



APPLICATION OF GIS TECHNIQUE FOR MAPPING OF DAYTIME AIR QUALITY INDEX IN NNAMDI AZIKIWE UNIVERSITY, AWKA CAMPUS

Kingsley Idhoko, Akpomuode C Ogenerume, Jonah T Oweifighe, Ejike Uzoke

► To cite this version:

Kingsley Idhoko, Akpomuode C Ogenerume, Jonah T Oweifighe, Ejike Uzoke. APPLICATION OF GIS TECHNIQUE FOR MAPPING OF DAYTIME AIR QUALITY INDEX IN NNAMDI AZIKIWE UNIVERSITY, AWKA CAMPUS. International Journal of Research , 2024, 11 (02), pp.199 - 211. hal-04466554

HAL Id: hal-04466554

<https://hal.science/hal-04466554>

Submitted on 26 Feb 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

Public Domain

Application of GIS Technique for Mapping of Day Time Air Quality Index in Nnamdi Azikiwe University, Awka Campus

Idhoko Kingsley E¹., Akpomuode Oghenerume C¹., Oweifighe Jonah T.¹, Uzoke Ejike R¹.

1. Department of Surveying and Geoinformatics, Nnamdi Azikiwe University, Awka, Anambra State, Nigeria.

Abstract

Air quality models play a very important role in formulating air pollution control and management strategies by providing information about better and more efficient air quality planning. This study involved the mapping and monitoring of Air Quality Index of various locations in Nnamdi Azikiwe University, Awka Campus. The Methodology of the project adopts the use of GIS (Geographical Information System) technique data analysis. This research was performed in order to identify air pollution levels of Nnamdi Azikiwe University Awka. Air quality parameters considered were, Carbon Dioxide (CO₂), Total Volatile Organic Compounds (TVOC), Formaldehyde (HCHO), TEMPERATURE, and HUMIDITY. The respective Air quality data were captured using portable digital air pollution detecting device for creation of data. The sampling positions were recorded with the aid of a highly sensitive hand-held receiver of the Global Positioning System (GPS). GIS technology was used to integrates common database operation such as query and statistical analysis offered by maps and use to converts data between different data models (unlike most database and statistical software). Observations took a duration of one month which involved capturing of both morning and evening. The study area digitization was performed using maps downloaded from Google Earth Map. Digitization was carried out using Arc Map software. ArcGIS 10.1 software was used principally for mapping the recorded air pollution levels based on the computation.

Keywords: Air Mapping, Air mapping Index, GIS, Environmental Pollution, IDW (inverse distance weighting)

1. Introduction:

Air is one of the most indispensable and essential substance for human life. According to AyseEmelOnal *et al*, (2013 and 2015), humans can only survive for up to 4-12 minutes without breathing air. Air is one of the five essentials (air, water, food, heat and light) for humans (khitoliya 2004). Air comprises of many gases and dust particles. It is the clear gas in which living things live and breathe. It has an indefinite shape and volume. It has no color or smell. It has mass and weight, because it is matter.

Air pollution has been the most important health issue in recent years. Man in his quest to make the planet earth a better place for him to inhabit and survive results in the earth's environment undergoing different forms of pollution. Changes in the gaseous composition of earth's atmosphere due to human activities have become a prime concern for today's world. India and other developing countries have experienced a progressive degradation in air quality due to industrialization, urbanization, lack of awareness, number of motor vehicles, use of fuels with poor environmental performance, badly maintained poor roads and ineffective environmental regulations (Joshi and Chauhan, 2008). The air pollutants emitted from the different industries into the atmosphere are either gaseous or particulates (Joshi *et al.*, 2009). Atmospheric pollution is the state whereby some gases in the atmosphere exist at higher-than-normal conditions, and can be seriously harmful to human health and environment (Suleiman, 2013).

In our current day to day life, the air quality remains one of the major environmental issues in the human society. Quality of air affects the entire human race as well as plant and animal populations on the earth. Due to population growth, economic development, growing transportation demand, as well as living standards, the air quality has been deemed impure. Therefore, the need to monitor and map the AIR QUALITY INDEX of Nnamdi Azikiwe University, Awka Campus, Anambra State, Nigeria cannot be over-emphasized. The monitoring and mapping of QUALITY INDEX of Nnamdi Azikiwe University, Awka Campus can be actualize using GIS Technique.

The application of GIS for air quality analysis and health risk map helps in finding out the relationship between the distribution of air quality, density of population and health risk of the population. This study investigated the level of 5 major parameters (CO₂, HCHO, TVOC, HUMIDITY and TEMPERATURE) in Nnamdi Azikiwe University Awka South Local Government Area of Anambra State, Nigeria; with high industrial activities, high vehicular and human traffic density.

