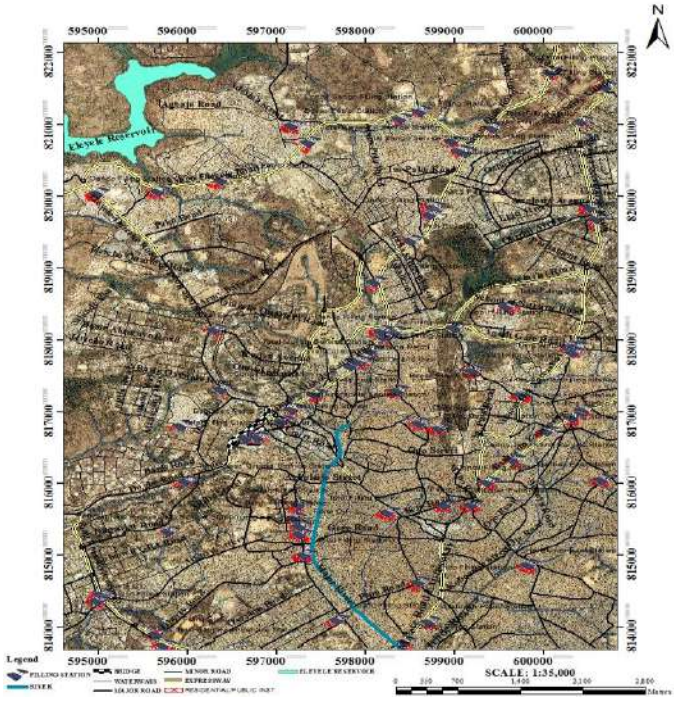

Fig. 3: Digitized features of the study area from the Quickbird image.

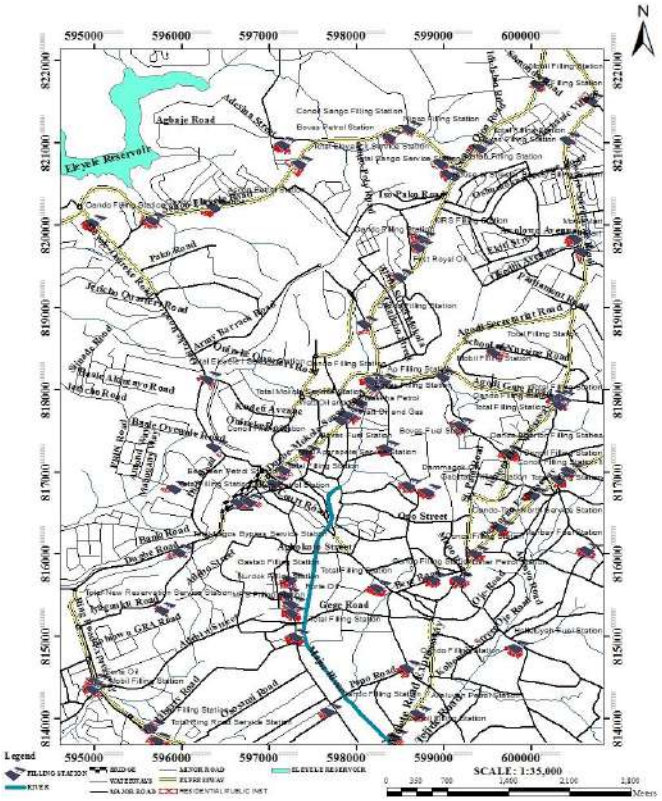

Fig. 4: Showing building (red colour) around filling stations (deep blue colour)

