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Carbon Sequestration and Its Effect on Air Quality in Rivers State, Nigeria.

[1]Macpepple, Eunice,[2]Tolubanwo, Stephenaand [1]Uzor, Augustine

[1]*Department of Agricultural and Environmental Engineering*
Rivers State University of Science and Technology, Port Harcourt, Nigeria
[2]*National Root Crop Research Institute, Umudike, Nigeria*
Corresponding Author: Macpepple, Eunice

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ABSTRACT: The study of carbon sequestration and its effect on air quality in Rivers State, Nigeria has been conducted. Industrialization and urbanization have led to the release of harmful gases into the atmosphere especially carbon (Carbon Monoxide CO, Carbon Dioxide CO_2, Particulate Matter$PM_{2.5}$ and PM_{10}). This gas causes environmental pollution and affects the ecosystem and increasing the mortality rate. In this study field analysis was conducted with a handheld electrochemical sensor device that could detect the level of carbon in the atmosphere. The sources of carbon were observed from the field analysis to be illegal refinery, open burning, vehicular emissions, and industrial emissions from production and power plants. Nevertheless, following the (USEPA) standards for the areas (Etche,Chokocho, Etche farm land, Eleme junction, Rumuokoro junction, and Rumuodara junction). The level of carbon in the atmosphere was determined for two different intervals (morning, evening) and the result showed that the level of carbon (carbon monoxide CO, carbon dioxide CO_2, particulate matter $PM_{2.5}$ and PM_{10}) in the atmosphere in these areas where high and they vary for their individual locations. Also, for evening intervals it was very high compared to the morning intervals due to wind speed, wind direction, relative humidity and temperature. Furthermore, the level of carbon in all these areas are unhealthy for sensitive categories such as children and the elderly.

KEYWORD:sequestration, climate change, Rivers State, air quality, carbon

I. INTRODUCTION

One of today's most pressing environmental challenges is climate change and particularly, the need to reduce increasing levels of carbon dioxide (CO_2) in the atmosphere.

Ambient air quality is compromised as a result of natural occurrences and anthropogenic activities. Forest fires and volcanic eruptions account for some of the natural causes, while vehicular emissions, gas flares, industrial activities, construction activities, domestic lighting and heating are anthropogenic. The release of the gases from these activities changes the natural composition of the air resulting in air pollution. At present more than 300 substances are known which can be emitted into the air, and are significant as air pollutants. Lesser-known substances are continually being added to this number due to the introduction of new manufacturing processes and technologies.

The release of this harmful carbon oxides and particulate matter into the atmosphere have posed tremendous harm to public health, particularly because of its size. Particulate matter ($PM_{2.5}$) is so small that it could enter the lungs and bloodstream during respiration causing potential damage in many ways. This microscopic particle can penetrate deep into the lungs and have been linked to the wide range of serious health effects including premature death, heart attacks and strokes as well as acute bronchioles and aggravated asthma among children [1].Human exposure to air pollution may result in a variety of health effects, depending on the types of pollutants, the magnitude, duration and frequency of exposure and the associated toxicity of the pollutants of concern. People are exposed to air pollutants (whether indoor or outdoor) and this depends on the activities of individuals. Among the different population groups, children, elderly and chronically ill people are especially sensitive and susceptible to levels of air pollution exposure. It is important to note here that health impact assessment combines estimates of population exposure with information on toxicity of the pollutant or the relationship between exposure and response [2].

Achieving the deep emissions reductions necessary to stabilize atmospheric concentrations of greenhouse gases requires a fundamental shift in the way we generate, transport, and use energy.

II. CARBON SEQUESTRATION

The rapid increase of greenhouse gases (GHG) in the atmosphere in the lastcentury and their correlation with changes in climatic trends has created huge concerns worldwide. Estimations on how climate is going to change are limited by the fact thatwe cannot predict with accuracy the magnitude of the changes and establish clearcause and effect relationships [3],[4],[5].The bestmethod to tackle this problem will be to look at current trends and estimate what the worst–case scenario could look like if those trends are maintained.Nigeria as one of the largest producers of crude has alot of industrial activities in its major cities which also helps in flaring greater percent of her gas, the degree of emission emanating from gas flare also contribute to changes in the atmospheric conditions causinggreenhouse effect.

