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Comparative Assessment of Air Quality Around Dominant Landuse Regions of Somolu and Surulere Local Government Areas of Lagos State, Nigeria

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ABSTRACT

Concerns about quality of air in the cities are on the increase but the relative contribution by various anthropogenic and landuse activities have remained shrouded in obscurity. The paper mapped the dominant landuses in Somolu and Surulere Local Government areas (LGAs) of Lagos State and assessed their surrounding air quality in 2017 with a view to establish the quality indexes and conformity with regulatory standards. Data for the landuses were generated using Pleaides satellite imagery at 2.5m spatial resolution while the ambient air quality were measured in-situ across 22 and 26 sampled points respectively in the LGAs. The results show preponderance of residential, transportation, commercial and institutional landuses in the two LGAs over industrial, forested wetlands and water bodies. Temperature, noise, CO and CO_2 are higher generally around transportation and commercial landuses but lowest around residential areas. Sampled sites in Somolu have higher CO and noise quality indexes than site in Surulere but Somolu has more of CO_2; given all the parameters found within acceptable limits. The study justifies the need for monitoring gaseous pollutants in the LGAs more so when it discovers that the landuses which are important determinants of the ambient values are changing rapidly.

KEYWORDS: Urban Land use, Air quality, Surulere, Somolu

INTRODUCTION

Ambient air (air found in the environment) is one of the major natural resources that significantly aid human's existence and continuous survival. The quality of air in the environment cannot be compromised because it is very crucial especially as it regards the quality of life of man on earth. An average man breathes 22,000 times each day which makes the air the main key to life as man cannot do without it (Zagha and Nwaogazie, 2015). The quality of air in the environment therefore determines the quality of life. However, it has been observed over the years that the ambient air is highly polluted by man through his varying activities which leaves unintended consequences. Therefore, there has been a general interest in air pollution studies (Subramani, 2012). Air pollution is seen as the contamination of air by discharge of harmful substances, causing harm to man, which is not confined to physical injury but encompasses irritation caused to any of his senses or harm to his property (Ramamohana, 2017).

The air becomes polluted whenever there is a discharge of substances beyond a particular threshold into the air which is majorly caused by anthropogenic factors. Balogun and Orimogunje (2015), observed that man induced factors, especially landuse activities, have played a greater role in altering the quality of air in city all over the world. Mucher *et al*. (1993) defines landuse as 'a series of operation that is carried out by humans on land, with the intention to obtain products and/or benefits through the use of land resources'. Some categories of landuses do not emit air pollutants directly into the environment but because of the activities they are involved in, they attract other sources that do.

Pollution has been overtime related to different landuses especially industrial and transportation (Ajayi and Dosunmu, 2002; Akanni 2010; Nwandinigwe 2015) and it is believed generally to be caused principally by anthropogenic activities, especially industries, vehicular emissions with lesser concern about cooking from homes and public places. Poor air quality is a global problem and the need to monitor it is also universal as seen from numerous researches on the issue, especially as it relates to cities in Nigeria as seen in the works of Koku and Osuntogun (2007); Soneye (2012); Balogun *et al.* (2015); Njoku *et al*. (2016) to mention a few. Although, pollution can occur naturally through volcanic eruption, earthquakes etc., these have not been responsible for this part of the world. Therefore, understanding the spatial patterns of landuse and its implication on air quality and the environment is very important for planning and policy making.

This paper examined the ambient air quality around dominant landuses of Shomolu and Surulere Areas by assessing the distribution of landuse, establishing the level of ambient air concentration around the different landuses and their conformity with existing standards. And also determine the air quality index for the different landuses within the area.

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MATERIALS AND METHODS

The Study Area

Shomolu Local Government Area is located between Longitude 3.366ºE and 3.411ºE of the Greenwich meridian and between latitude 6.517ºN and 6.599ºN of the equator (Fig.1) (Google Earth). The local government is bounded on the North and North east by Kosofe Local Government, on the west by Mushin Local Government and South by Lagos Mainland Local Government and occupies an area of 11.46km^2. Surulere on the other hand is located between longitude 3.314ºE to 3.389ºE of the Greenwich meridian and latitude 6.457ºN to 6.521ºN of the equator (Google Earth). It occupies an area of 23 km²and was carved out of the old Mainland Local Government on 27th August 1991. The local government is bounded on the North by Mushin Local Government, on West by Amuwo Odofin Local Government and East by Lagos Mainland Local Government and south by part of Ajeromi Ifelodun and Apapa.Somolu and Surulere LGA are two of the seventeen LGA's of Lagos Metropolis (Akinmoladun and Adejumo, 2011).