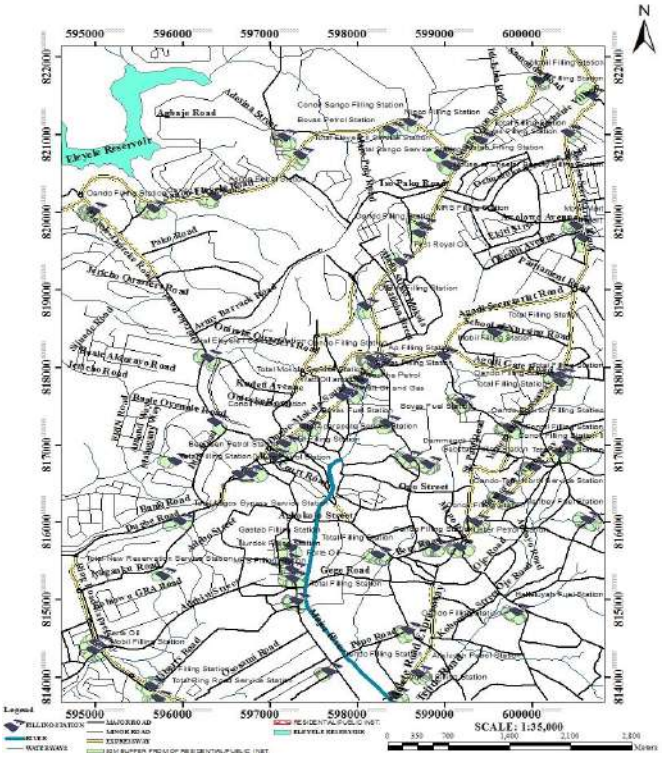

Fig. 5: Fifty meters (50m) buffer zone radius area (tzavorite green colour) of Residential houses/Public institutions to filling stations

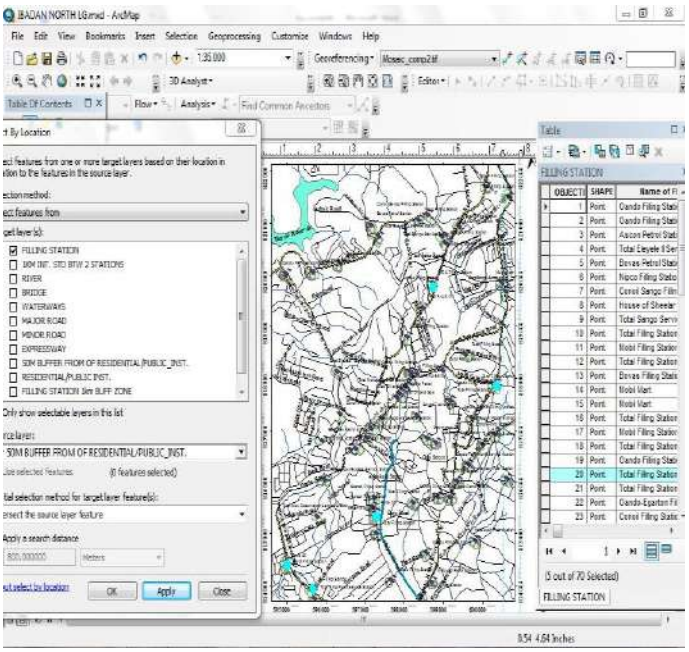

Fig. 6: Query showing selection of 50m distance between filling stations and Residential houses/Public institutions.

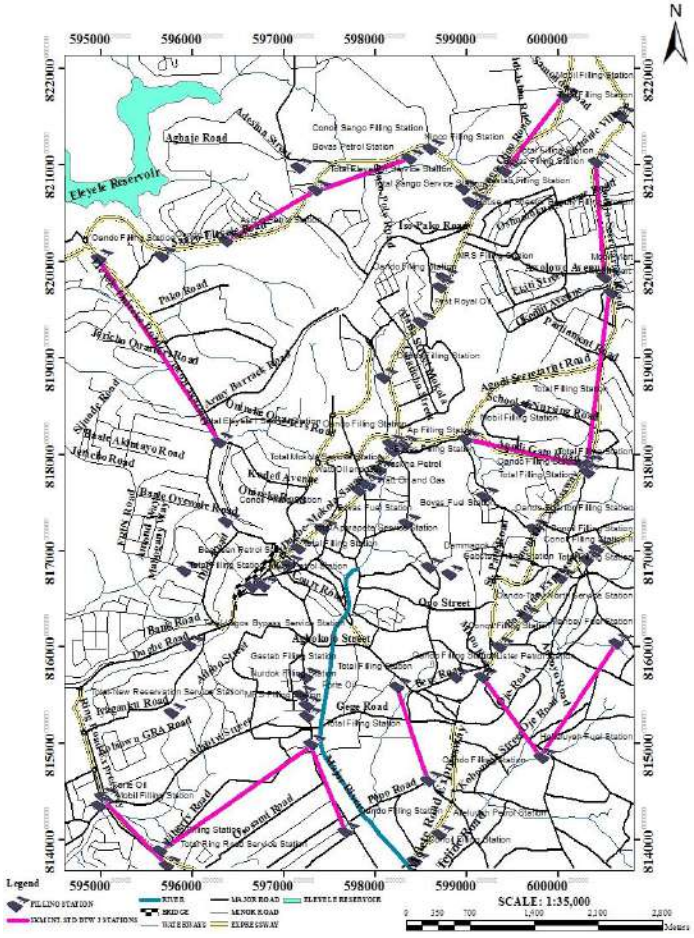

Fig. 7: One (1) kilometer distance between two filling stations by International Standard (Purple line colour)