Two of the most important greenhouse gases are carbon dioxide (CO_2) andmethane (CH_4). They are produced naturally and anthropogenically, but the rapidincrease of atmospheric GHG concentrations is associated with fossilfuelcombustion.CO_2 is a dominant greenhouse gas, and a good percentage of its source comes from humanfossil fuel burning, automobile activities and discharges of other chemical gases. Carbon dioxide increases air temperature through a “heat island” effect. Thus, GHG levels have been increasing since the times of industrialrevolution: CO_2 from 280 ppm to 381 ppm and CH_4 from 700 ppb to 1750 ppb[6], [5].

Awareness and concern on this issue has created ageneralized interest on finding effective ways to reduce net GHG emissions. Thereare three different ways to accomplish this [7], [8]: reducingglobal energy use, using an alternative no- carbon source of energy, andsequestering carbon from point sources or from the atmosphere through naturaland engineered systems. The use of ecosystems that naturally capture and sequester carbon is, as oftoday, one of the most efficient and cost- effective approaches to counteract the GHG[5]. [9].There are five natural carbon pools. From largest to lowest carbon stock. These pools according to [8] areoceanic, fossil fuel, pedologic (soil), atmospheric, andbiotic (mostly vegetation). These pools are interconnected through feedback loopsand biogeochemical cycles [10]. The carbon stock in these pools isusually transient, except for the oceanic and the pedological pools, which are morestable and permanent [11], [7].

Thus, it has been found out thatplants have an absorbing power to take in $CO_2$from the atmosphere via leaves or trees depending on their structural properties[12], [13]. Trees can also act as sinks for CO_2 by fixing carbon during photosynthesis and storing excess carbon as biomass [14].A typical tree trunk in forest area has been identified to be able tosequester CO_2up to 50% of its volume, 30% in its branches and stems, and 3% in foliage [15]. Larger trees tend to extract and store more carbon dioxide from the atmosphere having a greater leaf area to trap air borne pollutants, cast shade, and intercept or slow rainfall run-off [16].

Many scientists have consideredusing the oceans as carbon sinks, but techniques to successfully enhance andmanage its carbon sequestration capacity are yet to be developed. The soil pool istherefore the most suitable carbon pool to manage and maximize in a cost–effectivemanner. Most carbon sequestration studies have been done in agricultural soils [17]. [18]. and boreal peatlands [19], [20].

This research aims to identify the sources of excess carbon in the study area and the levels atwhich they are present in the ambient air. These it is believed, would help reduce the emissions of carbon in the atmosphere therebymitigating the effect of climate change.

III. MATERIALS AND METHODS

Study Area

Rivers State, southern Nigeria, comprising the Niger River delta at the Gulf of Guinea, is bounded by States Anambra and Imo on the north, Abia and AkwaIbom on the east, and Bayelsa and Delta on the west. Rivers State contains mangrove swamps, tropical rainforest, and many rivers. The latitude of Rivers State is 4.8396^0N, 6.9112^0E and covers a total land mass area of 11,077KM^2 (4,277 square meters). The topography ranges from flat plains with a network of Rivers to tributaries.

The population of Rivers State is over 5,198,716 as of the 2006 census. Rivers State is the sixth most populous state in Nigeria. In general rainfall is seasonal, variable, as well as heavy; occurs between the months of March and October through November. The wet season peaks in July, lasting more than 90 days while only the dry months are January and February having little or no effect. The total annual rainfall decreases from about 4700mm (185 in) on the coast, to about 1,700mm (67 in) in the extreme north. The average temperatures are typically between 25 and 280 (77 and 820F) some parts of the state also receive up to 150mm (6 in) of rainfall during the dry periods. Relative humidity rarely dips below 60% and fluctuates between 90% and 100% for most of the year [21].

Field work to investigate the level and sources of criteria pollutant especially carbon and its compounds was carried out and analytical data gathering technique was used to determine the sources of carbon and itscompounds in the study area.

Materials used included Temtop LkC-1000s multifunctional air quality monitor, Portable multigas detector for four (4) common gases, Smart air pollution Detector, Lead color screan (laser 2.5, Tvoc sensor); and for wind speed, a digital hand held Cole Parmer combination Anemometer that measures air velocity, temperature and humidity, was used to determine the wind speed of various locations. The equipment ascertains the wind via wind vanes that generates on revolution, signal that is directly proportional to the wind force.