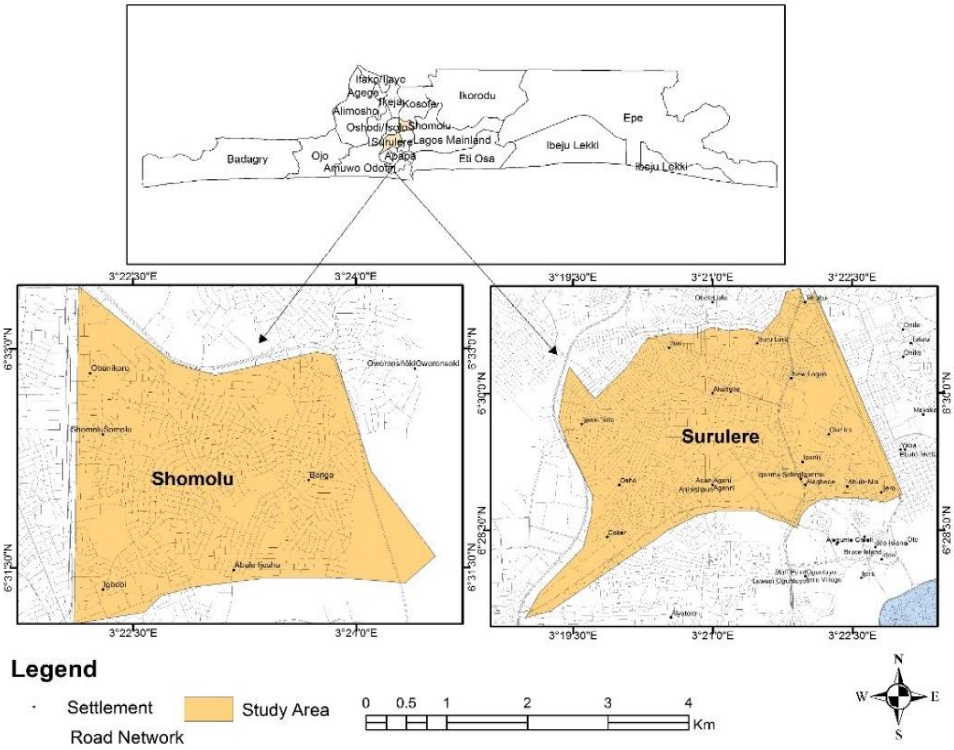


Figure 1. Map of Somolu and Surulere in Lagos State

The data that were used in this study includes the administrative map of Shomolu and Surulere Local Government Areas of Lagos state which gives an insight to the boundaries of the two local governments within the state. A street guide of Lagos State which provides the road network and street name for easy identification and accessibility to unknown places. Pleaides imagery with 2.5m spatial resolution covering the two LGA's was used which gives a synoptic view of the two local government areas and allows for image analysis and then comparison. Also, the Garmin 72H, GPS was used to obtain the coordinates of locations where measurements were taken for spatial analysis. Academic journals, articles, publications that provides information on air quality issues, how assessment of air quality is done, monitoring of air quality, standards of measurement, unit of measurement, effects of poor air quality on man and the environment were also sourced. Level 2 classification scheme adopted after Anderson (1976) was used for the landuse of the study area as shown in Table 2.

Table 1: Data and their characteristics

Data	Type	Date	Source	Scale/Resolution
Pleaides Imagery	Spatial	2017	GoogleEarth	2.5m
Samples Locations	Spatial	Fieldwork (2017)	Garmin 72H GPS)	-

Table 2: Land use and their description

Land use	Description
Residential	This is a landuse in which housing predominates. These include single family housing, multi-family residential, storey buildings, bungalows, estate etc.
Commercial	These are areas used by profit businesses such as offices, complexes, shopping malls, and markets. They are those used predominantly for the sale of products and services.
Industrial	Industrial areas include a wide array of landuses from light manufacturing to heavy manufacturing plants.
Transportation	These include major transportation routes, highways and railways.
Institution	This includes various educational, health and administrative facilities. However, Small institutional units, for example some secondary and elementary schools, are included within another category, such as residential.
Wetland	These are where the water table is at near or above the surface for a significant part of most years.
Water	These include areas cover mainly with water such as lagoon, rivers, creeks and ponds.

The systematic sampling approach used was based on landuse category that was developed and the spatial distribution of sampling sites. The parameters that were assessed include: CO, CO_2, measured in Parts per million (ppm), and temperature. The field work was done for 10 days in each of the study areas consecutively due to the unavailability of instrument in pairs. A total number of 22 and 26 sampling locations were visited in Shomolu and Surulere respectively. The spatial distributions of sampling sites are shown in Figure 2 and Table 3.

