Quantifying Industrial Pollution on Residential Neighborhood in Trans-Amadi Industrial Layout, Port Harcourt, Nigeria

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INTRODUCTION

- Industries have generated a surge of interest among environmentalists and planners who are interested in the environmental impacts of industries (Joana *et al*, 2014).

- Studies have shown that there is a correlation between environmental damage and Industrial growth particularly in developing countries (e.g., Remoundou and Koundouri, 2009; Dechezleprêtre and Sato, 2017).

INTRODUCTION…..

- Ogedengbe & Onyuanyi (2017) observed that, industrial activities are responses to the need to better the lots of man but these are not without attendant consequences on the environment.

- The unpleasant side effect of industrialization is the waste generated from industrial processes. These include liquid, gaseous, noise, heat, and solid wastes leading to industrial Pollution.

Study Area

- Trans-Amadi, the study area is an industrial layout in Port-Harcourt L.G.A, Rivers State, Ngeria.

- It is a thousand hectare (10.11725 km²) industrial area, as well as a diverse residential neighbourhood in the city of Port Harcourt.

- Trans-Amadi is situated at 4°47' N, 4°48'N latitude and 7°1'E, 7°2' E longitude

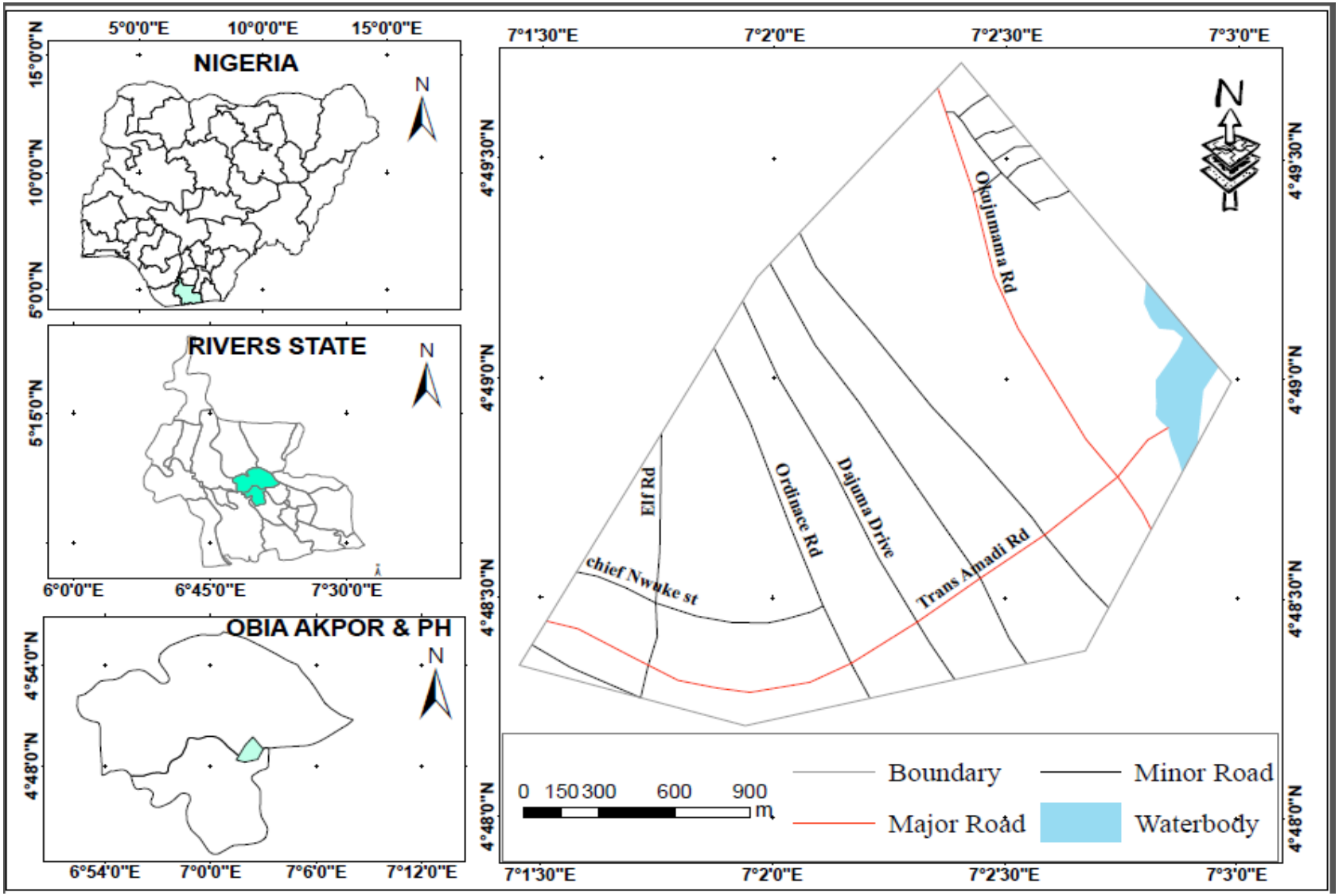

Figure 1: Trans- Amadi Industrial Layout, Port Harcourt

MATERIAL AND METHODS

- High resolution IKONOS imagery of 2010 was acquired for the purpose of mapping land use in the investigated area. The choice of land use mapping with high resolution data is consistent with works by previous researchers (*Janssen and Vanderwel*, 1994; *Bethelet al.*, 2001; *Ghaleb and Rania*, 2010).

- Stratified sampling technique was used to select sampling locations. The study area is majorly occupied by industries; as such, the distribution of data points was influenced by accessibility challenge

MATERIAL AND METHODS...

- Six land-use types (academic, administrative, commercial, industrial, mixed use and residential) were observed in the investigated area. A total of 20 sample points that cut across the various land-use types within the study area were selected for air and noise evaluation.

- Hgh Volume Sampler (HVS) GS332D model and Beta attenuation monitors were employed to measure the gaseous pollutants and Particulate Matter concentration. Samplings for noise level and air quality were carried out at 20 sites and their coordinates were recorded using GPS receiver.

Figure 2: Representation of Sample points

MATERIAL AND METHODS….