These standard devices mentioned above were used to conduct the test for the following geographical locations in the study area:

a) Chokocho Etche in Etche local government area of Rivers State.
b) Eleme junction
c) Rumuodara
d) Rumuokoro
e) Bundu waterside
f) Rivers state university (F&G, Hostel B)

The hand-held air quality test monitor was used in these different areas of the state and data were gathered.

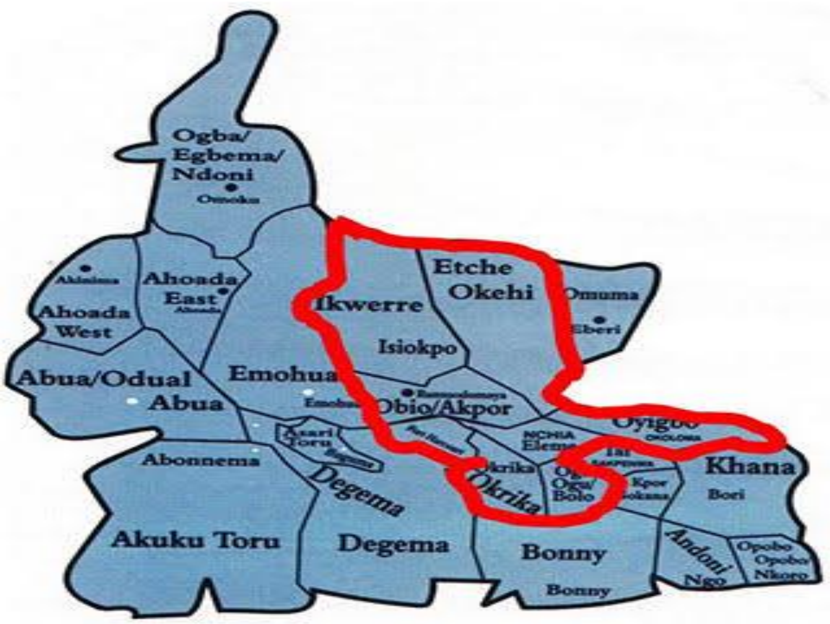

Fig. 1: Map of Rivers State

IV. RESULTS AND DISCUSSION

Data from the Morning Field Survey are as follows:

Table 1: Variation Data for Carbon in Chokocho Etche.

Parameters	Description of wind direction	Station 1	Station 2	Temperature (^{0}C)	Wind speed (m/s)	Relative Humidity (%)
CO (µg/m^3)	0.5km(Leeward)	16	14	22.50	1.553	72.58
$PM_{2.5}$ (µg/m^3)	0.5km(Windward)	121.9	76	23.68	1.398	72.08
PM_{10} (µg/m^3)	0.5km(Windward)	241.0	136	22.70	1.350	72.08
AQI	0.5km(Windward)	185	167	21.50	1.553	72.58

Pm=microgram per cubic meter; AQI = Air quality index; C0= carbon monoxide.

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Table 2: Variation Data for Carbon in Eleme Junction

Parameters	Description of wind direction	Station 1	Station 2	Temperature (^{0}C)	Wind speed (m/s)	Relative humidity (%)
CO (µg/m^3)	2km Leeward	14.10	18.22	29.00	3.378	58.38
$PM_{2.5}$ (µg/m^3)	2kmWindward	100.5	136	29.00	3.378	58.38
PM_{10} (µg/m^3)	2km Windward	181.1	230	29.00	3.378	58.38
AQI	2km Windward	163	193	29.00	3.378	58.38

µg/m^3= microgram per cubic meter; AQI = Air quality index; C0= carbon monoxide.

Table 3: Variation Data of Carbon in Rumodara.

Parameter	Description of wind direction	Station 1	Station 2	Temperature (^{0}C)	Wind speed (m/s)	Relative humidity (%)
CO (µg/m^3)	3 km(Leeward)	14	16	32	3.305	57.98
$PM_{2.5}$ (µg/m^3)	3 km(Windward)	72.6	84.2	32	3.305	57.98
PM_{10} (µg/m^3)	3 km(Windward)	130	151	32	3.305	57.98
AQI	3 km(Windward)	165.0	168.0	32	3.305	57.98

Pm= microgram per cubic meter; AQI = Air quality index; C0= carbon monoxide.