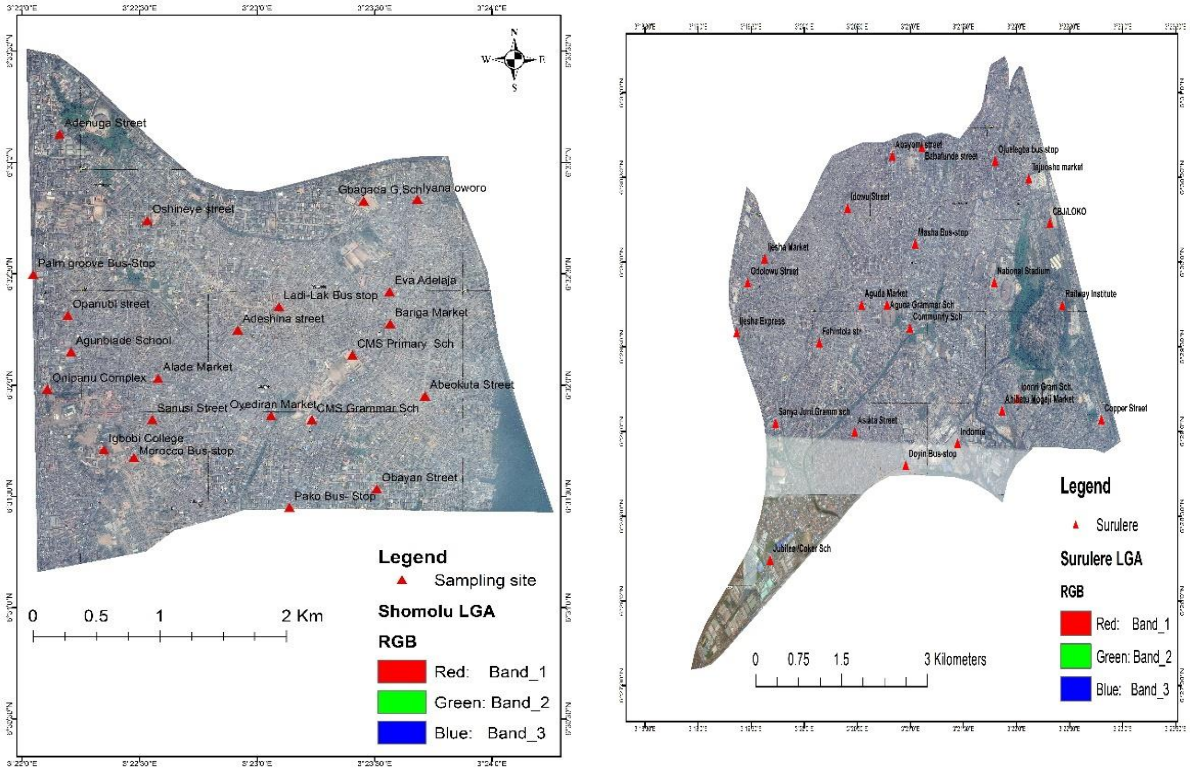


Figure 2: Spatial distribution of sampling locations in the LGAs.

The Air Quality Indexes

The Air Quality Index in Somolu and Surulere was calculated using a formular suggested by Tiwari and Ali (1987) and which was improved upon by Kaushik *et al*. (2007).

$$\text{Quality rating} = \frac{\text{The observed value of pollutant (ppm)}}{\text{The recommended values of NAAQS (ppm)}}$$

Table 3: Distribution of the sampling locations for Air Quality Measurements

Landuse	S/N	Shomolu Long (^{0}E)	Shomolu Lat (^{0}N)	Shomolu Location	Surulere Long (^{0}E)	Surulere Lat (^{0}N)	Surulere Location
Transportation	1	3.38553	6.52390	Pako Bus Stop	3.36332	6.509980	Ojuelegba bus stop
	2	3.39471	6.54726	I/Oworo Bus Stop	3.35054	6.501926	Masha Bus-stop
	3	3.38489	6.53920	Ladi-lak Bus-Stop	3.34927	6.480030	Doyin Bus-stop
	4	3.36744	6.54160	P/Groove Bus stop	3.32272	6.493080	Ijesha Express
	5	3.374599	6.52790	Morroco round about	-	-	-
Residential	6	6.525547	3.39183	Obayan Street	3.35179	6.511320	Babatunde Street
	7	3.38197	6.53745	Adeshina Street	3.34717	6.510450	Agboola Street
	8	3.37555	6.54567	Oshineye Street	3.33987	6.556330	Abayomi Street
	9	3.3699	6.53856	Opanubi Street	3.33570	6.492060	Fehintola Street
	10	3.369324	6.55211	Adenuga Street	3.32445	6.497990	Copper Street
	11	3.395242	6.53251	Abeokuta Street	3.38001	6.484509	CBJ/Loko
	12	3.37629	6.53212	Sanusi Street	3.37189	6.503862	Asiata Street
	13	-	-	-	3.32445	6.497990	Odolowu Street
	14	-	-	-	3.34847	6.492550	Idowu Street
Commercial	15	3.39237	6.53836	Bariga market	3.36844	6.508240	Tejuosho market
	16	3.36845	6.53303	Onipanu Complex	3.32710	6.500360	Ijesha Market
	17	3.37632	6.53383	Alade market	3.34234	6.495820	Aguda Market
	18	3.3845	6.53042	Oyediran market	3.36439	6.485400	Abibatu Mogaji Market
	19				3.34632	6.495820	Aguda Grammar Sch
Institutional	20	3.38722	6.53074	CMS Grammar Sch	3.34994	6.493520	Community School
	21	3.39009	6.53558	CMS Pry Sch	3.32803	6.470520	Jubilee School
	22	3.39273	6.54033	Evans Adelaja	3.32884	6.484160	Sanya Junr Grams
	23	3.38951	6.54703	Gbagada Grams	3.36718	6.486090	Iponri Grams
	24	3.37256	6.52613	Igbobi Boys College.	3.75857	6.489724	St' Saviour school
	25	3.37013	6.53582	Agunbiade Pry Sch	3.36318	6.498010	National Stadium
Recreation	26	-	-	-	3.37385	6.495761	Railway Institute
Industrial	27	-	-	-	3.3574	6.482180	Indomie