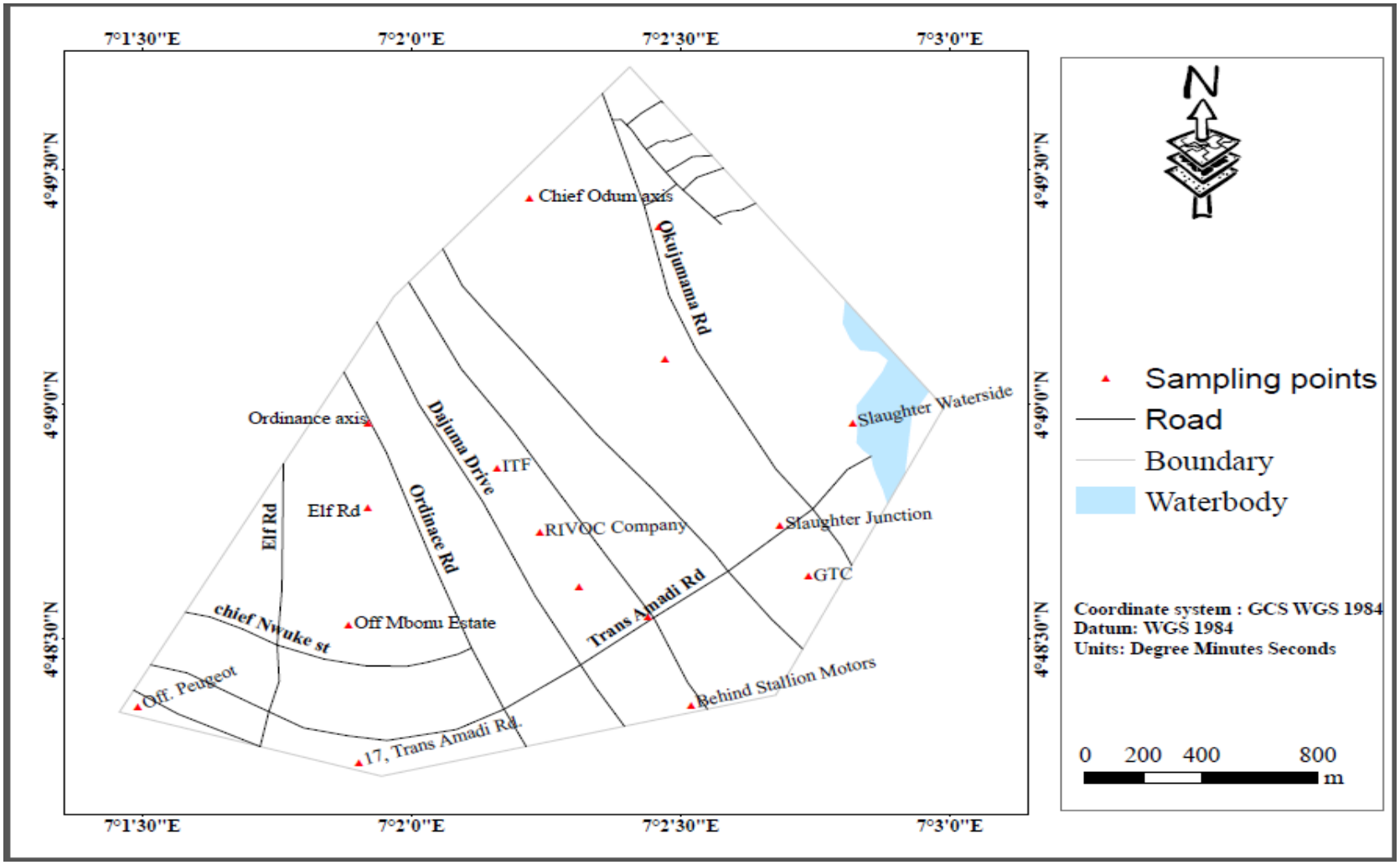

Figure 2: Representation of Sample points

DATA ANALYSIS

- The high-resolution image (IKONOS) with a 4m resolution acquired was imported into the ArcGIS environment and digitised for features extraction.
- The identification (or on-screen digitizing) of the different land use classes was used to produce the land use map of the study area and produce the statistics of the area of land occupied by each land use class.
- The land-use were categorised and stored in the geodatabase in ArcCatalog and was used to produce the land-use map of the study area.

DATA ANALYSIS

- The correctness of the land use map produced was determined using ground truth information of 21 field sites.

- These sites were located using a handheld GPS receiver with a precision of ±3m. They were chosen by structured random sampling to cover all obtained land use classes and sub-categories.

- The sites selected from field were compared with interpretation results.

- Further analysis to determine the percentage occupied by each land-use type was also carried out using Microsoft Excel.

DATA ANALYSIS

Air Quality Analysis

- Kriging, a popular interpolation method was utilized in this study. Kriging method weights the surrounding values to predict values for unknown locality based on its spatial arrangement.

- Ordinary Kriging method with spherical semi variogram type was used to develop air quality model as well as to study error.

- The error analysis was carried out between actual and interpolated values by means of one statistical tests– root mean square error (RMSE) to validate the model.

- A cross validation analysis of the best interpolation technique to be used was done using the one with the least RMSE (*Dilip et al.,* 2011).

DATA ANALYSIS

- Ordinary kriging interpolation technique had the least RMSE hence was used to interpolate for the un-sampled points within the study area and a Continuous surface of the each of the pollutants was created.
- Five classes are used to illuminate minute difference in values, this was used to produce maps showing the concentration of the criteria air pollutants within the study area (*Alaigba*, 2012).
- The data was matched with Nigerian Ambient Air Quality Standard (NESREA, 2009) as presented in Table 1.
- Air Now (Air Quality Index Calculator) online software was used to calculate and categorise the ambient air quality.

DATA ANALYSIS

Table 1: Nigerian Ambient Air Quality Standard

S/N	Pollutant	Time of Average	Limit
1	Suspended Particulate Matter (PM_{10}) and $PM_{2.5}$	Daily average of hourly values of 1 hr.	250 µg/m^3
2	Sulfur dioxide (SO2)	Daily average of hourly values of 1 hr.	0.40mg/Nm^3
3	Nitrogen Oxides (NOx)	Daily average of hourly values. 8 hourly values	10mg/Nm^3
4	Carbon Monoxide(CO)	Daily average of hourly values of 8 hourly average.	10mg/Nm^3
5	Ozone (O3)	Daily average of hourly values of 8 hourly average.	0.120 mg/Nm^3

Source: NESREA (2009)

DATA ANALYSIS

Noise cross validation analysis

- The data exploratory and cross validation analysis applied to the air quality data was also applied to the noise data.
- A day and night noise map of the area was produced using the Kriging interpolation technique.
- The noise level was matched with Maximum Permissible Noise levels for General Environment (dB).

- The classification scheme used is natural break (Jenks) (NESREA, 2009) for both day and night in order to showcase the natural distribution of values as bulk of values will fall under similar colour zone, and this in turn accentuate extreme values into distinctive colours for ease of identification.

- The classification scheme used is presented in Table 2.