Table4: Variation Data of Carbon in Rumuokoro.

Parameters	Description of wind direction	Station 1	Station 2	Temperature (^{0}C)	Wind speed (m/s)	Relative humidity (%)
CO (µg/m^3)	0.5km(Leeward)	16	18	28	2.012	73
$PM_{2.5}$ (µg/m^3)	0.5km(Windward)	97.5	65.0	28	2.303	73
PM_{10} (µg/m^3)	0.5km(Windward)	163	112.2	28	2.801	73
AQI	0.5km(Windward)	168	156	28	2.401	73

µg/m^3= microgram per cubic meter; AQI = Air quality index; C0= carbon monoxide.

Data from the Evening Field Survey

The same field analysis was conducted for the same areas at the evening intervals to verifier when carbon and other criteria pollutant are more in the atmosphere, and identify the source.

Table 5: Variation Data for Carbon in Eleme Junction Evening Intervals.

Parameters	Description of wind direction	Station 1	Station 2	Temperature (^{0}C)	Wind speed (m/s)	Relative humidity (%)
C0(µg/m^3)	0.5Km(Leeward)	34	42	20	4.021	45
Pm 2.5 (µg/m^3)	0.5Km(Windward)	289.9	289.7	20	4.021	45
Pm 10 (µg/m^3)	0.5Km(Windward)	299.9	420.6	20	4.021	45
AQI	0.5Km(Windward)	225	230	20	4.021	45

$\mu g/m^3$= microgram per cubic meter; AQI = Air quality index; C0= carbon monoxide.

Table 6: Variation Data of Carbon in Rumuodara.

Parameters	Description of Wind Direction	Station 1	Station 2	Temperature (^0C)	Wind speed (m/s)	Relative humidity (%)
C0($\mu g/m^3$)	0.5Km(Leeward)	24	36	21	5.001	45
Pm 2.5 ($\mu g/m^3$)	0.5Km(Windward)	123.8	242.6	21	5.001	45
Pm 10 ($\mu g/m^3$)	0.5Km(Windward)	220.9	390.0	21	5.001	47
AQI	0.5Km(Windward)	200	225	21	5.001	46

($\mu g/m^3$)= microgram per cubic meter ; AQI = Air quality index; C0= carbon monoxide.

Table 7: Variation Data of Carbon in Rumuokoro.

Parameters	Description of wind direction	Station 1	Station 2	Temperature (^0C)	Wind speed (m/s)	Relative humidity (%)
CO ($\mu g/m^3$)	0.5Km(Leeward)	26	34	21	4.501	45
Pm 2.5 ($\mu g/m^3$)	0.5Km(Windward)	149.6	129.0	21	4.501	45
Pm 10 ($\mu g/m^3$)	0.5Km(Windward)	242.7	221.2	21	4.501	45
AQI	0.5Km(Windward)	200.5	200	21	4.501	45

$\mu g/m^3$= microgram per cubic meter; AQI = Air quality index; C0= carbon monoxide.

Table 8: Six Levels of Air Quality Concern by USEPA Standards

Daily AQI Color	Levels of concentration	Values of Index
Green	Good	0-50
Yellow	Moderate	51-100
Orange	Unhealthy for sensitive groups	101-150
Red	Unhealthy	151-200
Purple	Very unhealthy	201-300
Ox blood	Hazardous	301-400

Good 0-50: the air quality can be considered good no health effects expected.
51-100: the air quality is moderate and acceptable.
101-150: the air quality is unhealthy, usually, it wound effect a healthy person but people who already have lung issues, older people and children might develop some respiratory problem.
151-200: unhealthy, everyone living in such area would likely experience disorder.
201-300: very unhealthy and triggers an important health alert because it is very dangerous for all living being.
301-500: This is categorized as hazardous, warning issues and needs government intervention.

Comparison of Data from Field Analysis to EPA Standards and WHO Standards as against Field Results.
Chokocho Etche

The station 2 test was carried out in the farm and the results showed that there is criteria pollutant in Chokocho farm lands especially carbon and its oxides due to the release of harmful gases in the atmosphere from human activities but it is reduced due to the high farming activities in the area. Comparing the United States Environmental Protection Agency standard (USEPAs) and the World Health Organization standard (WHO) it is found that the levels of CO, $PM_{2.5}$,PM_{10}, are above the allowable limit.

