Asian Journal of Advanced Research and Reports

14(4): 49-60, 2020; Article no.AJARR.59015
ISSN: 2582-3248

Noise Attenuation Using Vegetal Supported Barriers and Buffers Zones in Obio/Akpor, Port Harcourt, Nigeria

Mark Ogoro[1*], Idika Sandra Ezinne[1] and Dollah Osademe Chukwudi[2]

[1]Department of Geography and Environmental Management, University of Port Harcourt, Nigeria.
[2]Institute of Geosciences and Space Technology (IGST), Rivers State University, Nkpolu-Oroworukwo, Port Harcourt, Nigeria.

Authors' contributions

This work was carried out in collaboration among all authors. Author MO designed the study, performed the statistical analysis and wrote the protocol. Author ISE wrote the first draft of the manuscript. Authors ISE and DOC managed the analyses of the study. Author DOC managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJARR/2020/v14i430342
Editor(s):
(1) Dr. Fagbadebo Omololu Michael, Durban University of Technology, South Africa.
Reviewers:
(1) Debajyoti Bose, Shoolini University, India.
(2) Hu-Wenlin, China.
Complete Peer review History: http://www.sdiarticle4.com/review-history/59015

Original Research Article

Received 10 May 2020
Accepted 15 July 2020
Published 05 December 2020

ABSTRACT

Noise pollution is an unwanted sound which degrades the quality of our environment therefore, making the environment we live and work unpleasant for living. This situation is not different in Port Harcourt metropolis in the wake of increased human activities, which has resulted to and accelerates noise level. This situation has led to the adoption of possible measures to check noise levels using vegetal cover supported barriers. Hence, the need to examine environmental noise exposure attenuation using vegetal cover and its supported barriers. Environmental research design was employed and a total of twelve samples were collected for each barrier types with the aid of the digital noise meter (EXTECH instrument digital sound meter with RS232) to measure noise level in decibels (dBA). Findings revealed that areas with bare surfaces across its property corridor witnessed did not decrease noise levels at destination while surface with vegetation such as lawns within its property boundary corridor witnessed reduced noise levels of destination. It is therefore, recommended

**Corresponding author: Email: mark.ogoro@uniport.edu.ng;*

that vegetal surfaces walls should be encouraged to support erected noise barrier walls across the urban space in the bid of attenuating urban noise and make urban regions/areas more habitable.

Keywords: Noise; environmental; attenuation; vegetal; pollution corridor.

1. INTRODUCTION

Noise is a type of pollution not seen but heard; Noise pollution is the 3rd most hazardous environmental pollution by [1]. The impact of noise upon living quality has become an important aspect in the enactment of urban and environmental policy [2-4]. Noise is an unwanted sound that interrupts conservation; causes pain and inconvenience human activities in such environment. Noise pollution has become a common problem in big cities and could result in several health challenges such as deafness, nervous breakdown, mental disorders, heart troubles, dizziness and insomnia [5,6,7]. Obafemi [8] noted that noise was regarded ordinarily as an unwanted sound but in contemporary times, has become a unit which contributes immensely to degradation of the urban environment. Noise can be generated from different sources such as immobile or mobile facilities, indoor or outdoor sources [9-11]. Nevertheless, specific sites of noise pollution around our homes includes among others, transportation modes such as railways, airplane traffic and automobile traffic, blenders and fruit mixers at homes; emergency service sirens like ambulances, bullion vans, security vehicles, fire fighter trucks; electricity generators, loud music and public address systems [12,13].

Arana and Garcia [14] categorize noise as sound ranging between 30 and 65dBA, where 30dBA generally refers to the noise level at which people do not feel disturbed, while sound level at 45 – 65dBA refers to noise concentration that can cause disorders and unwillingness to work. Where noise level goes beyond 65dBA, the impacts on hearing organs as well as psychological disorders, permanent hearing losses and other negative effect not only on humans but also on a number of living things becomes visible [15-17]. In contrast to many other environmental problems noise pollution continues to grow and is accompanied by an increasing number of complaints from people exposed to it [18,19,20]. The rise in the pace of noise pollution alongside its cumulative adverse health effects is often neglected due to the ignorance of most people in the developing part of the world hence; little or no attention is paid to the reduction of this noise [21-23].