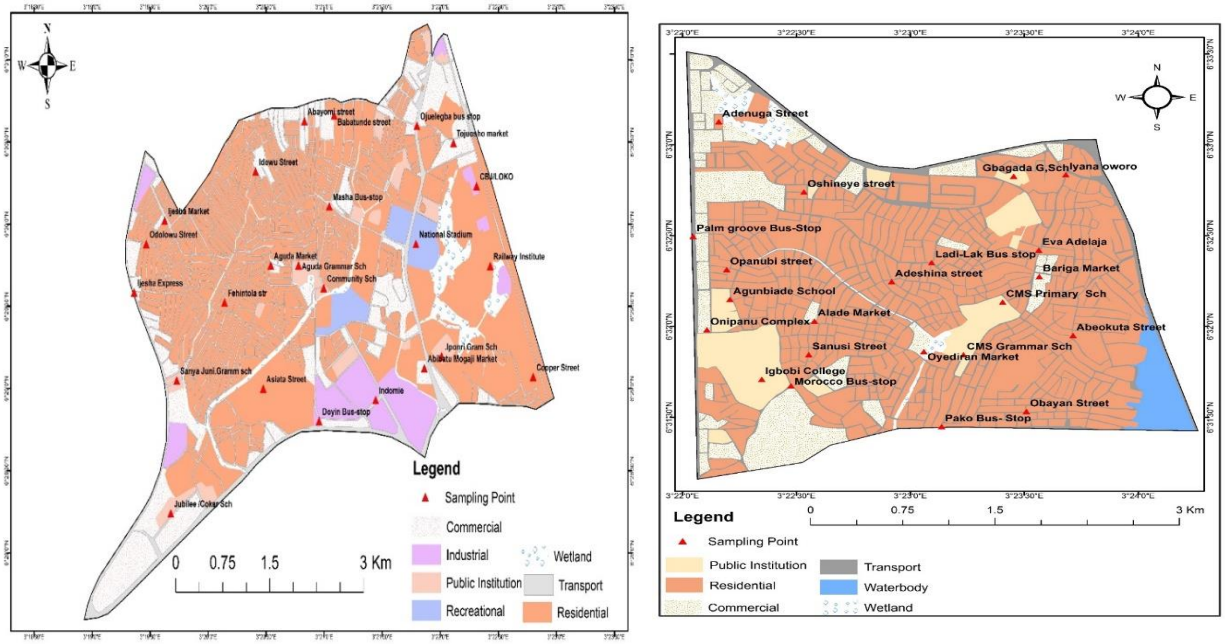
RESULTS AND DISCUSSION

Land Use Distribution

Surulere LGA is dominated by residential landuse, followed by transportation and commercial covering large proportions of 12.4 km^2 (53.6%), 3.2 km^2 (14.2%), and 3.2 km^2 (13.9%) respectively as shown in Figure 3 and Table 4. Other landuses include industrial uses covering 3.0 km^2 (8.6%), which was actually found around the south-western part of the local government, public institution 0.8 km^2 (2.86%), recreational 0.6 km^2 (2.7%), and wetland km^2 (4. 3%). The landuse of Shomolu LGA is also pronounced by residential, transport and commercial covering large proportions of 6.7 km^2 (58.3%), 1. 9 km^2 (15.2%), and 1.5 km^2 (12.9%). Other landuses include wetland covering 0.2 km^2 and waterbody (lagoon) around the south-eastern part of the study area. Public Institution covered 0.9 km^2 (8.08%) and wetland 0.2 km^2 (2.1%).

Table 4: Area and Percentage coverage of landuses in Shomolu and Surulere LGA

Land use/Land cover	Shomolu Area (km^2)	Shomolu Percentage	Surulere Area (km^2)	Surulere Percentage
Residential	58.3	6.7	12.4	53.6
Commercial	1.5	12.9	3.2	13.8
Public Institution	0.9	8.1	0.8	3.3
Transport	1.9	16.0	3.2	13.8
Wetland	0.2	2.1	1	4. 3
Water	0.3	2.8	0.0	0.0
Industrial	0.0	0.0	1.3	5.9
Recreational	0.0	0.0	0.6	2.6



(a) Surulere. (b) Shomolu.

