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Model Prediction of Pollution Standard Index for Carbon Monoxide: A Tool for Environmental Impact Assessment

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Authors' contributions

This work was carried out in collaboration between all authors. Author TH designed the study, carried out site visits, computational aspects, wrote the protocol and the first draft of the manuscript. Author ILN served as main supervisor of the study, provided guidance on data collection, analysis and modeling, confirmed the accuracy of the results and documentation. Author VW served as co-supervisor, assisted in initial design of study, and guided in data collection. All authors read and approved the final manuscript.

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ABSTRACT

A model for predicting pollution standard index (PSI) for Carbon monoxide is presented. The model is dependent on 8-hour mean traffic volume, wind speed and solar radiation. Field measurements of CO were carried out at two hour intervals for 5 days. The method adopted for developing the model involved sorting the field observations into 8-hour means and using the Excel (Microsoft office, 2015, regression tool) for development and calibration. Results show that the model yielded a goodness of fit, GF (R^2) of 0.939 and when verified the model gave a GFof 0.834. Field observations show good/moderate PSI values for CO concentrations in the afternoon hours when

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the solar radiation was above 150 W/m^2 and wind speed above 2m/s. It also showed unhealthy PSI values for CO concentrations in the evening/night hours when solar radiation falls below 150 W/m^2 and wind speed below 2m/s. Design tables were developed from combining the developed model and Pasquil generated table for atmospheric stability. These tables were used to plan Choba junction and results showed that 700 vehicles per hour (8 hour mean) is a safe traffic volume that can operate in Choba junction without negatively impacting the environment. To achieve this we recommend that two bypasses should be created. One bypass should be for the travelers who are leaving town and the other for the UNIPORT staff who operate from Abuja campus. It is strongly recommended that the Federal Ministry of Environment adopts these developed tables as a compulsory tool for planning environmentally safe junctions in Nigeria.

Keywords: Model prediction; pollution standard index; carbon monoxide; EIA assessment; Choba junction.

1. INTRODUCTION

The major source of air pollution in urban environments is the vehicular emissions [1]. It is worse at intersection points or junctions because vehicles need to deaccelerate and reaccelerate continuously in order to navigate through. It gets worse in developing countries where traffic control devices are unavailable. In recent times more attention has been given to the environment as air pollution impacts knows no physical boundaries. Many dispersion models have been developed in literature, they range from the Gaussian models [2-10] to the non-Gaussian models [11-14] the numerical models [15-19] and the empirical models [20-23]. The uniqueness of these models is that they need a source strength before they can predict the concentration of pollutants at other points. Lohmeyer [24] has challenged the strength of these developed models and even Allen [25] said more models are produced without verifications.

The failure of some of these models can be attributed to poor estimation of the strength source. The problem is seen in vehicle emission and the challenge to estimate the total emission produced as vehicles move. This problem has persisted and most times researchers tried to use the average laboratory estimation of conversion factors for each vehicle. These values are very unrealistic given the gradable nature of vehicles, different environmental conditions (meteorological parameters and topographical position), different models of vehicle and different driving patterns on the urban roads [26,27]. In this study, the concern of the man in the street with weather; if air is good, healthy or unhealthy is expressed through air quality index (AQI) [28] or pollution standard index (PSI) [29]. The PSI was instituted before the AQI but lacked pollutants such as $PM_{2.5}$ and PM_{10} which were included in the AQI. The PSI has been modified since 2014 to include these stated pollutants. The uniqueness of the PSI is its capability to estimate PSI for 8 hour carbon monoxide continuously and for this reason it is widely used in Singapore.

Literature has not yet considered or develop models which can estimates source emissions in terms of PSI and relate them to atmospheric stability. This work is aimed at developing an empirical model capable of predicting PSI at Traffic intersections. The pollutant used as the representation of automobile emission (gas) is Carbon monoxide (CO). It is a colorless/ odorless gas which is relatively stable, easily measured and comes mainly from vehicle emissions [1].

The result of this work will be a great tool in improving knowledge of environmental impact assessments and traffic management schemes [30].

2. MATERIALS AND METHODOLOGY

2.1 Study Area

The study area for this work is Choba junction which is one of the major junctions in Port Harcourt, Rivers State of Nigeria. The junction serves as an exit point towards the western part of Nigeria and it has very high traffic activities within it. Some of the major facilities which make Choba junction known for its high traffic activities are; the University of Port Harcourt campuses and teaching Hospital, Indomie noodles factory and Agofure travel terminal. Fig. 1 presents the map of the study area.

2.2 Measuring Equipment Used

The equipment used for this study are as listed in Table 1.