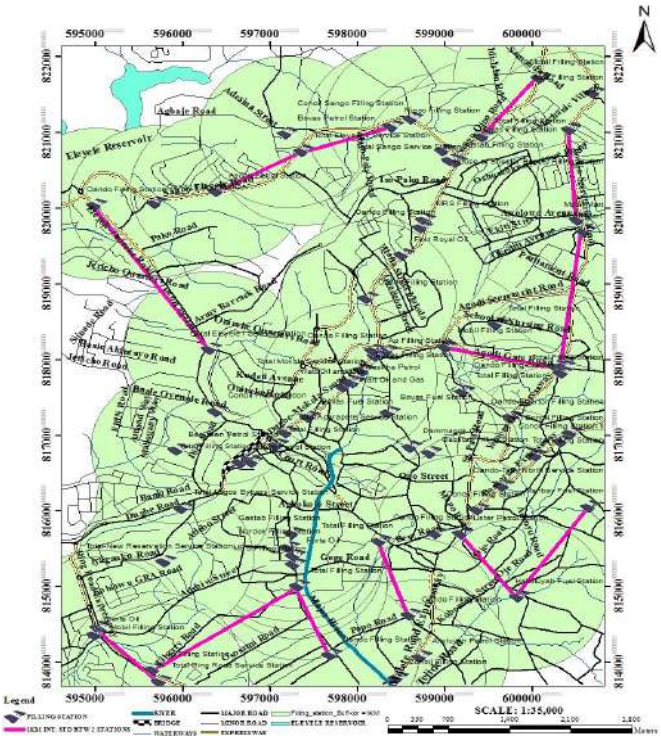

Fig. 8: 1Kilometer Buffer Radius Distance between filling stations.

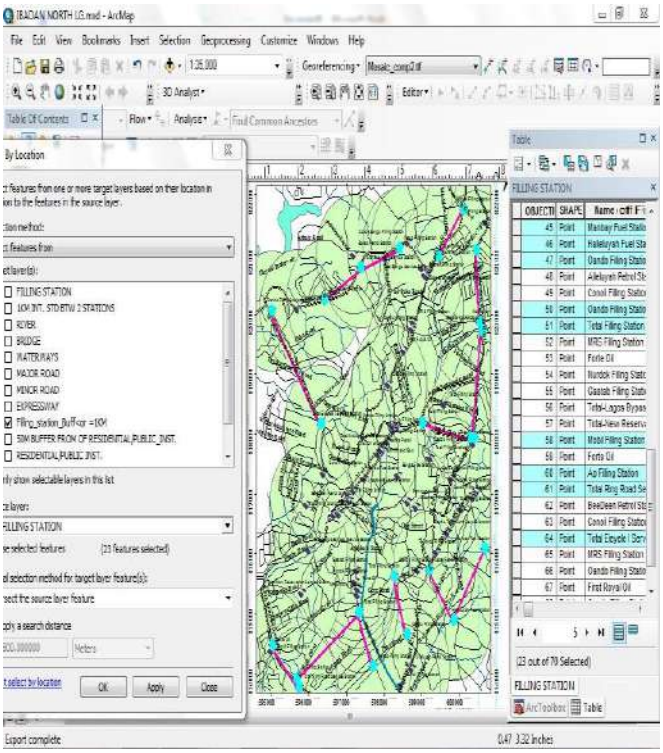

Fig. 9: Query showing selection of 1 km radius distance between filling stations.

TABLE1

ATTRIBUTE TABLE FOR THE FILLING STATIONS.