Figure 3: Land use distribution of the LGAs from the data analysis

The Ambient Air Quality at the selected Landuse sites

The concentration of CO, CO_2, Noise and Temperature are shown in Table 6.

Table 6(a): CO concentration across the Landuses in the LGAs

	Shomolu		**Surulere**	
Landuse	**Min**	**Max**	**Min**	**Max**
Residential	-	-	1ppm	1ppm – 5 ppm
Commercial	1ppm - 2ppm	3ppm - 10ppm	1ppm	1ppm – 5 ppm
Institution	1ppm	2ppm	1ppm	1ppm
Transportation	1ppm - 2ppm	1pp - 7ppm	1ppm- 2ppm	4ppm 30ppm

Table 6(b): CO_2 concentration across the Landuses in the LGAs

	Shomolu		**Surulere**	
Landuse	**Min**	**Max**	**Min**	**Max**
Residential	105-128ppm	153 -203ppm	170 - 192ppm	211 - 245ppm
Commercial	126 - 468ppm	219 - 1753ppm	165 - 195ppm	244 - 251ppm
Institution	107 - 146ppm	164 - 420ppm	175 - 187ppm	205 - 250ppm
Transportation	127- 230ppm	310 - 650ppm	165 - 197ppm	232 - 250ppm.

Table 6(c): Noise Concentration across the Landuses in the LGAs

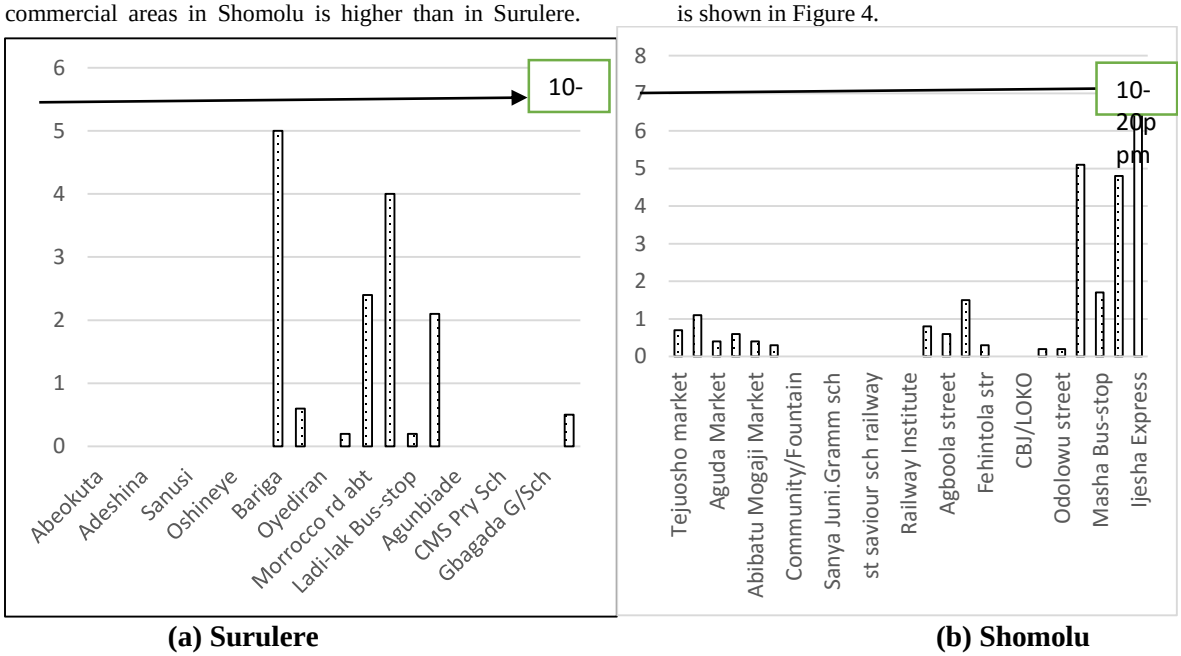
	Shomolu		**Surulere**	
Landuse	Min	Max	Min	Max
Residential	40.1 - 55.1dB	57.5 - 78.6dB	39.6dB - 63.6dB	62.4dB - 81.2dB
Commercial	39.4 - 51.9dB	73.1 - 89.4dB	58.9dB - 70.1dB	79.8Db - 82.3dB
Institution	40 - 52.3dB	59.6 - 170dB	52.1dB - 64.3dB	61.2dB - 76.5dB
Transportation	53.4 - 72.1dB	84.9 - 89.9dB	57.4dB and 74.5dB	83.4dB - 87.5dB