The air quality index in Chokocho Etche is 185($\mu g/m^3$) for station 1 and 167($\mu g/m^3$) for station 2 in the farm land, although the farm result came down a little compared to the station 1 result at Chokocho junction, both fall on the red zone in the air quality index chart indicating that Chokocho Etche is an unhealthy environment due to the high level of carbon and other criteria pollutants.

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Eleme Junction

Comparing the United States Environmental Protection Agency standard (USEPAs) and the World Health Organization standard (WHO) it was found that the levels of CO, $PM_{2.5}$,PM_{10}, are above the allowable limit.

The air quality index there is 163 (μg/m^3) for station 1 and 193 (μg/m^3) for station 2 for the morning interval; and 225 (μg/m^3) for station 1 and 230 (μg/m^3) for station 2 in the evening. Eleme junction fall under the red zone in the air quality index chart indicating that Eleme junction is unhealthy environment due high level of carbon and other criteria pollutant. Nevertheless, at the evening interval Eleme junction is very unhealthy.

Rumuodara

Using USEPAsand WHOstandards, itwas found that the levels of CO, $PM_{2.5}$,PM_{10}, are above the allowable limits.The air quality index in Rumuodara junction is 130 (μg/m^3) for station 1 and 151 (μg/m^3) for station 2 for the morning interval and 200 (μg/m^3) for station 1 and 225 (μg/m^3) for station 2 at evening. Rumuodara junction fall under the orange zone in the air quality index chart indicating that Rumuodara junction is unhealthy environment for sensitive group due high level of carbon and other criteria pollutant. Nevertheless, at the evening interval Rumuodara junction is very unhealthy.

Rumuokoro

Using USEPAsand WHO standards, it was found that the levels of CO, $PM_{2.5}$,PM_{10},are also above the allowable limit.The air quality index in Rumuokoro junction is 168 (μg/m^3) for station 1 and 156 (μg/m^3) for station 2 for the morning interval and 200.5 (μg/m^3) for station 1 and 200 (μg/m^3) for station 2 at evening. Rumuokoro junction fall under the orange zone in the air quality index chart indicating that Rumuokoro junction is also unhealthy environment for sensitive group due high level of carbon and other criteria pollutant. Nevertheless, at the evening interval Rumuodara junction is still unhealthy.

Table 9: Sources of Carbon Pollutant

Carbon pollutant	Sources
CO	Carbon monoxide is as a result of incomplete combustion from variable sources, responsible for black fumes when emitted into the atmosphere.
CO_2	Carbon dioxide is usually as a result of complete combustion but its effect on the environment is on a long-term, responsible for rise in temperature and ozone layer weakening.
$PM_{2.5}$ (soot)	Particulate matter less than 2.5 microns as a result of emission from combustion gasoline engine, use of hydrocarbon (fossil fuels), illegal refinery.
PM_{10}	Particulate matter less than 10 micron as a result of dust from construction sites, open burning (bush/waste materials), industrial sources, wind blown dust from open land, pollen and fragments of bacteria.

Data gathered from the field analysis for different locations shows that during the evening hour particulate matter and other criteria pollutant are more in the atmosphere thereby altering the air quality index. The emissions are highly affected by the wind speed, temperature and relative humidity.

Depending upon the source emissions of air pollutants may be classified as stationary or mobile sources. Another method of classifying emission source is by.

The fastest and cheapest way to prevent carbon from entering the atmosphere is not to emit them in the first place and this could be archived in several ways, such as:

- Reducing our consumption
- using current technologies more efficiently.
- Shifting to low - carbon technologies and practices.

From this research it is recommended that:

- Government should concentrate on having an urban forest for Port Harcourt city to help sequester carbon since the study area is blessed with different species
- All forms of activities that leads to release of carbon should be controlled.
- The national environmental standards and regulation enforcement agency (NESREA) should enforce laws to persecute perpetuators.
- Renewable energy technologies should be considered to reduce the use of fossil fuels.

- Automobiles with low fuel consumption should be used.
- More research should be conducted to help reduce adverse effect on plant and animals.