DATA ANALYSIS

Table 2: Classification Scheme Used –Natural Break (Jenks)

Facility	Day (dB) 5:59am – 9:59am	Night (dB) 10:00pm – 6:00 am
Residential Buildings	50	35
Mixed Residential with Commercial and entertainment.	55	45
Residential + Industry or small-scale production + Commerce.	60	50
Industrial.	70	60
Hospital, Institute of Hgher learning, Conference room, Public libraries, recreational sites. etc.	45	35

Source: NESREA (2009)

DATA ANALYSIS

Estimation of population covered by the industrial layout

- The population of the three localities (Amadi-Ama, Okuku-Ama, and Abuloma) covered by the industrial layout was estimated to have understanding of number of people exposed to the industrial pollution in the area.

- Population data of the 1991 census for the study area as obtained from National Population Commission (NPC) and Microsoft Excel was used to project the current population and an estimate of the population covered by the industrial layout was determined as shown in (Table 3) using the formula:
  - Pt = Po ExpRT.

- Where; Pt = the projected population, Po = the base population in 1991, Exp= Exponential, R= Population growth rate (4.5% for National), and T = the time interval. (1991 –2014) = 23.

- Methods for computing population at risk vary according to the health issue being considered.

DATA ANALYSIS

Table 3: Projected population

S/N	Locality	Base Population (1991)	Projected Population (2014)
1	Amadi - Ama	7,034	19,801
2	Okuku -Ama	5,603	15,773
3	Abuloma	10,454	29,429
	Total	23,091	65,003