2.3 Procedure

A location was established at the middle of the junction where the air pollutants (CO, O_3, SO_2, and NO_2), solar radiation and Particulate matters ($PM_{2.5}$, PM_5, $PM_{7.5}$, and PM_{10}) were measured at every two hour interval for a 5 day duration. The surveillance cameras were mounted on a 5 metre pole by the side of the junction with the direction of each camera facing north, south, east and west, respectively. The cameras were all connected to the recording station which was mounted in a temporary tent office. The weather station was also mounted on a 12 metre pole at the edge of the junction with its receiver mounted in the temporary tent office.

2.4 Model Formulation and Development

The pollution standard index (PSI) which was last modified in 2014 was adopted to estimate the PSI for the pollutants measured at Choba junction. Table 2 shows the PSI which are breakpoints used in defining six pollutants. Table 3 shows the different color codes used to identify the PSI categories.

The PSI can be computed with different pollutant concentrations and the linear interpolation function is presented as Equation (1).

$$I_P = \frac{I_H - I_L}{BP_H - BP_L}(C_P - BP_L) + I_L \quad (1)$$

Where I_P = the index of pollutant, p; C_P = rounded concentration of pollutant being considered; BP_H = the breakpoint that is greater or equal to C_P $(upperlimit)$; BP_L = the breakpoint that is less than or equal to C_P(lower limit); I_H=the PSI value corresponding to BP_H ; I_L = the PSI value corresponding to BP_L

With Equation (1) and the observed concentrations of CO monitored from the field, Table 4 is generated to show the PSI of 8 hour CO throughout the observations.

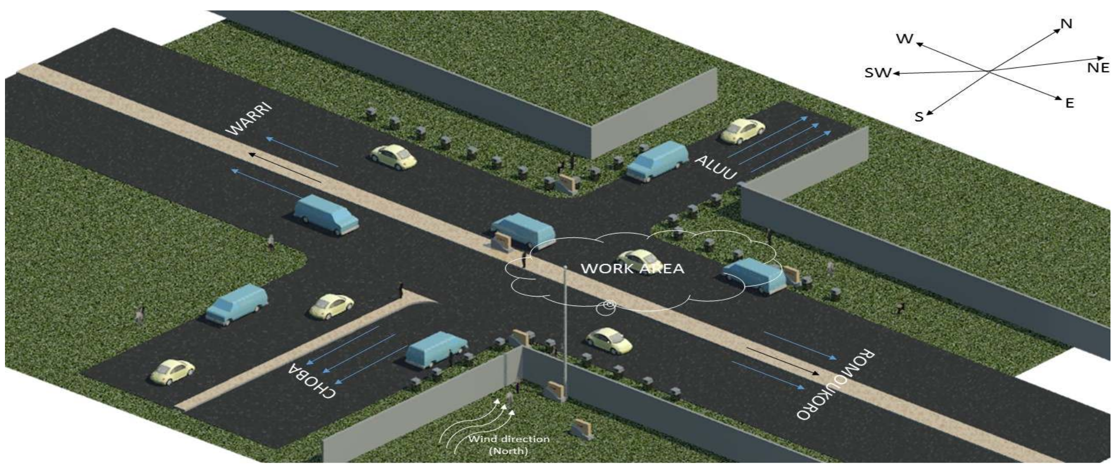

Fig. 1. Map of the study area; Choba Junction Port Harcourt Nigeria

Table 1. List of equipment for field measurements

S/N	Equipment	Number	Purpose
1	Surveillance cameras	4	To capture the traffic count
2	Surveillance camera recording station	1	To record the traffic activities
3	Weather station	1	To measure meteorological parameters
4	Solar radiation meter	1	To measure solar radiation
5	Aeroqual gas monitor	1	To measure pollutant gases
6	Aerocet Particulate matter	1	To measure particle matter

Table 2. Pollution standard index breakpoint for selected pollutants

Index category	PSI	24-hr $PM_{2.5}$ (μg/m^3)	24-hr PM_{10} (μg/m^3)	24- hr SO_2 (μg/m^3)	8-hr CO (mg/m^3)	8-hr O_3 (μg/m^3)	1-hr NO_2 (μg/m^3)
Good	0-50	0-12	0-50	0-80	0-5	0-118	-
moderate	51-100	13-55	51-150	81-365	5.1-10	119-157	-
unhealthy	101-200	56-150	151-350	366-800	10.1-17	158-235	1130
Very unhealthy	201-300	151-250	351-420	801-1600	17.1-34	236-785	1131-2260
	301-400	251-350	421-500	1601-2100	34.1-46	786-980	2261-3000
Hazardous	401-500	351-500	501-600	2101-2620	46.1 – 57.5	981-1180	3001-3750