Table 6(d): Temperature Ranges across the Landuses in the LGAs

	Shomolu		Surulere	
Landuse	**Min**	**Max**	**Min**	**Max**
Residential	27.1^0C - 28.3^0C	28.4^0C - 35.8^0C	26.2^0C - 28.8^0C	30^0C - 32.7^0C
Commercial	27.3^0C - 27.8^0C	32.1^0C - 34.1^0C	27.1^0C - 28.8^0C	30^0C - 31.9^0C
Institution	26.9^0C - 28.3^0C	26.9^0C - 33.8^0C	26.6^0C - 29.9^0C	30.9^0C - 32.9^0C.
Transportation	23.4^0C - 27.9^0C	31^0C - 35.4^0C	26.2^0C - 28.8^0C	30^0C - 32.7^0C

Comparative Analysis of the Air Quality

The landuses that were identified within the Shomolu and Surulere LGAs were the same except for recreational landuse that was identified in Surulere. For CO concentration in the ambient air, it was discovered that all residential areas in Shomolu has no readings for all the days while Surulere has. The CO concentration in commercial areas in Shomolu is higher than in Surulere. Meanwhile for institutional landuse, CO was not recorded except at one location but the level is higher in Shomolu. For transportation landuse the CO concentration was quite high in Shomolu when compared with other landuses but very high in Surulere. Therefore, from the observed results, across all landuses, CO concentration in Surulere is higher than in Shomolu but was still below existing limits and this is shown in Figure 4.



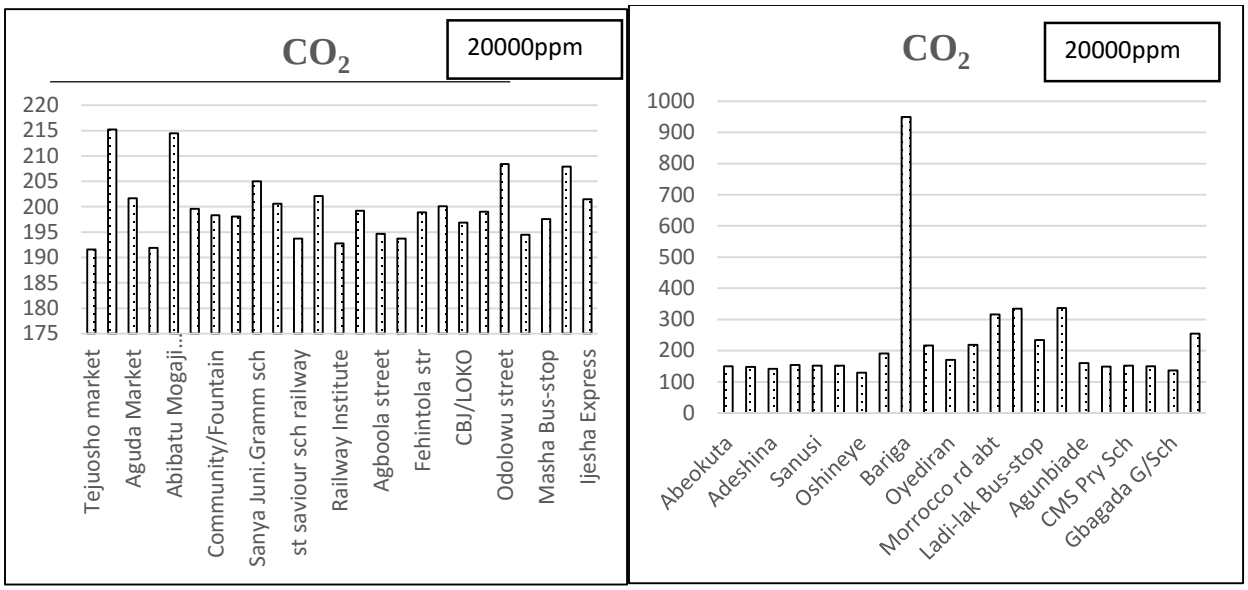
(a) Surulere **(b) Shomolu**

Figure 4: Concentration of CO in the LGAs

Carbon dioxide within residential landuses, the levels were higher in Surulere than in Shomolu. For commercial landuses, the concentration was higher in Somolu than Surulere. For institution landuses the levels were higher in Surulere than inSomolu. For transportation landuse, CO_2 across all the selected locations were high in Somolu and Surulere. However, recorded values in Surulere were higher than in Shomolu but were still below existing permissible limits. The concentration is shown in Figure 5.