RESULTS AND DISCUSSION

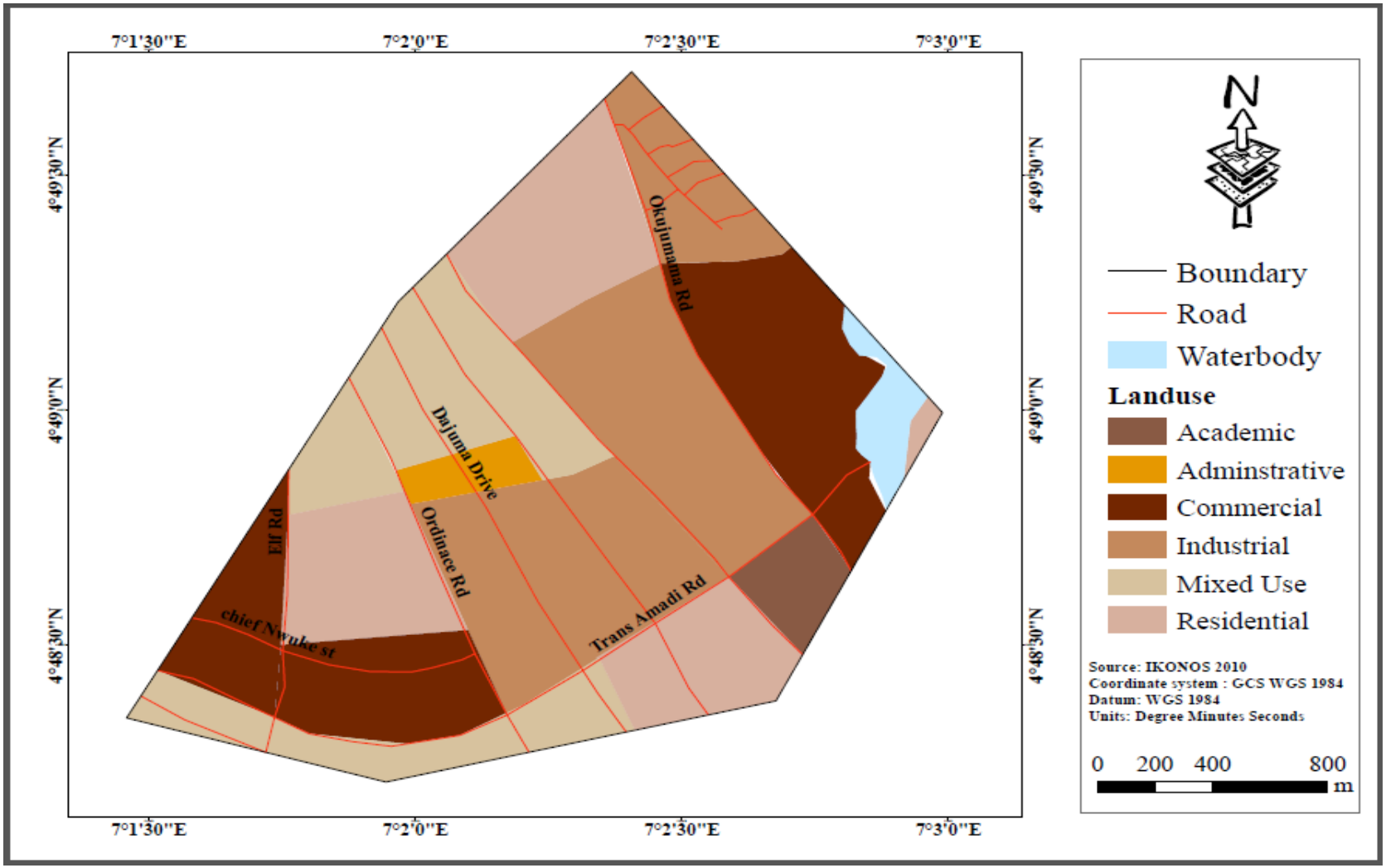

Figure 3: Land-use map of Trans- Amadi Industrial Layout

RESULTS AND DISCUSSION

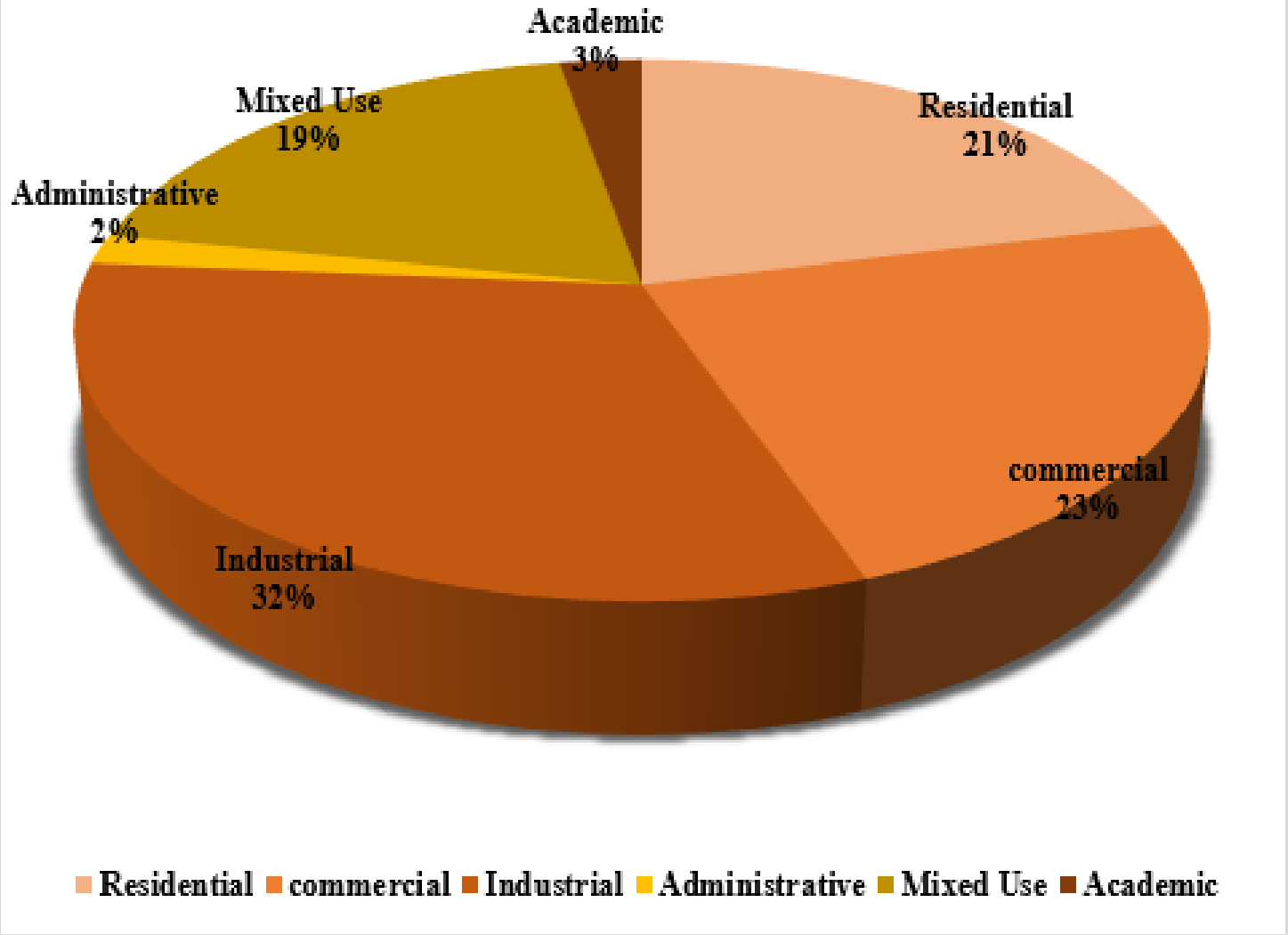

Figure 4: Percentage Land-use chart of Trans- Amadi Industrial Layout