Source – PSI [31]

Table 3. PSI colour codes

S/N	PSIcode	Colour	Health concern
2	0-50	Green	Good
5	51-100	Yellow	Moderate
7	101-150	Orange	Unhealthy for sensitive groups
8	151-200	Red	Unhealthy
9	201-300	Purple	Very unhealthy
11	301-500	Maroon	Hazardous

Source:Zagha & Nwaogazie [28]

From Table 4 the 8 hour mean PSI and their corresponding mean traffic, wind speed and solar radiation are extracted and presented as Table 5. The limit values are boundary positions imposed on the model. The first is attained by assuming that zero PSI would be achieved when the 8 hour mean traffic, solar radiation and wind speed are zeros. The last limit value is attained by multiplying the maximum hourly traffic that produced the worst CO concentration by two.

From Table 5 an empirical model relating PSI, 8 hour mean traffic, 8 hour mean solar radiation and 8 hour mean wind speed is developed using the Excel (Microsoft office, 2015, regression tool). Table 6 presents results of the model (Equation 2).

Extracting the coefficients from Table 6, a linear multiple regression model is represented as Equation (2).

PSI = 6.810671+ (0.0779 × 8-hr mean traffic) – (0.28272 × 8 hr-mean solar radiation) – (15.9254 × 8 hr-Mean wind speed) (2)

2.5 Evaluation of Contributory Effect of Model Variables

Given the value of R^2as 87.1264% (see Table 6) it became necessary to evaluate the contributory effect of the three independent variables of Equation (2), that is, Traffic volume, Solar radiation and Wind speed. Similar to Equation (2) three sets of regression models for which PSI is a function of each of the three independent variables were constructed using Excel (Microsoft office, 2015, regression tool) and the corresponding R^2 values are as presented in Table 7.

In an attempt to improve the value of R^2 of Equation (2) necessitated an addition of a fourth variable by a product of any of the two independent variables, *viz* a) wind speed multiplied by solar radiation; b) traffic volume multiplied by solar radiation; c) traffic volume multiplied by wind speed; and d) traffic volume squared multiplied by solar radiation. The application of multiple regression simulation using Excel (Microsoft office, 2015, regression tool) yielded the highest R^2 value of 0.936 (93.6%) which is an improvement of Equation (2) (R^2 = 0.8713). The resulting equation with the highest R^2 value is the PSI as a function of traffic volume, solar radiation, wind speed, and traffic volume multiplied by solar radiation (see Equation (3) and Tables 7 and 8).

PSI = -28.425 + (0.08559 × 8-hr mean traffic) + (0.887981 × 8 hr-mean solar radiation) – (17.3218 × 8 hr-Mean wind speed) – (0.00036 × 8-hr mean traffic × 8 hr-mean solar radiation) (3)

2.6 Model Verification

The models presented as Equations (2 & 3) are verified by correlating the observed PSI against the computed PSI (see Table 9) as shown in Figs. 2 and 3.

Table 4. PSI for 8 hr mean CO

S/N	Day	Traffic count	SR ± w/m^2	WS m/s	CO mg/m^3	8 Hour CO	PSI	8 Hour mean traffic	8 Hour mean SR	8 Hour mean WS
10:00	MON	3378	240.1	4.8	0					
12:00		3228	175.9	4.8	0.8					
14:00		3158	372	8	5.2	2	20	3255	262.7	8.8
16:00		3066	950.2	6.4	4.7					
18:00		2759	0.9	3.2	22.5					
20:00		1518	0	0	12.2					
22:00		822	0	0	8.1	11.875	129	2041	237.55	2.4
6:00	TUE	2298	0	0	10.3					
8:00		3436	280	4.8	0.7					
10:00		3556	350.9	9.7	0					
12:00		3236	413.8	8	4					
14:00		3470	1220	11.3	2.1	3.42	40	3200	452.94	6.78
16:00		2999	600	12.9	15.1					
18:00		2734	14	4.8	15.5					
20:00		1450	0	1.6	2.3					
22:00		689	0	1.6	6.1	9.75	100	1968	153.5	5.23
6:00	WED	2176	0	1.6	5.8					
8:00		3393	240.6	4.8	1.6					
10:00		3522	151.2	4.8	0					
12:00		3372	1025	6.4	10.5					
14:00		3357	83	12.9	3.4	4.26	50	3164	249.97	6.1
16:00		3104	37.8	6.4	6.2					
18:00		3070	12.4	1.6	12.7					
20:00		1614	0	0	18					
22:00		830	0	0	9.9	11.7	129	2155	12.55	2
6:00	THUR	2204	0	0	11.1					
8:00		3416	14.1	0	23.5					
10:00		3377	21.9	1.6	7.1					
12:00		3284	102	0	6.5					
14:00		3252	250	4.8	3	10.24	114	3107	77.6	1.28
16:00		3179	170.1	3.2	10.4					
18:00		2855	16	1.6	28.3					
20:00		1489	0	0	4.6					
22:00		893	0	1.6	1.8	11.275	129	2104	46.53	1.6
6:00	FRI	2301	0	0	6.1					
8:00	8	3926	60.2	0	8.4					
10:00	10	3754	341	1.6	10.2					
12:00	12	3292	1092	4.8	3.7					
14:00	2	3597	639	3.2	15.9	8.86	90	3374	426.44	1.92
16:00	4	3468	422.5	11.3	11.7					
18:00	6	3192	79.2	4.8	21.7					