Table

FILLING STATION

OBJECTI	SHAPE	Name of Filling Station	Easting	Northing	Location
1	Point	Oando Filling Station	595011.900	820056.085	Along Eleyele-Onireke Road
2	Point	Oando Filling Station	595695.527	820091.272	Along Sango Eleyele Road
3	Point	Ascon Petrol Station	596404.287	820242.072	Along Sango Eleyele Road
4	Point	Total Eleyele II Service Station	597379.460	820769.872	Along Sango-Eleyele Road
5	Point	Bovas Petrol Station	597193.474	821006.125	Along Ijokodo-Apete Road
6	Point	Nipco Filling Station	598414.953	821101.632	Sango Poly Road
7	Point	Conoil Sango Filling Station	598636.127	821197.139	Beside The Polytechnic, Ibadan Gate
8	Point	House of Sheelar Beauty Filling Station	598998.047	820784.952	Sango-Eleyele Road
9	Point	Total Sango Service Station	599138.793	820624.099	Sango-Mokola Road
10	Point	Total Filling Station	599445.420	820965.912	Sango-Ojoo Road
11	Point	Mobil Filling Station	600108.940	821740.018	Sango-Ojoo Road
12	Point	Total Filling Station	600712.478	821539.229	Along Bodija-University of Ibadan Road
13	Point	Bovas Filling Station	600446.146	821062.635	Bodija-Secretariat Road
14	Point	Mobil Mart	600617.516	819711.490	Along Awolowo Junction-Secretariat Road
15	Point	Mobil Mart	600538.664	819865.843	Bodija-Secretariat Road
16	Point	Total Filling Station	599607.495	818490.39	Along Secretariat Road
17	Point	Mobil Filling Station	599025.239	818192.261	Total Garden-Gate Road
18	Point	Total Filling Station	600294.442	817929.343	Along Gate-Idi-Ape Road
19	Point	Oando Filling Station	600377.241	817929.343	Along Gate-Idi-Ape Road
20	Point	Total Filling Station	600359.339	817848.700	Along Gate-Yemetu-Oje Road
21	Point	Total Filling Station	599225.887	817601.165	Along Adeoyo-Yemetu Road
22	Point	Oando-Egarton Filling Station	599773.070	817262.432	Along Yemetu Expressway
23	Point	Conoil Filling Station	600457.050	817047.467	Bashorun Expressway
24	Point	Total Filling Station	600059.690	816754.333	Along Bashorun Expressway
25	Point	Conoil Filling Station II	600346.310	816936.727	Along Bashorun Expressway
26	Point	Oando-Taffy North Service Station	599681.873	816356.974	Along Basorun Expressway
27	Point	Oando Filling Station	598349.160	818130.131	Mokola-Gate Road, Ibadan
28	Point	Ap Filling Station	598227.883	818065.703	Mokola-Dugbe Road
29	Point	Total Mokola Service Station	598193.774	818145.291	Adjacent Underbridge Mokola, Ibadan
30	Point	Bovas Filling Station	598076.287	817872.418	Mokola-Dugbe road
31	Point	Waskha Petrol	597962.590	817717.033	Mokola-Dugbe Road, Ibadan
32	Point	Watt Oil and Gas	597858.704	817662.585	Mokola-Dugbe Road
33	Point	Bovas Fuel Station	597461.391	817262.658	Dugbe Expressway, Ibadan
34	Point	Total Aparapete Service Station	597194.773	817058.773	Dugbe Expressway, Ibadan
35	Point	Bovas Fuel Station	598371.029	817317.550	Dugbe Area, Ibadan
36	Point	Total Filling Station	597082.446	816890.290	Dugbe Area, Ibadan
37	Point	Dulum Petrol Station	596674.607	816658.846	Dugbe Road, Ibadan
38	Point	Total Filling Station	596810.530	816671.916	Dugbe-Oke-Ado Road
39	Point	Gabstab Filling Station	598849.438	816793.032	Along Yemetu-Oke Road
40	Point	Dammagok Oil	598625.997	816869.790	Along Bere-Oje Road
41	Point	Conoil Filling Station	599391.704	816039.643	Bashorun Expressway, Ibadan
42	Point	Total Filling Station	598275.681	815620.475	Along Bere Road, Ibadan
43	Point	Oando Filling Station	598906.395	815728.474	Bere Road, Ibadan
44	Point	Lister Petrol Station	599208.792	815724.154	Bashorun Expressway, Ibadan
45	Point	Manbay Fuel Station	600673.258	816082.710	Oje Area, Bere Road, Ibadan
46	Point	Halleluyah Fuel Station	599852.466	814894.722	Oje-Bere Road, Ibadan
47	Point	Oando Filling Station	598616.958	814648.484	Popo, Bere Road
48	Point	Alleluyah Petrol Station	598733.597	814099.850	Molete Expressway
49	Point	Conoil Filling Station	598465.759	813823.373	Molete Expressway Road, Ibadan
50	Point	Oando Filling Station	597710.935	814125.009	Along Ososami Road, Ibadan
51	Point	Total Filling Station	597333.808	815033.300	Liberty-Ososami Road, Ibadan
52	Point	MRS Filling Station	597292.983	815323.076	Along Ososami-Gege Road
53	Point	Forte Oil	597292.983	815426.311	Ososami Road, Ibadan
54	Point	Nurdok Filling Station	597226.912	815546.064	Osasami Road, Ibadan
55	Point	Gastab Filling Station	597275.386	815725.195	Ososami Road, Ibadan
56	Point	Total-Lagos Bypass Service Station	596001.026	816063.892	Dugbe Road, Ibadan
57	Point	Total-New Reservation Service Station	595809.600	815357.456	Along Iyaganku Road, Ibadan
58	Point	Mobil Filling Station	595045.548	814481.995	Along Ring Road Expressway, Ibadan
59	Point	Forte Oil	595007.695	814388.992	Along Ring Road Expressway, Ibadan
60	Point	Ap Filling Station	595678.616	813929.818	Liberty Road, Ibadan
61	Point	Total Ring Road Service Station	595751.453	813776.859	Along Ring Road Expressway, Ibadan
62	Point	BeeDeen Petrol Station	595944.746	816827.1	Dick Road, Ibadan
63	Point	Conoil Filling Station	596397.815	817342.675	Onireke Road, Ibadan
64	Point	Total Eleyele I Service Station	596330.832	818159.977	Along Onireke Road, Ibadan
65	Point	MRS Filling Station	598777.854	819869.722	Sango-Mokola Road, Ibadan
66	Point	Oando Filling Station	598748.719	819760.466	Sango-Mokola Road, Ibadan
67	Point	First Royal Oil	598526.565	819403.562	Sango-Mokola Road
68	Point	Oando Filling Station	598120.095	818833.613	Sango-Mokola Road, Ibadan
69	Point	Gastab Filling Station	599081.900	820650.982	Sango-Eleyel Road, Ibadan
70	Point	Watt Oil and Gas	597907.907	817740.809	Sango-Mokola Road