The attenuation of sound by vegetation is commonly attributed to processes of absorption and scattering [24,25,26]. Absorption and scattering from the surfaces of leaves, branches, trunks and the ground can alter the level of sound causing interference in the sound waves and a reduction in noise level [27]. To maximize noise attenuation, a vegetation barrier should ideally form an irregular structure comprising trees, shrubs, herbs and litter layers as shown in Fig. 1.

Plants have been used in many applications and environments to reduce environmental noise. In the most advanced societies, the planting of vegetal cover and barriers along freeways has helped to reduce the amount of noise distributed to adjacent communities along such highways [28,29,30]. Vegetation has many other known benefits to their environment and the people in them though noise reduction/attenuation is one of those less known benefits of plants within an environment especially in developing countries [31,32,33].

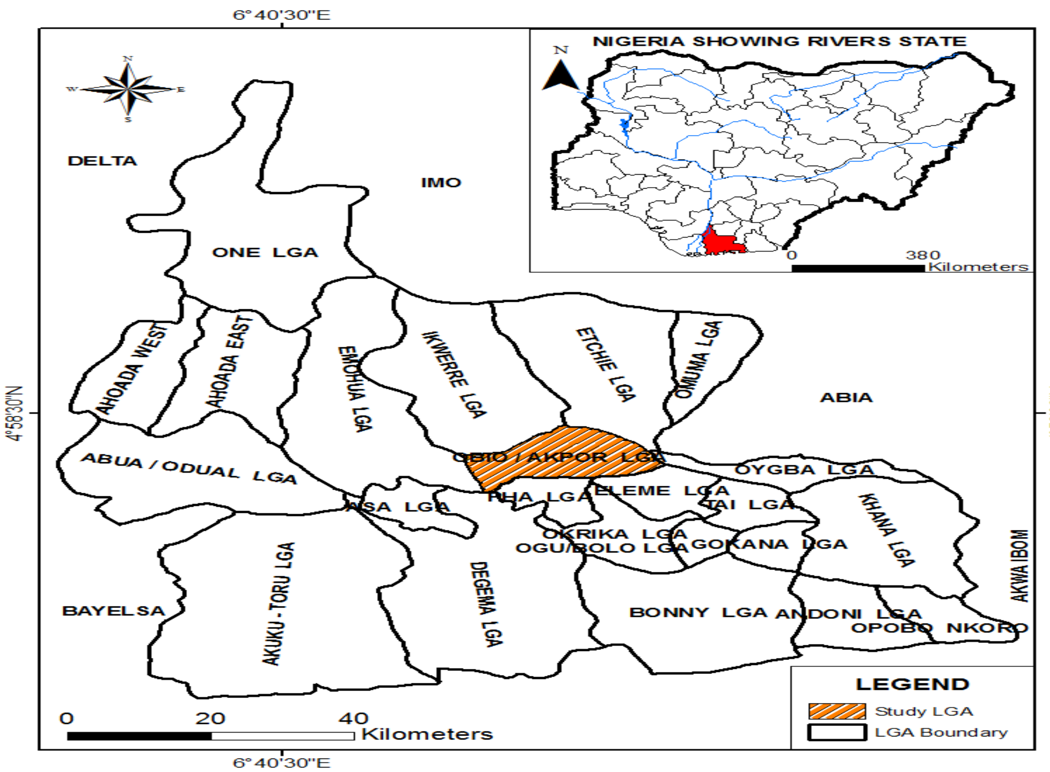
Reducing noise at the source is seen as the most effective way to minimize environmental noise other options are to increase the distance from the source or to place a barrier between the source of noise and the receiving location/area [34-36] therefore, the use of vegetation needs to be examined around residential areas in Obio Akpor Local Government Area.

1.1 Study Area

Obio Akpor LGA is one of the 23 local governments areas of Rivers state, found in the south southern part of Nigeria, otherwise called the Niger Delta Region of Nigeria, located approximately between latitude 4°45' N through 4°56' N and longitude 6°52'E through 7°6' E. It has a general elevation of less than 15.24 m above mean sea level and is bounded by Ikwerre LGA to the north, Port Harcourt LGA to the south, to the east, Oyigbo LGA and to the West, Emohua LGA as shown in Figs. 3 and 4. Obio/Akpor, Port Harcourt and Eleme LGAs, make up the Port Harcourt metropolis which is on a firm ground and about 66km from the Atlantic Ocean [37]. It is one of the major centres of economic activities in Nigeria and constitutes part of adjoining communities of the Port Harcourt metropolis major city in Rivers State and the Niger Delta [38,39]. Consequent on rapid urbanisation and the rising industrial and commercial growth of the metropolis, more goods and services are being made available, thus the generation of and the increase in noise pollution across the area [40].