±SR-solar radiation; WS-wind speed

Table 5. Eight (8)-hour mean PSI, position of day, wind speed and solar radiation

S/N	PSI	Position in day	Mean traffic	Mean SR	Mean WS
1	**0**	**Limit value**	**0**	**0**	**0**
2	20	Morning/afternoon	3255	262.7	8.8
3	129	Evening/ night	2041	237.55	2.4
4	40	Morning/afternoon	3200	452.94	6.78
5	100	Evening/ night	1968	153.5	5.23
6	50	Morning/afternoon	3164	249.97	6.1
7	129	Evening/ night	2155	12.55	2
8	114	Morning/afternoon	3107	77.6	1.28
9	129	Evening/ night	2104	46.53	1.6
10	90	Morning/afternoon	3374	426.44	1.92
11	500	**Limit value**	5704	0	0

Table 6. Result of regression analysis for three contributory factors

Summary output						
Regression statistics						
Multiple R	0.933415					
R Square	0.871264					
Adjusted R Square	0.816091					
Standard Error	57.79816					
Observations	11					
ANOVA						
	df	***SS***	***MS***	***F***	***Significance F***	
Regression	3	158261.8	52753.93	15.79162	0.001691	
Residual	7	23384.39	3340.628			
Total	10	181646.2				
	Coefficients	***Standard error***	***t Stat***	***P-value***	***Lower 95%***	***Upper 95%***
Intercept	6.810671	43.41778	0.156864	0.879781	-95.8561	109.4774
Mean Traffic	0.077943	0.013401	5.816256	0.000653	0.046255	0.109631
Mean SR	-0.28272	0.142626	-1.98226	0.087888	-0.61998	0.054535
Mean WS	-15.9254	7.862933	-2.02538	0.082474	-34.5183	2.667486

Table 7. R^2 effect of independent variables of equation (2)*

S/N	Model	Regression statistic, R^2
1	PSI as a function of Traffic volume only	0.49204
2	PSI as a function of solar radiation only	0.16533
3	PSI as a function of wind speed only	0.22893
4	PSI as a function of Traffic volume, solar radiation and wind speed	0.871264
5	PSI as a function of traffic volume, solar radiation, wind speed and wind speed multiplied by solar radiation	0.87141
6	PSI as a function of traffic volume, solar radiation, wind speed and traffic volume multiplied by solar radiation	0.93571
7	PSI as a function of traffic volume, solar radiation, wind speed and traffic volume multiplied by wind speed	0.92592
8	PSI as a function of traffic volume, solar radiation, wind speed and square of traffic volume multiplied by solar radiation	0.8843

**The contributory effect of each of the independent variables confirms that none is insignificant*

Table 8. PSI as a function of traffic volume, solar radiation, wind speed and traffic volume multiplied by solar radiation

Summary output						
Regression statistics						
Multiple R	0.967322					
R Square	0.935712					
Adjusted R Square	0.892853					
Standard Error	44.11674					
Observations	11					
ANOVA						
	df	*SS*	*MS*	*F*	*Significance F*	
Regression	4	169968.5	42492.12	21.83241	0.001012	
Residual	6	11677.72	1946.287			
Total	10	181646.2				
	Coefficients	***Standard error***	***t Stat***	***P-value***	***Lower 95%***	***Upper 95%***
Intercept	-28.425	36.12058	-0.78695	0.461256	-116.809	59.95883
Mean Traffic	0.08559	0.010693	8.003975	0.000203	0.059424	0.111756
Mean Sr	0.887981	0.489602	1.813678	0.119664	-0.31003	2.085995
Mean Ws	-17.3218	6.028643	-2.87325	0.028306	-32.0734	-2.57025
T*Sr	-0.00036	0.000146	-2.45252	0.04962	-0.00072	-8.2E-07