REFERENCES

[1]. Kim, K. Y., Kim, Y. S., Roh, Y. M., Lee, C. M., & Kim, C. N. (2008). Spatial distribution of particulate matter (PM10 and PM2. 5) in Seoul Metropolitan Subway stations. Journal of hazardous materials, 154(1-3), 440-443.

[2]. Henry, S., Ahamefula, A. C., Onum, A. S., Samuel, U. O., & Kenneth, N. C. Ambient Air Quality Evaluation of Port Harcourt and Environs, South-Southern Nigeria.

[3]. Bodansky, D. (1991). Global warming and clean electricity. Plasma Physics and Controlled Fusion, 33(13), 1489.

[4]. Leven, C. L. (1992). Book Review: Industrial Change and Regional Economic Transformation: The Experience of Western Europe LLOYD RODWIN and HIDEHIKO SAZANAMI (Eds), 1991 London: Harper-Collins Academic 402 pp.,£ 40.00 hardback,£ 15.95 paperback. Urban Studies, 29(5), 812-814.

[5]. IPCC.(2005).IPCCspecialreportoncarbondioxidecaptureandstorage.IntergovernmentalPanelon Climate Change, Geneva (Switzerland). Working Group III.

[6]. Da Silva, R. G. (2006). Weather and climate and animal production. Update of the guide to agricultural meteorological practices, (134).

[7]. Schrag, D. P. (2007). Preparing to capture carbon. science, 315(5813), 812-813.

[8]. Lal, R. (2008). Carbon sequestration. Philosophical Transactions of the Royal Society B: Biological Sciences, 363(1492), 815-830.

[9]. Stern, N., & Stern, N. H. (2007). The economics of climate change: the Stern review. cambridge University press.

[10]. Torbert, H., Rogers, H., Prior, S., Schlesinger, W., & Brett Runion, G. (1997). Effects of elevated atmospheric CO2 in agro-ecosystems on soil carbon storage. Global Change Biology, 3(6), 513-521.

[11]. Metz, B., Davidson, O., De Coninck, H. C., Loos, M., & Meyer, L. (2005). IPCC special report on carbon dioxide capture and storage. Cambridge: Cambridge University Press.

[12]. Gratani, L., Crescente, M. A., &Petruzzi, M. (2000). Relationship between leaf life-span andphotosynthetic activity of Quercus ilex in polluted urban areas(Rome). Environmentalpollution, 110(1) , 19-28.

[13]. Pal, A., Kulshreshtha, K., Ahmad, K. J., &Behl, H. M. (2002). Do leaf surface characters playa role in plant resistance to auto-exhaustpollution?. Flora-Morphology, Distribution, FunctionalEcology of Plants, 197(1), 47-55.

[14]. Nowak, D. J., & Crane, D. E. (2002). Carbon storage and sequestration by urban trees in theUSA. Environmental pollution, 116(3), 381-389.

[15]. Birdsey, R. A. (1992). Carbon storage and accumulation in United States forest ecosystems (Vol. 59). US Department of Agriculture, Forest Service.

[16]. Brack, C. L. (2002). Pollution mitigation and carbon sequestration by an urban forest. Environmental pollution, 116, S195-S200.

[17]. Lal, R., & Kimble, J. M. (1997). Conservation tillage for carbon sequestration. Nutrient cycling in agroecosystems, 49(1), 243-253.

[18]. Six, J., Frey, S. D., Thiet, R. K., & Batten, K. M. (2006). Bacterial and fungal contributions to carbonsequestration in agroecosystems. Soil Science Society of America Journal, 70(2), 555-569.

[19]. Holden, J. (2005). Peatland hydrology and carbon release: why small-scale process matters. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 363(1837), 2891-2913.

[20]. Roulet, N. T., Lafleur, P. M., Richard, P. J., Moore, T. R., Humphreys, E. R., &Bubier, J. I. L.L. (2007). Contemporary carbon balance and late Holocene carbon accumulation in a northern peatland. Global Change Biology, 13(2), 397-411.

[21]. Emenike, G. C., &Akpu, D. N. (2017). Assessment of Road Traffic Violations in Port HarcourtMetropolis, \Nigeria. International Journal of New Technology and Research, 3(4), 263311.