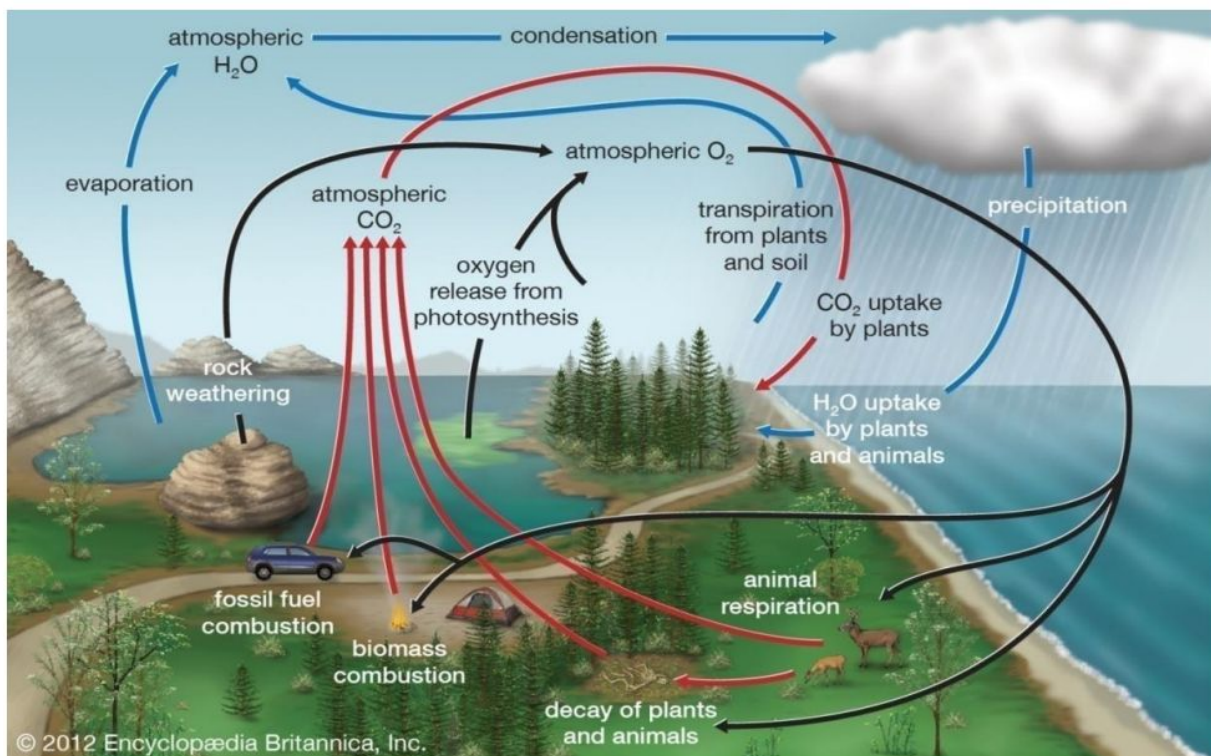


FIG 1. PICTURE SHOWING ECOSYSTEM OF AIR GAS

2. Methodology

Observations were taken for a period of one (1) month from MARCH 4th to April 4th 2021 using the AIR QUALITY MONITOR. It included data acquisition for both Morning and Evening with an interval of 30 minutes for each Stations. Readings were taken base on 3 observations per 10 minutes in each station alongside the collection of station coordinates. For stations far apart, interpolation stations were observed with both coordinates and parameter data. Position of each point was done using the Global Positioning system (GPS).

Procedure for taking measurements.

1. Hold Air Quality Meter at any Arm's length, at a random point around your station point.
2. Wait for 10minutes before taking reading. Take 3 readings at random points at station point.
3. Using GPS receiver, obtain the coordinates of each station
4. Record all values and data on field book sheet
5. Repeat these steps at all stations

Software used was the ARCGIS 10.5 for mapping the recorded Air Quality parameters based on the computation. These values were mapped as points data relative to the specific location. To capture the adjoining areas and to cover the entirety of the study area, spatial interpolation

technique IDW (inverse distance weighted) was employed. Generally, interpolation predicts cell values in a raster format using a given albeit limited number of sample data. IDW however explicitly implements the law of geography, which is pivoted on the hypothesis that closer things are more related than those farther apart. For its prediction, IDW utilizes the given values surrounding the predicted location. It predicts that each given point has a local influence that shrinks with space; thereby giving greater weights to points closest to the prediction location, based on distance decay effect. This process leads to the procedure being referred to as inverse distance weighted. This technique was applied to measure the spatial distribution and range of acoustics in the area for the period of the observations were done. Akintuyi, A. O; Raji, S. A. Adewuni, D. and Wunude, E. O (2014).