Table 9. Observed (Actual) PSI and predicted PSI

S/N	Actual PSI	Predicted PSI, equation (2)	Predicted PSI, equation (3)
1	**0**	**6.8**	-28.4
2	20	46.1	23.2
3	40	20.2	8.4
4	50	85.6	74.0
5	90	118.7	87.8
6	100	33.5	77.0
7	114	206.7	197.4
8	129	60.5	141.1
9	129	139.4	122.8
10	129	132.2	130.0
11	500	451.4	459.8

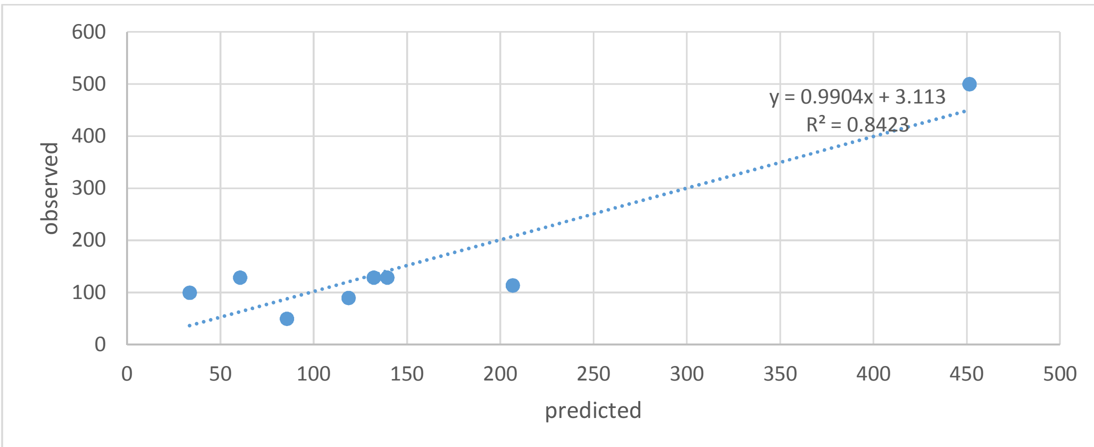

Fig. 2. A plot of predicted PSI (Equation 2) and observed PSI

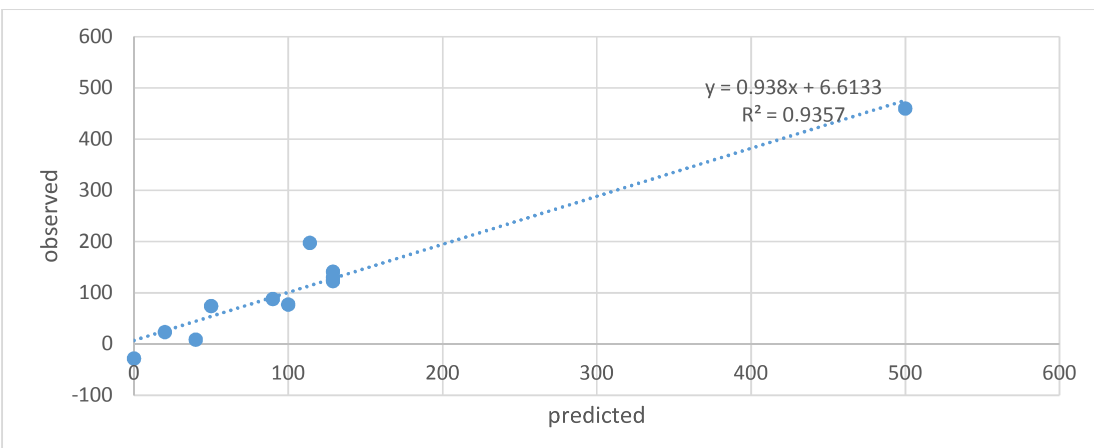

Fig. 3. A plot of predicted PSI (equation 3) and observed PSI

3. RESULTS AND DISCUSSION

A model to predict PSI has been developed, the model attains a correlation coefficient of 0.9334 in development and 0.8423 in verification. Carbon monoxide (CO) pollutant has been used in this analysis because highway vehicles produce 60% of carbon monoxide emissions as in the USA (U.S EPA, 2010). From it is seen that highway vehicles produce 16% of VOC's, 1% of SO_2, 9% of $PM_{2.5}$, 12% of PM_{10}, 0% of lead and 8% of Ammonia emissions. From Table 4 the health effect of different traffic volumes are represented with their equivalent PSI values. It is seen that the evenings/mornings have higher CO concentrations than the afternoons. This effect can be traced to atmospheric stability as the afternoon's records show low stability causing low concentration of pollutants and the evenings /night records show high stability causing very high pollutant concentrations [30,32-35]. Works of Sucevic and Djurisic [36] have shown connections between Pasquills stability classes and atmospheric stability classes (see Tables 10 and 11) and this can be used to establish a relationship with the developed model (Equation 2).