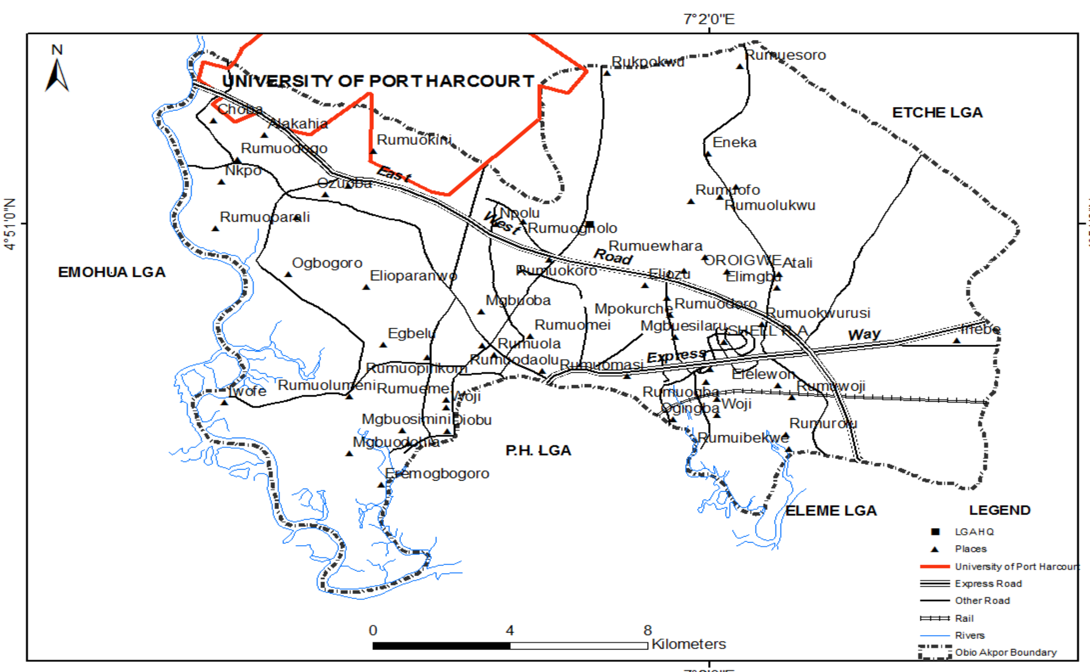
Fig. 1. Noise attenuation using vegetation supported barrier along a major road

Fig. 2. Early stage development of a vegetation supported noise attenuation wall barrier



Source: Ministry of Land & Housing, Rivers State

Fig. 3. Rivers state showing study area (Obio/Akpor LGA)



Source: Ministry of Lands & Housing, Rivers State

Fig. 4. Study area (Obio/Akpor LGA) showing communities

The expansion of industrial and commercial activities led to the creation of industrial areas and government reserve areas. The growth in economic activities propelled the growth of population and ultimately urbanization. Sequel to the fast rate of growth in population, the problem of migration and urban growth is mismanaged. Port Harcourt's expansion and growth came in a manner that jettisoned the plan set in motion for the city development, particularly the city's fringes towards the Northern area, the Southern area, and the water fronts. For 30 years of governance by the military, control principles for development and planning were disregarded and formal planning procedures abandoned [41].

2. MATERIALS AND METHODS

The sources of data for this study include primary and secondary sources. The primary sources includes data obtained from the field using questionnaire instrument, interview, and field observation constitutes the primary sources of data while data obtained from literature, text books was classified as secondary data.