A. Discussion of Results

a) Distance between filling stations: From the study area, it shows that, filling stations is too clustering and this resulted in non compliance with the International Standard. The result from this study shows that distances between one filling station to the other filling station along the same route reveals twenty-three (23) 32.86% that conform with the international standard of 1000m (1km) (see Fig. 9) while the remaining forty-seven (47) 67.14% was not in conformity. The spatial distribution of filling stations (4 filling stations in 1 km) contradicts international standards, that is, 2 stations within 1 km [20] and his result is similar to the result of findings of this study.

This fact was consistent with findings obtained from a previous study conducted by [21], which indicated that irregular and unsound urban development is the common problem of all urban settlements today; and that the increasing continuation of this problem is inevitable in this order, where the economy-ecology balance is not taken into consideration and economic concerns always win.

TABLE2
FILLING STATIONS THAT CONFORMED WITH THE INTERNATIONAL STANDARD OF 1 KILOMETER FROM THE STUDY AREA

S/N	Filling Station to Filling Station	Distance Between Stations (km)	Route
1	Total Eleyele I service station to Oando	2.32	Along Eleyele–Onireke Road
2	Ascon to Total Eleyele I service station	1.11	Along Sango-Eleyele Road, Ibadan
3	Total Eleyele I service station to Nipco	1.08	Along Sango-Eleyele Road, Ibadan
4	Mobil filling station to Total filling station.	1.01	Along Sango-Ojoo Road, Ibadan
5	Halleluyah to Mambaw filling station	1.43	Along Oje road, Ibadan
6	Lister Petrol station to Halleluyah fuel station	1.04	Along Kobomoje street Oje-Rd, Ibadan
7	Total filling station to Oando station	1.04	Along Popo-Bere Road, Ibadan
8	Total filling station to Oando station	1.00	Along Dugbe-Awolowo Road, Ibadan
9	Bovas filling station to Mobil Mart	1.20	Along Bodija-Secretariat Rd, Ibadan
10	Oando filling station-Ap filling station	1.29	Along Total Garden-Agodi Gate Road
11	Ap filling station to Total filling station	1.99	Along Liberty Road, Ibadan
12	Forte oil to Total Ring Road service station	1.01	Along Ring Road Expressway, Ibadan

b) Distance of 50m (164 feet) radius between filling stations to the nearest Residential houses/Public institution: The infringements of required distances between filling stations, the distances between the filling stations and the nearest houses/places of public assembly are clear indications of pressing concerns about the health and safety hazards these filling stations posed and the hazards residents were prone to [11].

This fact is further proven by the finding by [22] which stated that the siting of fuel stations in close proximities and within residents flout standards. The result of this study showed that only 5 (7.14%) filling stations comply with the 50m radius distance to the residential/public institution while 65 (92.86%) of filling stations (Fig. 6) did not comply with 50m radius as stipulated by the [23].