Fig. 4 represents a chart that shows the relationship between PSI (function of CO concentration), traffic, wind speed and solar radiation. From the assessment of Fig. 4 it is seen that Pasquill was correct in his research. High CO concentration (PSI) were recorded when the solar radiation was less than 150 W/m^2 and the wind speed less than 2 m/s. From Table 8 it is seen that the atmospheric stability condition associated with solar radiation of less than 150 W/m^2 and wind speed less than 2 m/s is of stability class D (neutral) and this class of stability impedes dispersion thereby increasing the concentration of pollutants (Leton, 2005).

Combining the information on Table 10 with the developed model (Equation (2)), we can develop an environmental impact assessment table to guide in intersection designs/planning both in the study area and other areas with associated meteorological parameters. Tables 12 – 16 show the relationship between Pasquill stability class, Traffic and PSI. These tables are developed by adopting Equation (2) for different solar radiations and velocities from the Pasquill Table. The tables are then coded by colors for the different PSI categories and it should be noted that all PSI less than zero are equated to zero (0).

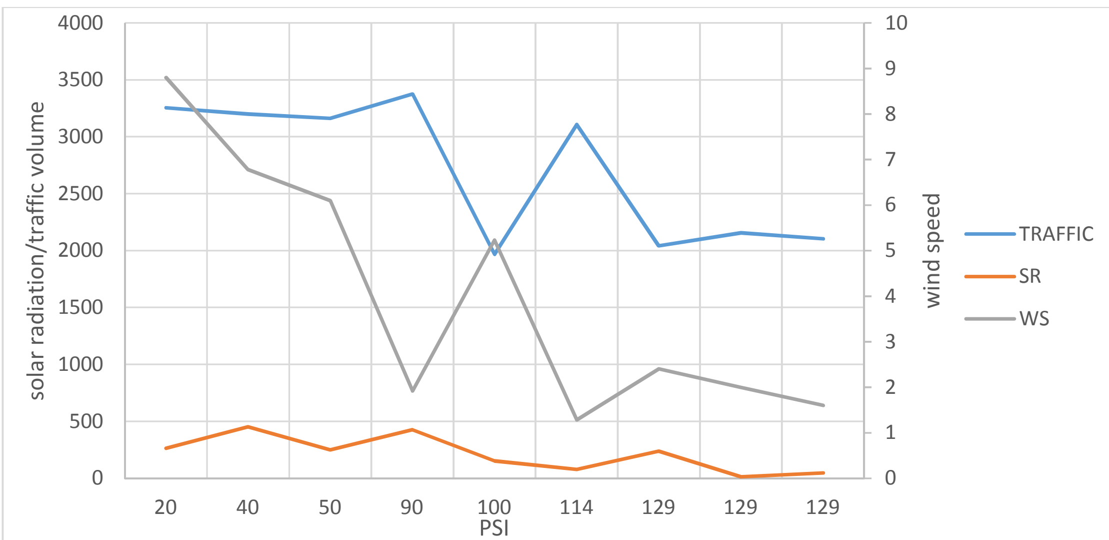

Fig. 4. Relationship between PSI, solar radiation, wind speed and Traffic flow

Table 10. Atmospheric stability classification

Wind speed at 10 m	Daytime				Nighttime
	Incoming solar radiation (Wm)				
	>600	300-600	150-300	<150	
<2	A	A	B	D	F
2-3	A	B	C	D	E
3-5	B	B	C	D	D
5-6	C	C	D	D	D
>6	C	D	D	D	D

Source –Sucevic and Djurisic [36]

Table 11. Pasquill classes and atmospheric Stability conditions

Atmospheric stability	Pasquill's classes
Very Stable	A
Unstable	B
Unstable	C
Neutral	D
Stable	E
Very Stable	F

Source – Sucevic and Djurisic [36]