The data for this study was collected with the use of a noise meter (Extech Instrument Digital Sound Level Meter with RS232) to measure noise from generating plant and in addition to the ambient noise, measurement tape, and camera. The tape was used to ensure equidistance in all sample measurement that is measurements were taken at 8 feet from the noise source (generating plant conveyed for the purpose of the study) and at 1 feet from the barrier at the receivers end while the camera was used to acquire picture data such as vegetation supported noise barriers walls. The Noise meter was used to measure the sound level in decibel (dBA) at 6 ft from the ground to avoid ground effect that is sound reflected or absorbed by the ground, at a distance of 8 ft from the noise source as specified by the tape, and 1 feet immediately inside the barrier (resident position). The data collected for this study was analyzed using elementary statistics such as tables, percentages, bar-graphs, and also parametric statics for further analysis. The average height of each barrier observed is 8 feet with a diameter of 0.416 feet and an area of 1.13 square feet.

3. RESULTS AND DISCUSSION

Table 1 shows the variation in noise attenuation between plastered barriers without vegetation support and barrier walls with vegetation support. Thus, the barrier with vegetation attenuates more noise than those without vegetation.

Table 1. Plastered wall barrier serving as properties barriers (boundary) across residential buildings

Sample point	Noise at source (dBA)	Noise at destination (without vegetation)	Noise at destination (with vegetation)
1	90.0	76.8	60.8
2	91.5	78.6	61.0
3	94.4	80.0	65.5
4	92.2	79.5	62.2
5	90.6	77.3	60.5
6	95.2	82.6	65.1
7	93.3	80.5	63.3
8	92.1	78.4	63.3
9	95.2	81.0	66.6
10	91.0	77.2	61.0
11	94.2	80.0	64.4
12	93.3	79.2	64.8

Table 2. Plastered surface analysis group statistics

Surface_Type		N	Mean	Std. deviation	Std. error mean
Noise	Without_vegetation	12	79.2583	1.71064	.49382
Attenuation	with_vegetation	12	63.2083	2.09348	.60434

Table 2 shows noise attenuation ability of plastered barrier surfaces with and plastered noise without vegetation support. From the analysis, there is difference in the mean of the both samples with plastered noise barrier without vegetal support owing a mean of record of 79.2 and plastered noise barrier with vegetation owing a mean record of 63.2.

From the analysis as shown in Table 3, assessing the level of noise attenuation between plastered barrier with vegetation support and without vegetation support. Findings reveals that the mean of the samples have equal variance and with a p value of 0.00 which is less than the critical value of 0.05 we hereby affirm that plastered noise barriers with vegetal supports attenuates noise more than plastered noise barriers without vegetal support.

The Table 4, shows recording of noise level in dBA at 8 meters from the noise source for unplastered noise barrier; at the at destination behind the barrier. From the Table, the highest noise level at destination is 69.1 for unplastered noise barrier without vegetation and 59.4 for unplastered noise barrier with vegetation as seen on the Table 4. From the figures recorded and shown in the Table 4, there is obvious difference between values at destination for unplastered noise barrier without vegetation and unplastered noise barrier with vegetation signifying a reduction in noise level from noise source and destination (barriers end).

The Table shows the mean difference and standard deviation of noise readings recorded between unplastered noise barrier surface without vegetation and unplastered noise barrier surface with vegetation. The mean difference of 8.175 was recorded as noise attenuation difference between unplastered barrier surfaces with vegetation and unplastered barriers surface without vegetation.

The test of significance between the noise attenuation ability of unplastered noise barriers with vegetation support and unplastered noise barrier without vegetation support. The result gave a P valve of 0.0601 for the test of variance which is greater than the P valve of 0.05 signifying equality of means between unplastered noise barriers without vegetation support and unplastered noise barriers with vegetation support. Also, with the P valve of 0.024 which is less than 0.05 critical valves, noise attenuation ability of unplastered noise barrier without vegetation support differs significantly from that of unplastered noise barriers with vegetation support.

Table 7 shows the mean valve of recorded noise level at source and 8 meters from source at receiver's end across a bare surfaced noise buffer zone. From the table, the mean noise level at source is recorded at 89.9083dBA while that of the receivers end (barriers) is put at 84.7417dBA giving a noise level difference of 5.166 dBA

Table 8 shows the test result using the student t test to analyze the difference between noise level at source and the barrier at receiver's end and given a P valve of 0.965 which is greater than the critical valve of 0.05 for test of equality of variance. The results show that the two samples valves recorded exhibit equality of means. The test for significance in the noise attenuating ability of bare surfaced buffer zone reveals that with a P valve of 0.002 which is less than the critical valves of 0.05, it can be concluded that noise level differs significantly between source region and destination region across a bared surfaced buffer zone.