The five filling stations are; MRS filling station along Dugbe-Awolowo road, Oando filling station along Sango-Mokola expressway, Total filling station along Yemetu Oja expressway, Forte oil and Total Ring Road service station along Ring road expressway.

However, Fig. 3 reveals that, most of the filling stations are established in a developed area and in some of these areas, residential houses and other public institutions were majorly located.

B. Questionnaire data analysis

Data analysis was also done by non-parametric method of Chi-square ($\varkappa^2$) to test for effects of location of filling station on residential houses and public institutions, and people's health.

The degree of freedom (df) or critical value were calculated as follows

Df = (R-1) (C-1). Where R = number of rows = 3

C = number of column = 4

= (3-1) (4-1)

= 2 x 3 = 6

Df = 12

For this study, 95% level of confidence and 5% level of significance were used, the degree of freedom (df) at 6 = 12.592 which is approximately equal to 12.59.

Expected frequency (E) = $\frac{\text{Total Number of respondents}}{\text{No of responses option}}$

Expected frequency (E) = $\frac{250}{3}$

= 83.3

C. Residential Houses and Public Institutions

a) Location of filling station has no significant effects on Residential Houses and Public Institutions

TABLE3A

CHI-SQUARE ANALYSIS SHOWING THE EFFECTS OF LOCATION ON RESIDENTIAL HOUSES AND PUBLIC INSTITUTIONS

Responses options (O) and their percentages					
Variables	**A %**	**SA %**	**D %**	**S D %**	**Row Total**
Location of filling station at nearby residential houses and public institutions is dangerous as insurgence of tanker explosion lead to loss of lives and properties.	85 34.0%	121 48.4%	28 11.2%	16 6.4%	250
Location of filling station improves the standard of living of people in your area.	14 5.6%	24 9.6%	81 32.4%	131 52.4%	250
Location of filling station contributes positively to your environment in terms of development.	29 11.6%	18 7.2%	85 34.0%	118 47.2%	250
Column Total	**164**	**127**	**194**	**265**	**750**

Sources: Author field work, 2021

TABLE3B

RESULT OF THE HYPOTHESES ON RESIDENTIAL HOUSES AND PUBLIC INSTITUTIONS

Hypotheses	**Options (O)**	**Exp. Freq. (E)**	**O-E**	**$(O-E)^2$**	**$\frac{(O-E)^2}{E}$**	**$(x^2)\ \sum\frac{(O-E)^2}{E}$**	**Df**	**Critical value**	**Remarks**
H_O 1	85	83.3	1.7	2.89	0.03	108.22	6	12.59	H_O1 Rejected
	121	83.3	37.7	1421.29	17.06				
	28	83.3	-55.3	3058.09	36.71				
	16	83.3	-67.3	4529.29	54.37				
Total	**250**	**333.2**	**-83.2**	**9014.56**	**108.17**				
H_O 2	14	83.3	-69.3	4802.49	57.65	127.25	6	12.59	H_O2 Rejected
	24	83.3	-59.3	3516.49	42.21				
	81	83.3	-2.3	5.29	0.06				
	131	83.3	47.7	2275.29	27.31				
Total	**250**	**333.2**	**-83.2**	**10599.56**	**127.23**				
H_O 3	29	83.3	-54.3	2948.49	35.40	101.08	6	12.59	H_O3 Rejected
	18	83.3	-65.3	4264.09	51.19				
	85	83.3	1.7	2.89	0.03				
	118	83.3	34.7	1204.09	14.45				
Total	**250**	**333.2**	**-83.2**	**8419.56**	**101.07**				