More categories of the Tables presented on Tables 12 – 16 have been developed in house. Before we can effectively use the information presented on Tables 12 – 16, a detailed atmospheric analysis should have beencarried out on the locality concerned using the areas meteorological history [30,36]. Using these Tables developed for Environmental impact assessment, intersections can be planned with the impact of the environment earlier estimated. These tables are used to check the level of impact the people will face in that environment based on the variation of the 8-hr mean traffic expected to operate through that point/location. If using a high traffic imposes high environmental impacts (high PSI factors) then the traffic can be reduced by providing other diversions/bypasses before the intersection point. Using Choba junction as a practical example, the observed peak 8 hour mean is 3372 vehicles and if this is approximated to 3400 vehicles then we would use Table 16. In that case, if such traffic is allowed to operate at the intersection then the people will face unhealthy situations unless the solar radiation gets to 400 W/m^2 and the wind speed 6 m/s. A solution for the case of Choba junction is to create divisions or bypasses to help reduce the traffic at the intersection. Field observations at Choba junction showed that out of 100% of the vehicles accessing the junction, 50% are travelers that access it to connect the East-West road and continue towards the western direction of the junction out of Port Harcourt. Twenty percent (20%) are University staff vehicles who want to get into Abuja campus, and 10% for to access Aluu community (a neighboring village to Choba). It was seen that only 20% of the Traffic actually have need to use this junction. If we create a bypass for the 50% travelers and 30% (mostly Uniport workers) to also avoid the junction then we have reduced the 8-hr mean traffic to 20% that is, 675 vehicles per hour (see Fig. 5). Approximating the value to 700 vehicles and from Table 14 it is certain that Choba junction will always have good/moderate PSI levels.

Table 12. Modified Pasquill table for 500 vehicles (8-hr mean traffic)

For 500 8-hr mean traffic								
Velocity (m/s)	Solar radiation (W/m^2)							
	10	50	100	200	300	400	500	600
0.5	35.0	23.7	9.5	-18.7	-47.0	-75.2	-103.5	-131.8
1	27.0	15.7	1.6	-26.7	-55.0	-83.2	-111.5	-139.8
2	11.1	-0.2	-14.3	-42.6	-70.9	-99.1	-127.4	-155.7
3	-4.8	-16.1	-30.3	-58.5	-86.8	-115.1	-143.3	-171.6
4	-20.7	-32.1	-46.2	-74.5	-102.7	-131.0	-159.3	-187.6
5	-36.7	-48.0	-62.1	-90.4	-118.7	-147.0	-175.2	-203.5
6	-52.6	-63.9	-78.0	-106.3	-134.5	-162.9	-191.1	-219.4

Table 13. Modified Pasquill table for 500 vehicles (8-hr mean traffic) including PSI coding

For 500 8-hr mean traffic								
Velocity (m/s)	Solar radiation(W/m^2)							
	10	50	100	200	300	400	500	600
0.5	35.0	23.7	9.5	0	0	0	0	0
1	27.1	15.7	1.6	0	0	0	0	0
2	11.1	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0
4	0		0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0

Table 14. Modified Pasquill table for 700 vehicles (8-hr mean traffic) including PSI coding

For 700 8-hr mean traffic								
Velocity (m/s)	Solar radiation(W/m^2)							
	10	50	100	200	300	400	500	600
0.5	50.6	39.2	25.1	0	0	0	0	0
1	42.6	31.3	17.1	0	0	0	0	0
2	26.7	15.4	1.2	0	0	0	0	0
3	10.8	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0

Table 15. Modified Pasquill table for 3000 vehicles (8-hr mean traffic) including PSI coding

For 3000 8-hr mean traffic								
Velocity (m/s)	Solar radiation(W/m^2)							
	10	50	100	200	300	400	500	600
0.5	229.8	218.5	204.4	176.1	147.8	119.6	91.3	63.0
1	221.9	210.6	196.4	168.2	139.9	111.7	83.3	55.1
2	206.0	194.7	180.	152.2	124.0	95.7	67.4	39.2
3	190.0	178.7	164.6	136.3	108.0	79.8	51.5	23.3
4	174.1	162.8	148.7	120.4	92.1	63.9	35.6	7.3
5	158.2	146.9	132.7	104.5	76.2	48.0	19.7	0
6	142.3	131.0	116.8	88.5	60.3	32.0	3.7	0