Table 9 shows the mean noise record derived from lawn surface buffer zone between the noise at source and noise at destination across the buffer zone of 8 meters. From the analysis, there is a recorded 20.8416dBA difference in mean valve computed from the analysis. This deduced some level of noise attenuation across bare surfaced noise buffer zone.

Table 10 shows the results of test for equality of variance between noise measured at source and destination between buffer fallow using lawns. From the analysis, given a P valve of 0.898 which is greater than the critical valve of 0.05 affirm the equality of variance between noise valve at source and destination followed by a lawn. The test for significance given a P valve of 0.00 which is greater than the critical valve of 0.05 reveals that there is significant noise attenuation ability using the lawn as a noise buffer zone.

Table 11 shows the mean value of noise as measured across vegetal buffer zone. The result shows a mean difference of 18.0833 between the noise level at source and that of the destination across a noise buffer zone using vegetation. The analysis reveals that the vegetation belt serving as barrier attenuates noise hence the mean difference between the values obtained at noise source and that of the destination.

Table 3. Independent samples test

		Levene's test for equality of variances		t-test for equality of means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean difference	Std. error difference	95% confidence interval of the difference	
									Lower	Upper
Noise_Attenuation	Equal variances assumed	1.046	.317	20.565	22	.000	16.05000	.78043	14.43148	17.66852
	Equal variances not assumed			20.565	21.160	.000	16.05000	.78043	14.42774	17.67226

Table 4. Unplastered wall used as properties barriers/boundaries

Sample point	Noise at source(dBA)	Noise at destination (without vegetation)	Noise at destination (with vegetation)
1	80.1	60.2	50.1
2	82.3	65.2	49.5
3	70.2	63.4	59.4
4	74.7	68.4	56.3
5	79.2	65.2	55.2
6	81.3	68.9	60.3
7	85.9	65.1	58.7
8	85.4	63.1	56.2
9	86.9	69.1	53.4
10	81.5	63.1	58.4
11	85.1	41.3	40.3
12	76.1	43.1	40.2

Table 5. Unplastered surface analysis group statistics

Surface_Type		N	Mean	Std. deviation	Std. error mean
Noise_Attenuation	Without_vegetation	12	61.3417	9.32830	2.69285
	with_vegetation	12	53.1667	6.92483	1.99903

Table 6. Independent samples test

		Levene's test for equality of variances		t-test for equality of means						
		F	Sig.	T	Df	Sig. (2-tailed)	Mean difference	Std. error difference	95% confidence interval of the difference	
									Lower	Upper
Noise_Attenuation	Equal variances assumed	.281	.601	2.438	22	.023	8.17500	3.35374	1.21978	15.13022
	Equal variances not assumed			2.438	20.300	.024	8.17500	3.35374	1.18584	15.16416

Table 7. Bare surface analysis group statistics

Noise_Level		N	Mean	Std. deviation	Std. error mean
Noise_Attenuation	Noise_at_source	12	89.9083	3.63229	1.04855
	Noise_at_destination	12	84.7417	3.68201	1.06290

Table 8. Independent sample test

		Levene's test for equality of variances		t-test for equality of means						
		F	Sig.	T	Df	Sig. (2-tailed)	Mean difference	Std. error difference	95% confidence interval of the difference	
									Lower	Upper
Noise_Attenuation	Equal variances assumed	.002	.965	3.460	22	.002	5.16667	1.49306	2.07025	8.26308
	Equal variances not assumed			3.460	21.996	.002	5.16667	1.49306	2.07022	8.26312

Table 9. Lawn analysis

Noise Level		N	Mean	Std. deviation	Std. error mean
Noise_Attenuation	Noise_at_source	12	89.0083	3.32879	.96094
	Noise_at_destination	12	68.1667	3.27368	.94503

Table 10. Independent sample test

		Levene's test for equality of variances		t-test for equality of means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean difference	Std. error difference	95% confidence interval of the difference	
									Lower	Upper
Noise_Attenuation	Equal variances assumed	.017	.898	15.464	22	.000	20.84167	1.34777	18.04656	23.63677
	Equal variances not assumed			15.464	21.994	.000	20.84167	1.34777	18.04652	23.63682