Sources: Author computation, 2021

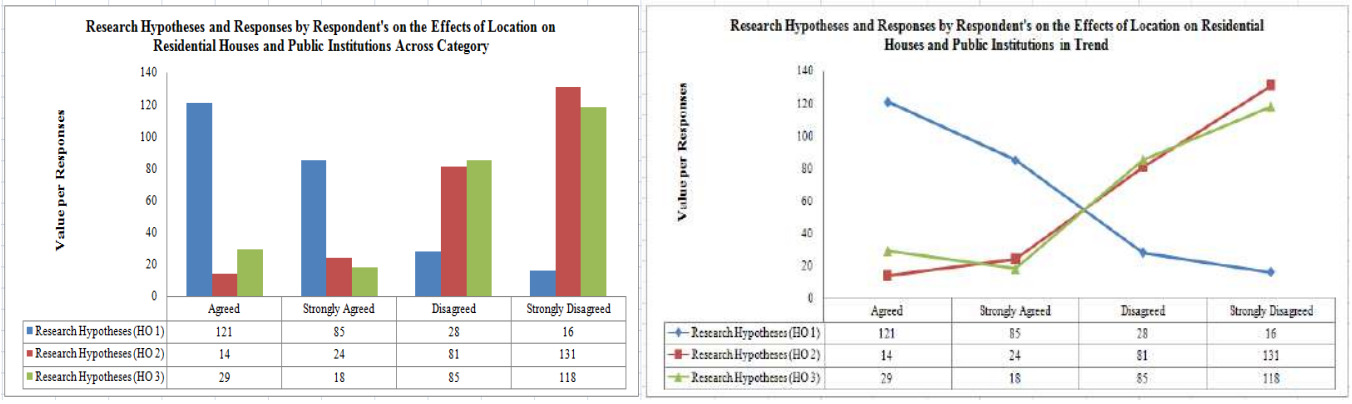

Fig. 10: Showing respondent's responses across category and in trend

From TABLE 3(a & b), the calculated chi-square (x^2) values are; 108.22, 127.25, and 101.08for hypotheses 1, 2, and 3 respectively on environment which indicate a degree of freedom of 6, and calculated chi-square (x^2) value of 108.22, 127.25, and 101.08 is greater than the critical value of 12.59. Since the calculated X^2 value of 108.22, 127.25, and 101.08 was greater than the table value of 12.59 thus, the null hypothesis 1 (H_O (1-3)) was rejected. This shows that location of filling stations had significant effects on the residential houses and public institutions. Therefore, this result is similar to the result obtained by ([24], [25]).

D. People's Health

a) Location of filling stations has no significant effects on people's health

TABLE4A

CHI-SQUARE ANALYSIS SHOWING THE EFFECTS OF LOCATION OF FILLING STATIONS ON PEOPLE'S HEALTH

Variables	A %	SA %	D %	S D %	Row Total
Location of filling stations cause several physical, chemical and human interaction risks (ergonomic hazards).	37 14.8%	182 72.8%	20 8.0%	11 4.4%	250
Location of filling stations from exposure to diesel, petroleum fumes and fuel components such as benzene and formaldehyde contributes to tiredness leading to vomiting, cancers and acute myeloid leukemia and acute non-lymphocytic leukemia.	42 16.8%	186 74.4%	16 6.4%	6 2.4%	250
Location of filling stations at nearby hospital can endanger patient mental ability.	62 24.8%	173 69.2%	9 3.6%	6 2.4%	250
Column Total	**88**	**374**	**98**	**190**	**750**

Sources: Author field work, 2021

TABLE4B

RESULT OF THE HYPOTHESES ON PEOPLE'S HEALTH

Hypotheses	Options (O)	Exp. Freq. (E)	O-E	$(O-E)^2$	$\frac{(O-E)^2}{E}$	$(x^2)\ \sum\frac{(O-E)^2}{E}$	Df	Critical value	Remarks
H_O 1	37	83.3	-46.3	2143.69	25.73	253.54	6	12.59	H_O1 Rejected
	182	83.3	98.7	9741.69	116.95				
	20	83.3	-63.3	4006.89	48.10				
	11	83.3	-72.3	5227.29	62.75				
Total	**250**	**333.2**	**-83.2**	**21119.56**	**253.53**				
H_O 2	42	83.3	-41.3	1705.69	20.48	273.20	6	12.59	H_O2 Rejected
	186	83.3	102.7	10547.29	126.62				
	16	83.3	-67.3	4529.29	54.37				
	6	83.3	-77.3	5975.29	71.73				
Total	**250**	**333.2**	**-83.2**	**22757.56**	**273.20**				
H_O 3	62	83.3	-21.3-	453.69	5.45	240.04	6	12.59	H_O3 Rejected
	173	83.3	89.7	5975.29	96.59				
	9	83.3	-74.3	5520.49	66.27				
	6	83.3	-77.3	8046.09	71.73				
Total	**250**	**333.2**	**-83.2**	**19995.56**	**240.04**				