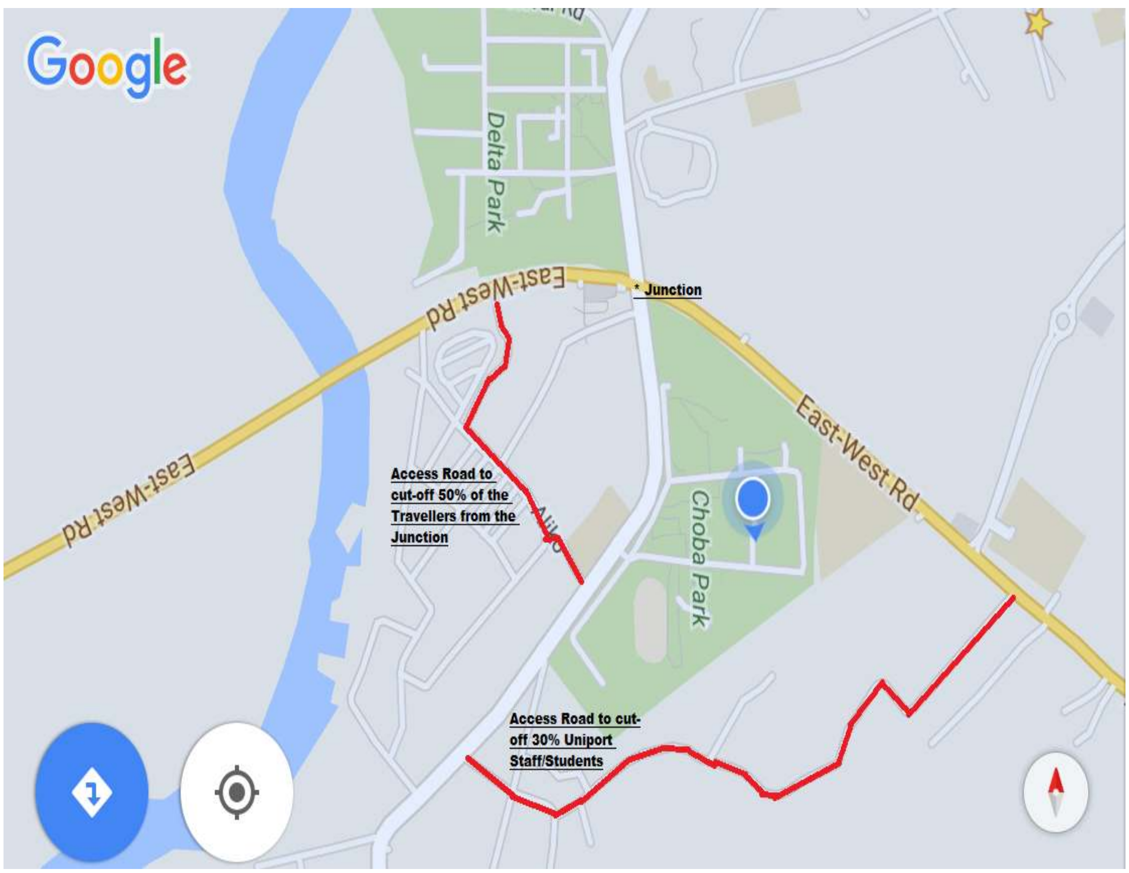

Fig. 5. Study area showing proposed bypass (in red lines)

Table 16. Modified Pasquill table for 3400 vehicles (8-hr mean traffic) including PSI coding

	For 3400 8-hr mean traffic							
Velocity (m/s)	Solar radiation(W/m^2)							
	10	50	100	200	300	400	500	600
0.5	261.0	249.7	235.6	207.3	179.0	150.8	122.5	94.2
1	253.1	241.8	227.6	199.3	171.1	142.8	114.5	86.3
2	237.1	225.8	211.7	183.4	155.2	126.9	98.6	70.3
3	221.2	209.90	195.8	167.5	139.2	111.0	82.7	54.4
4	205.3	194.0	179.8	151.6	123.3	95.0	66.8	38.5
5	189.4	178.1	163.9	135.6	107.4	79.1	50.8	22.6
6	173.4	162.1	148.0	119.7	91.4	63.2	34.9	6.6

4. CONCLUSION

The following conclusions can be drawn from this study:

1. A model has been developed to predict PSI from 8-hr mean traffic, solar radiation and wind speed. The model yielded a correlation coefficient of 0.933415 in development and 0.8423 in verification.
2. The available design tables can be valuable in planning intersections especially when the Environmental impact is put into consideration.
3. The traffic in Choba junction has a negative impact on the environment especially in the evening periods when the atmosphere is very stable because of low solar radiation and wind speed.
4. Observations showed that 50% of the traffic in Choba junction are travelers trying to connect to the East-West road in order to leave Port Harcourt city. Thirty percent (30%) are mostlyUniport staff trying to get into Abuja campus. Only 20% of the traffic recorded actually have activities for which they cannot avoid the junction.
5. For traffic at Choba junction to have zero negative effect on the environment, it requires a maximum of 700 vehicles an hour (8-hour mean). To achieve this two access/bypass roads should be created.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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