Table 11. Vegetal surface analysis group statistics

Noise_Level		N	Mean	Std. deviation	Std. error mean
Noise_Attenuation	Noise_at_source	12	86.6333	3.13030	.90364
	Noise_at_destination	12	68.5500	3.12075	.90088

Table 12. Independent samples test

		Levene's test for equality of variances		t-test for equality of means						
		F	Sig.	t	Df	Sig. (2-tailed)	Mean difference	Std. error difference	95% confidence interval of the difference	
									Lower	Upper
Noise_Attenuation	Equal variances assumed	.000	.988	14.172	22	.000	18.08333	1.27599	15.43709	20.72958
	Equal variances not assumed			14.172	22.000	.000	18.08333	1.27599	15.43709	20.72958

Table 13. Berm analysis group statistics

Noise_Level		N	Mean	Std. deviation	Std. error mean
Noise_Attenuation	Noise_at_source	12	92.7500	1.78300	.51471
	Noise_at_destination	12	79.6250	1.91602	.55311

Table 14. Independent samples test

		Levene's test for equality of variances		t-test for equality of means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean difference	Std. error difference	95% confidence interval of the difference	
									Lower	Upper
Noise_Attenuation	Equal variances assumed	.043	.838	17.372	22	.000	13.12500	.75555	11.55809	14.69191
	Equal variances not assumed			17.372	21.887	.000	13.12500	.75555	11.55762	14.69238

The Table 12 reveal the result of test for equality of variance given the p value of 0.988 which is greater than the critical value of 0.05 affirming the equality of mean between noise level recorded at source and that of the destination over a vegetation covered noise buffer zone of 8 meters from the noise source. Also, the test of significance reveal with a p value of 0.00 which is greater than the critical value of 0.00 affirms that the noise attenuating ability of vegetation fallowed buffer zone differs significantly.

Table 13 shows the mean value of noise as measured across Berm buffer zone. The result shows a mean difference of 13.125 between the noise level at source and that of the destination across a noise buffer zone using Berm. The analysis reveals that the Berm serving as barrier attenuates noise hence the mean difference between the values obtained at noise source and that of the destination.

The Table 14 reveals the result of test for equality of variance given the p value of 0.838 which is greater than the critical value of 0.05 affirming the equality of mean between noise level recorded at source and that of the destination over a Berm noise buffer zone of 8 meters from the noise source. Also, the test of significance reveal with a p value of 0.00 which is greater than the critical value of 0.00 affirms that the noise attenuating ability of Berm fallowed buffer zone differs significantly.

4. CONCLUSION

From the graphical presentations, there is a difference in noise attenuation ability across the noise buffer zone and material choice for the buffer (vegetated noise buffer corridor, Lawn noise corridor, Berm noise corridor, Bare surface noise corridor) thus, this signifies a very high relationship when tested for significance. The analysis of noise attenuation using vegetal cover supported barriers and noise buffer zones in the study area reveals that, noise propagation decreases in relation to surrounding landscape surfaces. It is also noticed from the analysis that, plastered noise barriers supported with vegetal cover, unplastered noise barriers supported with vegetal cover and noise buffer corridor or landscape covered by vegetation attenuate noise more significantly than plastered noise barriers also not support with vegetal cover.