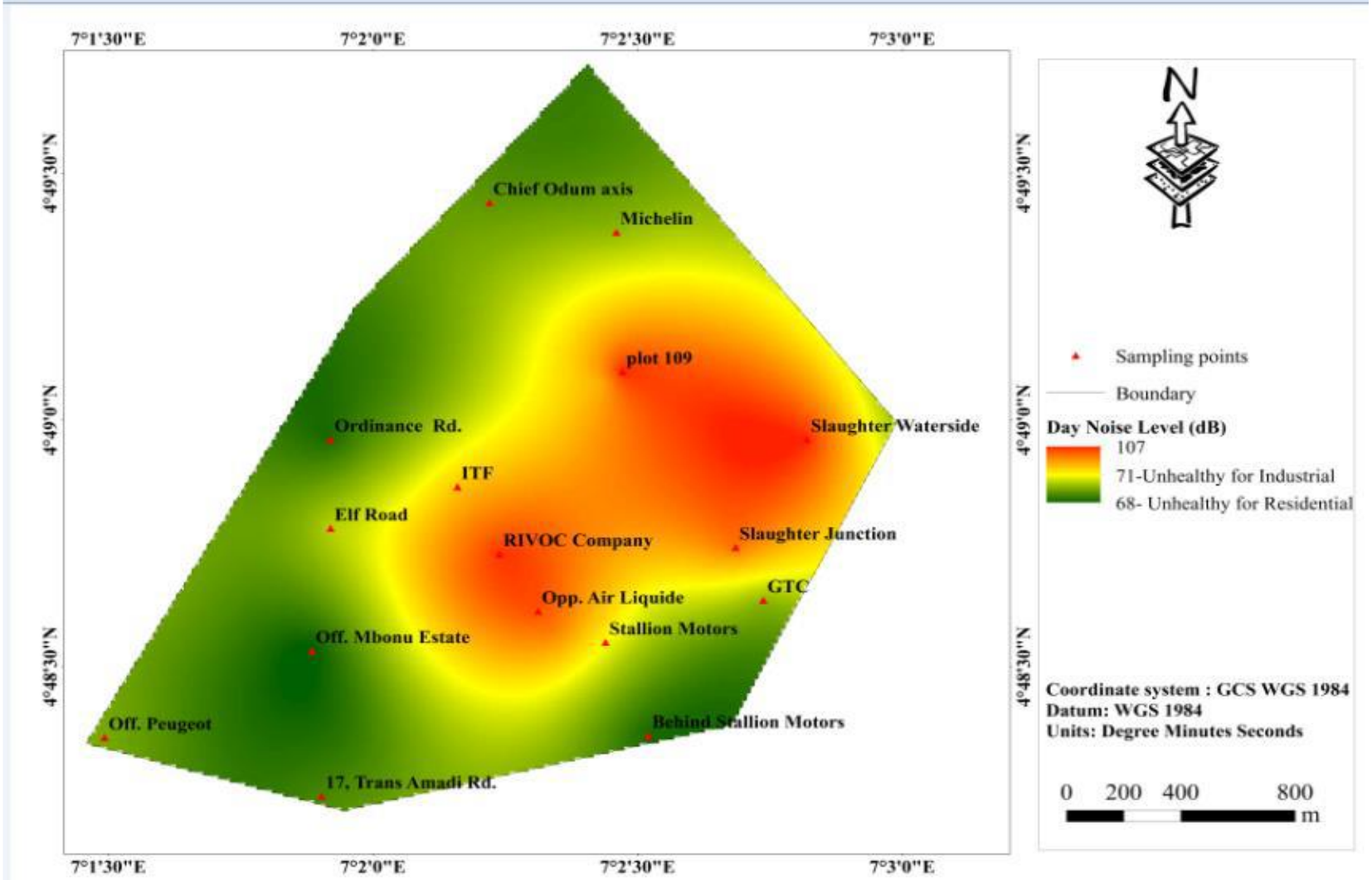

Figure 5: Noise Level of the Study Area during the Day

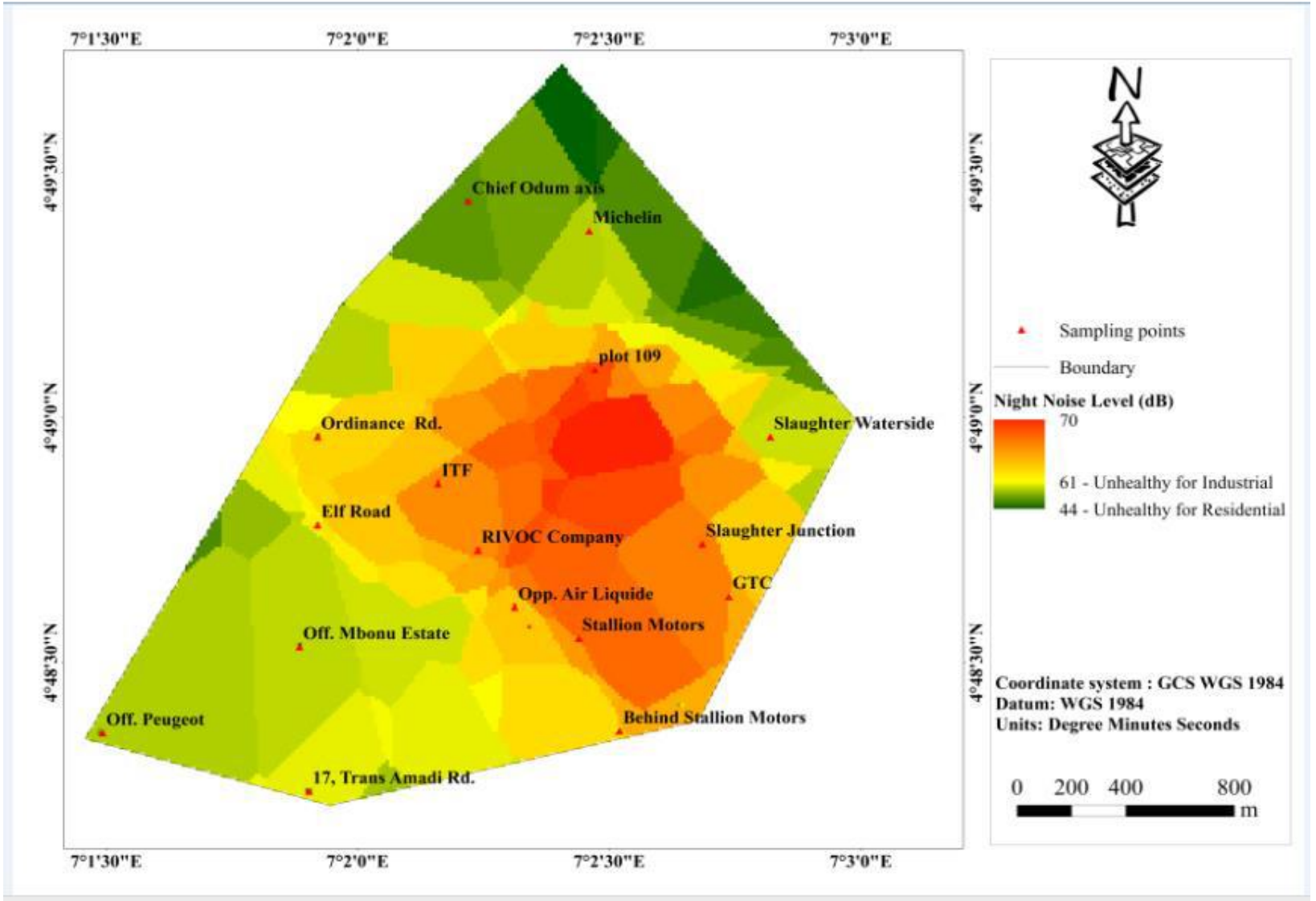

Figure 6: Noise Level of the Study Area at Night

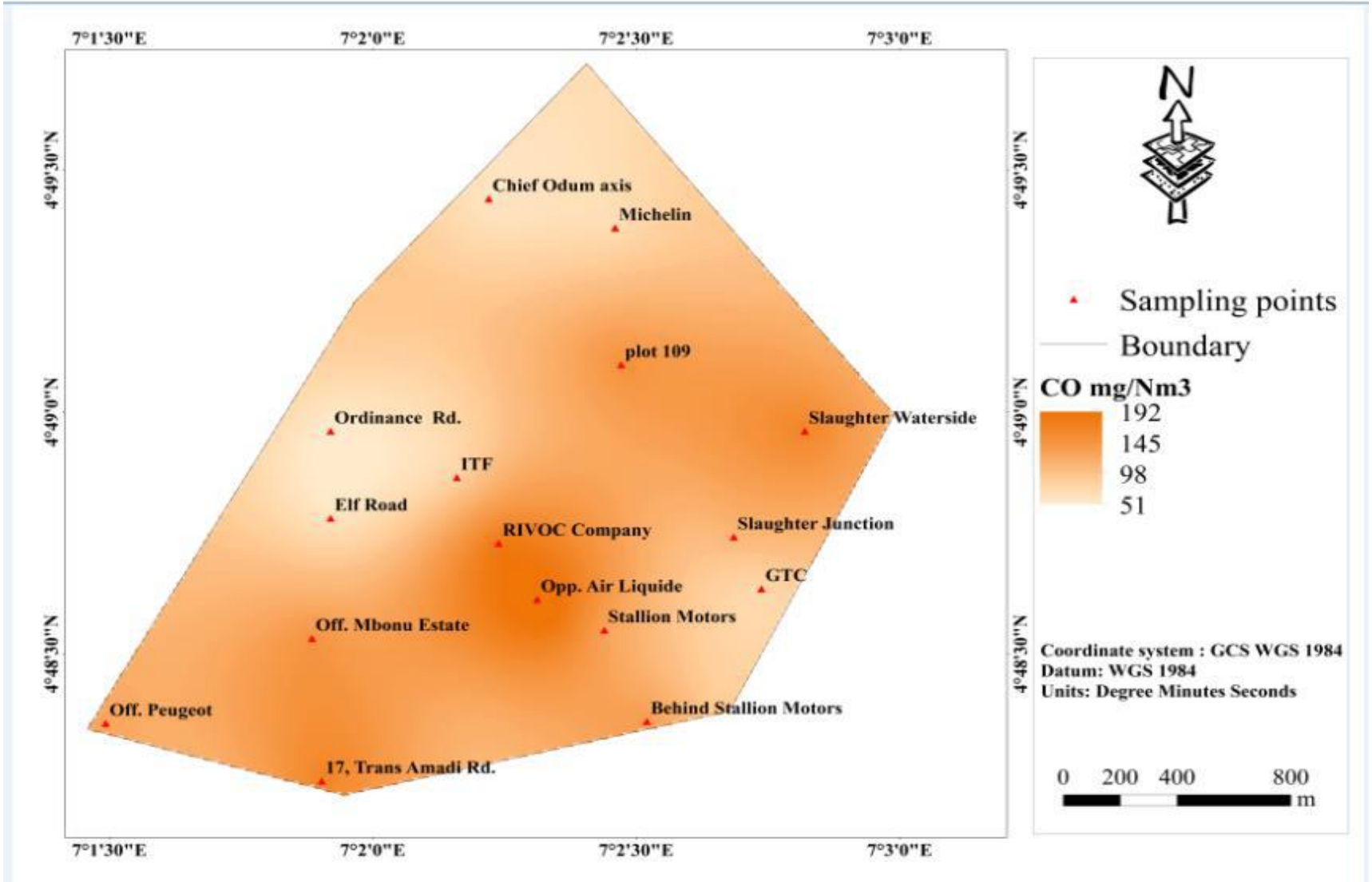

Figure 7: Ambient Air Carbon Monoxide (CO) Concentration

CONCLUSION

- The results indicated that noise level during the day and at night were found to be above the permissible range.

- Six criteria air pollutants tested (suspended particulate, Ozone, Sulfur dioxide, Ntrogen oxides, and Carbon monoxide) were found to be between the permissible range for industrial area apart from the Ntrogen Oxide and Carbon monoxide.

- Air quality index for the pollutants were categorized as: PM10 = 66 (moderate), PM2.5=168 (unhealthy), SO2= 0 (good), CO = 137 (unhealthy), O3 = 0 (good), and NOx=122 (unhealthy for sensitive groups).

- A total population of 65,003 persons living in the layout are at risk of air pollution.

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Thank You!