Sources: Author computation, 2021

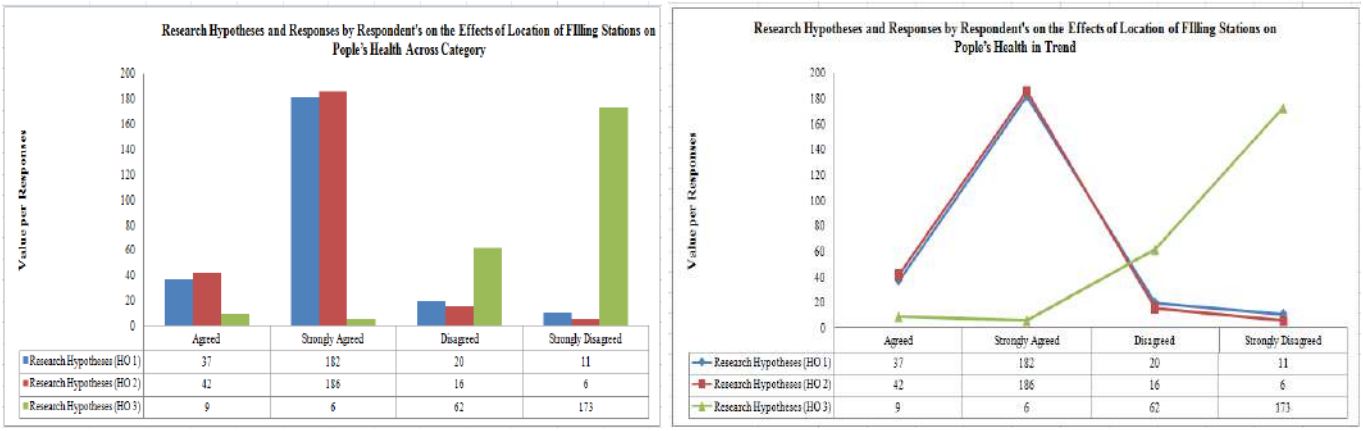

Fig. 11: Showing respondent's responses across category and in trend

From TABLE 4 (a & b), the calculated chi-square (x^2) values are; 253.54, 273.20, 240.04for hypotheses 1, 2, and 3 respectively on peoples heath which indicates a degree of freedom of 6, and calculated chi-square (x^2) value of 253.54, 273.20, 240.04 is greater than the critical value of 12.59. Since the calculated X^2 value of 253.54, 273.20, 240.04 was greater than the table value of 12.59 thus, the null hypothesis 2 (H_O (1-3)) was rejected. Therefore, the result shows that, locations of filling stations had significant effects on the people's health in the study area. The result from this study is similar to the result obtained by ([24], [25]).

E. Potential Health Risks Associated with the Rapid Increase of filling stations in the Study Area

From the result of TABLE 3A, it shows that 121(48.4%) answers from respondents' out of 250 strongly agreed that location of filling station at nearby residential houses and public institutions is dangerous as insurgence of tanker explosion lead to loss of lives and properties.

Gattas et al. (2001) [26] as stated by [27] indicated that exposure to diesel, petroleum fumes and fuel components such as benzene and formaldehyde contribute to cancers, acute myeloid leukemia and acute non-lymphocytic leukemia. The formulated research hypotheses question two (H_2) from the results shows that, 186 (74.4%) out of 250 respondents' strongly agreed with [26]. Several empirical studies have shown that, fuel stations provide suitable grounds for fire outbreaks and expose employees and residents to several physical, chemical and ergonomic hazards [28].

From the hypotheses results, it shows that, 182 (72.8%) out of 250 respondents' strongly agreed with [28] and 173 (69.2%) out of 250 strongly agreed that nearby hospital endangered patient mental ability. Generally from the result of the formulated hypotheses, it shows that location of filling stations closer to Residential houses and Public institutions has significant effects on the health of the people within the location of such filling station (TABLE 4A) as the responses from the respondents' is in agreement with the statement made by ([26], [28]).

V. CONCLUSION

This study has used field method, remote sensing and GIS application to show the spatial location and conformity standard between filling stations. From the findings of this study, it was observed that location of filling stations had significant effects on residential houses/public institutions and people's health as all hypotheses formulated was null and rejected. The result also reveals that International Standard (IS) of one kilometer distance between filling stations was not followed and 50m (164 feet) distance from filling stations to Residential houses/Public institutions stipulated by the Energy Regulation Board (ERB) were not followed in siting filling stations except in five locations.

It is therefore recommended that any filling stations that are not in compliance with the International Standard and Energy Regulatory Board should be sanctioned and prosecuted by the concern authority such as Department of Petroleum Resources (DPR). Government urgent attention is needed both Federal and State as the rate at which petrol stations competes with residential houses and public institutions.

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