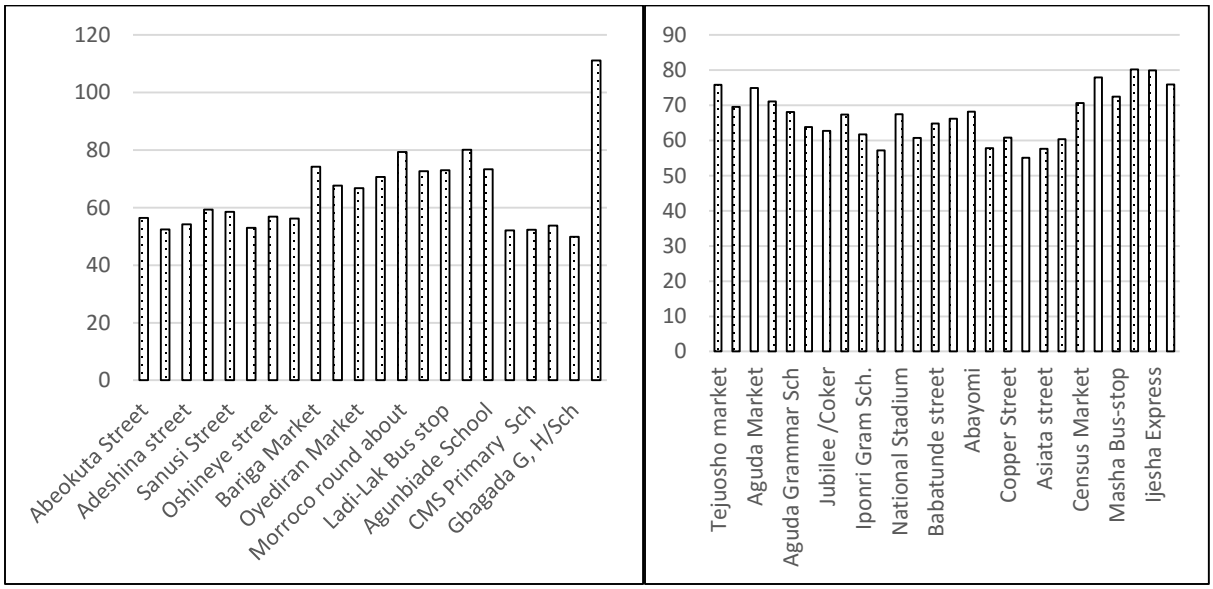
On noise, residential landuses, the noise levels in Surulere is higher than in Somolu. For commercial landuses levels in Surulere is higher than in Shomolu. For institution landuses, the noise level in Surulere is higher than in Shomolu. And lastly for transportation landuse, the noise level in Shomolu is higher than in Surulere. Generally, the noise level in Surulere is higher than in Shomolu (Figure 6)

For temperature it was observed that the temperature level both in Shomolu and Surulere were below existing limits at most of the selected locations except for some locations where it was slightly above 30^0c and this was attributed to street cooking activities around those locations.



(a) Surulere. **(b) Shomolu.**

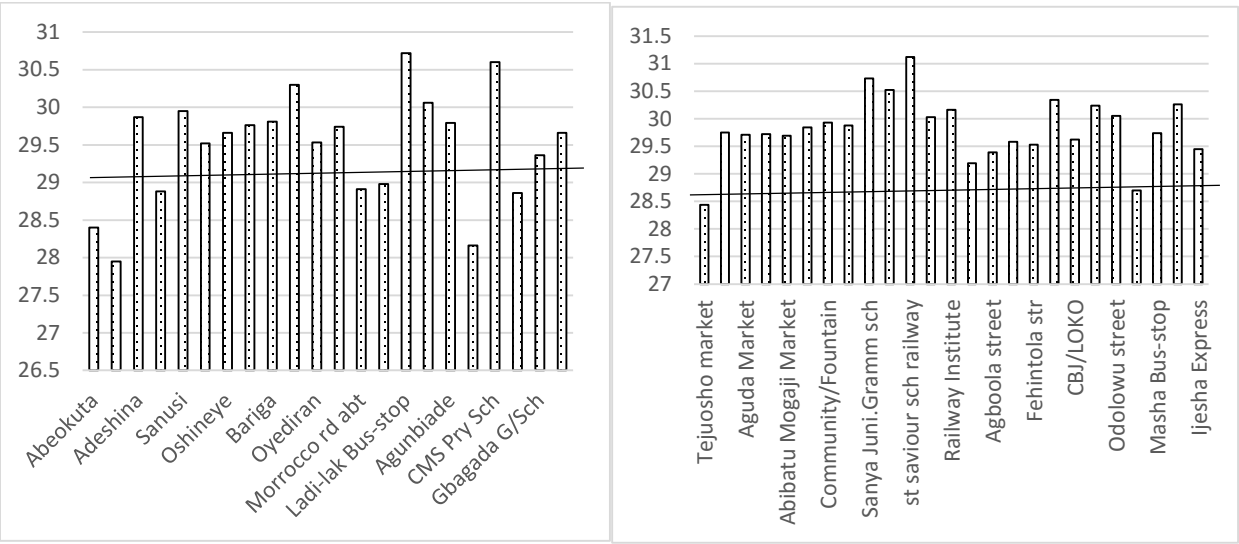
Figure 5: Concentration of CO_2 in the LGAs



(a) Surulere **(b) Shomolu**

Figure 6: Noise Levels in the LGAs

The results of Air Quality Index(AQI) as presented in Table 7a and 7b indicates the quality of CO and CO_2 at Shomolu and Surulere respectively.The result revealed that all the major streets in Shomolu and Surulere are very good expect for Ojuelegba Bus Stop,Masha Bus-Stop in Surulere and Bariga Market at Shomolu are poor(CO), while CO_2 is very good across the LGAs



(a) Surulere **(b) Shomolu**

Figure 6: Temperature Values in the LGAs

Table 7(a): Air Quality Index (AQI) of CO in the LGAs.