5. RECOMMENDATIONS

The study therefore, recommends that noise limits legislature should be enacted for vehicular noise and noise generated from industrial establishments. Also, noise buffer zone should be encouraged and enforced for all landuse. Finally, environmental noise level should be enacted for various landuse to ameliorate noise level across space.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. WHO. Environmental noise guidelines for the European Region; 1999.
2. Awake. Can we save our environment? New York. Watchtower Bible and Track Society of Nigeria; 2003.
3. Awake. Protect yourself from fraud, New York. Watchtower Bible and Track Society of Nigeria; 2004.
4. Awake. Natural disaster is they getting worse? New York. Watchtower Bible and Track Society of Nigeria; 2005.
5. Bhargawa G. Development of India's urban and regional planning in 21st Century. Glan Plushing House: New Delhi, India; 2001.
6. Malcom JC. Handbook of Acoustic New York. USA Internet Scientific Publisher; 1998.
7. Mark U, Cumming A. Noise pollution, New York City; 2006. Available:http//en.Wikipedia.Org/wiki/noise pollution
8. Obafemi AA. Spatio temporal analysis of noise pollution in Port Harcourt metropolis. Ph,D Dissertation, Department of Geography and Environmental Management, University of Port Harcourt; 2005.
9. Ogionwo. Master plan, 1995 Port Harcourt; 1979.
10. Onuu. Industrial noise in Nigeria; measurements, analysis, dose and effects. Journals of Building Acoustics; 2006.
11. Oyawale T. Nigeria National Merit Award. Savorite Limits. Port Harcourt; 2005.
12. FEPA. National interm guideline and standard for industrial effluents, Gaseous emission and hazardous waste in Nigeria Federal Environmental Protection Agency; 1992.
13. Kaushik, Kaushik. Environmental studies (as per Mysore University syllabus). Third Edition, New Age International Publishers; 2008.

14. Arana M, Garcia A. A social survey on the effects on environmental noise pollution in the city of Curitiba. Brazil Applied Acoustics; 1998.
15. Aylor D. Noise reduction by vegetation and ground. The Journal of the A Acoustical Society of America; 1972.
16. Berglund, Lindvall. Community noise. Archivers of the Centre for Sensory Research; 1995.
17. Beverly BS, Godfrey SH. Road Engineering Journal. Texas Transaftv Inc.; 1997.
18. Oyegun CU, et al. Port Harcourt Region; 1999.
19. Pathak V, Tripathis B, Mishra V. Dynamics of traffic noise in a tropical city Varanasi and its' abatement through vegetation; 2008.
20. Standfield, Mathheson. Noise pollution: Non-auditory effects on health. Brit Med Bull; 2003.
21. Brookhouser. Sensorineurd hearing loss in children. Ped. Din N Amer; 1996.
22. Bruel, Kjar. Sound and vibrations measurement; 2000. Available:http://www.nonoise.org/library/envnoisse/index.ltn
23. Carter. Transportation noise, sleep and possible after effect; 1996.
24. Coren. Daylight saving time and traffic accident. N Engl.; 1996.
25. Adedayo OO, Egbewale BE. Does knowledge of hazard of exposure to noise change attitudes and translate to healthful practices? (The Internet Journal of Health IS SN: 1528 — 8315) LLC, Internet Scientific Publisher; 1996.
26. Fang CF, Ling. Investigation of the noise reduction provided by cree belts. Land Scape and Urban Planning. 2003;63:187-195.
27. Embleton TFW. Sound propogation in homogeneous deciduous evergreen woods. J. Acoust. S.; 1963.
28. Federal Highway Authority. Highway Traffic Noise United States; 2005.
29. Federal Highway Authority; 2000.
30. Haddart L. The use of vegetation for traffic, Noise screening – Research report 238, transport and road research laboratory. Port Harcourt; 1990.
31. In-Plant Environmental System (IES). Noise barrier and sound absorber; 2001. Available:http://www.artusaindustries.us/atlanta
32. Mamman AB, Oyebanji JO, Petters SW. Nigeria: A people united, a future assured. Abuja: Millenium Edition, Gabumo Publishing; 2000.
33. Makinde OO. Influences of socio cultural experiences on residents satisfaction in Ikorodu low cost housing estate, Lagos State. Environment, Development and Sustainability; 2015.
34. Umeh LC, Uchegbu SN. Principles and procedures of Environmental Impact Assessment (E.I.A) Lagos Computer Edge Publisher; 2002.
35. United State Department of Transportation Noise and Air Quality Branch. Highway traffic noise analysis and abatement policy and guide; 1995.
36. United State Department of Transportation. Highway traffic noise problems and response; 2004. Available:http://www.nonoise.org/response
37. Oyegun CU, Adeyemo A. Port Harcourt Region. Port Harcourt: Paragraphics; 1999.
38. Miller TG. Living in the environment Ninth Edition USA, Woods; 1996.
39. Noise Pollution Clearing House (NPC). Noise barrier stimulation, noise. Org/library; 2001.
40. Wise, Dineen. Energy efficiency and noise attenuation. Ohio Worth Publishing Company; 1995.
41. Nigerian Urban and Regional Planning Act; 1992.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/59015