S/N	Surulere	AQI	Shomolu	AQI
1	Babatunde Street	Very Good	Abeokuta Street	Very Good
2	Agboola Street	Very Good	Adenuga Street	Very Good
3	Abayomi Street	Very Good	Adeshina Street	Very Good
4	Fehintola Street	Very Good	Obayan Street	Very Good
5	Copper Street	Very Good	Sanusi Street	Very Good
6	CBJ/Loko	Very Good	Opanubi Street	Very Good
7	Asiata Street	Very Good	Oshineye Street	Very Good
8	Odolowu Street	Very Good		
9	Idowu Street	Very Good		
10	Tejuosho Market	Very Good	Alade Market	Very Good
11	Ijesha Market	Very Good	Bariga Market	Poor
12	Aguda Market	Very Good	Onipanu Complex	Very Good
13	Census Market	Very Good	Oyediran Market	Very Good
14	Abibatu Mogaji Mkt	Very Good		
15	Aguda Grams	Very Good	Agunbiade Sch.	Very Good
16	Community/Fountain	Very Good	CMS Grams	Very Good
17	Jubilee /Coker	Very Good	CMS Pry Sch	Very Good
18	Sanya Jnr Grams	Very Good	Evans Adelaja	Very Good
19	Iponri Grams	Very Good	Gbagada Grams	Very Good
20	St Saviour School	Very Good	Igbobi College	Very Good
21	National Stadium	Very Good		
22	Railway Institute	Very Good		
23	Ojuelegba Bus Stop	Poor	Morocco	Good
24	Masha Bus-Stop	Poor	Pako Bus Stop	Moderate
25	Doyin Bus-Stop	Moderate	Ladi-Lak	Very Good
26	Ijesha Express		Palm-Groove	Good
27			Iyana Oworo	Very Good

Table 7(b): Air Quality Index (AQI) of CO_2 in the LGAs.

S/N	Surulere	AQI	Shomolu	AQI
1	Babatunde Street	Very Good	Abeokuta Street	Very Good
2	Agboola Street	Very Good	Adenuga Street	Very Good
3	Abayomi Street	Very Good	Adeshina Street	Very Good
4	Fehintola Street	Very Good	Obayan Street	Very Good
5	Copper Street	Very Good	Sanusi Street	Very Good
6	CBJ/Loko	Very Good	Opanubi Street	Very Good
7	Asiata Street	Very Good	Oshineye Street	Very Good
8	Odolowu Street	Very Good		
9	Idowu Street	Very Good		
10	Tejuosho Market	Very Good	Alade Market	Very Good
11	Ijesha Market	Very Good	Bariga Market	Very Good
12	Aguda Market	Very Good	Onipanu Complex	Very Good
13	Census Market	Very Good	Oyediran Market	Very Good
14	Abibatu Mogaji Mkt	Very Good		
15	Aguda Grams	Very Good	Agunbiade School	Very Good
16	Community/Fountain	Very Good	CMS Grams	Very Good
17	Jubilee /Coker	Very Good	CMS Pry School	Very Good
18	Sanya Jnr Grams	Very Good	Evans Adelaja	Very Good
19	Iponri Grams	Very Good	Gbagada Grams	Very Good
20	St Saviour School	Very Good	Igbobi College	Very Good
21	National Stadium	Very Good		
22	Railway Institute	Very Good		
23	Ojuelegba Bus Stop	Very Good	Morocco	Very Good
24	Masha Bus-Stop	Very Good	Pako Bus Stop	Very Good
25	Doyin Bus-Stop	Very Good	Ladi-Lak	Very Good
26	Ijesha Express	Very Good	Palm-Groove	Very Good
27			Iyana Oworo	Very Good

CONCLUSION

Landuse characteristics at varying intensity, contributes to the concentration of pollutants found within a geographical environment as these activities either generates pollutants to increase their concentration or attract activities that generates. It was discovered in this study that concentration of pollutants varies across different landuses with the highest concentration around transportation intercession. Although, the concentrations of pollutants were higher in Surulere than in Somolu, but they were still below the standards by World Health Organization and the existing national standard in Nigeria. As regards noise which was also considered in this study, the limits were exceeded especially at transportation intercession. From this study, it can be said that the air quality across different landuse within the two areas considered was good. However, this does not imply that the environment would remain constantly clean and therefore not monitored.

Monitoring the quality of air in the environment is key as this goes a long way to influence one's quality of life and maintaining a sustainable environment. Therefore, the air should be monitored continuously as to be able to know when the air quality is poor and the plants, animal life, humans and the environment at large are endangered and also to know the trends in pollutants concentration overtime. Also, there is need for the use of renewable source of energy which are environmentally friendly and which would also help to reduce pollutants generated into the environment.

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