3. Geography, climate and pollution sources

Nnamdi Azikiwe University is located in Awka South. Awka South LGA is one of the 21 local governments in Anambra State. It was created in 1989 from Awka local government area. It is one of the local governments that make up the capital city. Its geographical coordinate is 6° 10' 0" North, 7° 4' 0" East; bounded on the north by Awka North local government area, on the east by Oji-River local government area of Enugu State, on the south by Anaocha local government area and on the west by Njikoka local government area. It has a land area of 180 square kilometers. Awka is 96m above sea level. In Awka, the average annual temperature is 26.8°C(80.2°F). As in the rest of West Africa, the rainy season and dry season are the only weather periods that reoccurs in Awka. The average annual rainfall in Awka is around 1589 millimeters (62.6 inch per year), which occurs intermittently and becomes very heavy during the rainy season. The driest month is January, with 13mm/0.5 inch of rain. Most precipitation falls in September, with an average of 227mm/8.9 inch. February is the warmest month of the year. The temperature in February averages 29.2°C/84.6°F. In August, the average temperature is 24.9°C/76.8°F. It is the lowest average temperature of the whole year. There is a difference of 214mm/8 inch of precipitation between the driest and wettest months. The average temperatures vary during the year by 4.3°C/39.8°F. During the dry season the humidity is lower than in the rainy season. Temperature is most often high during the day and low during the night. This results in high evaporation rate during the day. Harmattan which occurs between the months of November and February is always accompanied by poor visibility mostly at night and early in the morning. The main sources of the air pollution levels in the school are domestic heating, industry and motor vehicles. Furthermore, the increased activities of vehicles circulate on an average daily basis in the city.

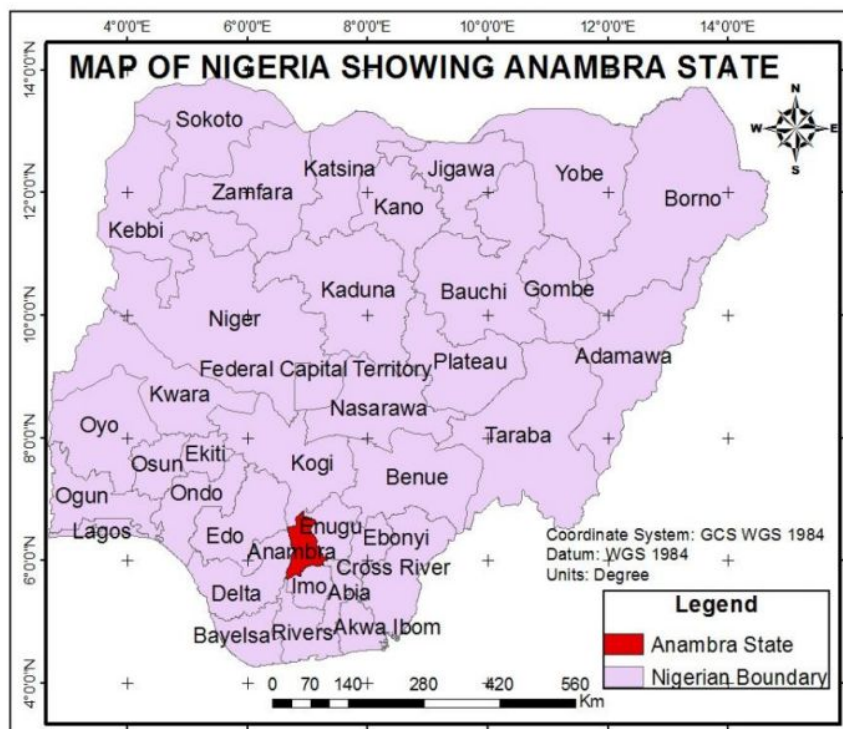


Fig 2. Picture showing the map of Nigeria

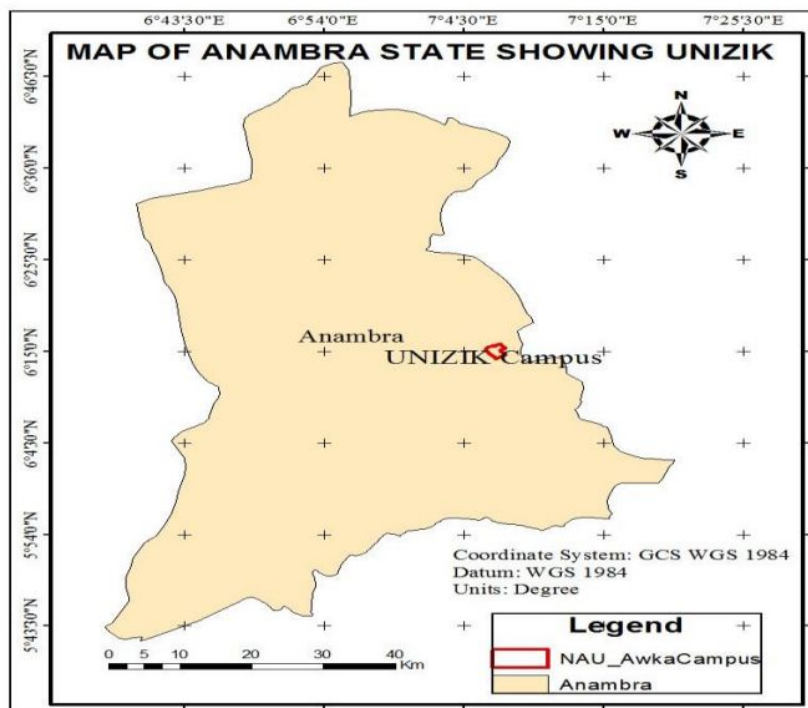


Fig 3. Picture showing the map of Anambra state

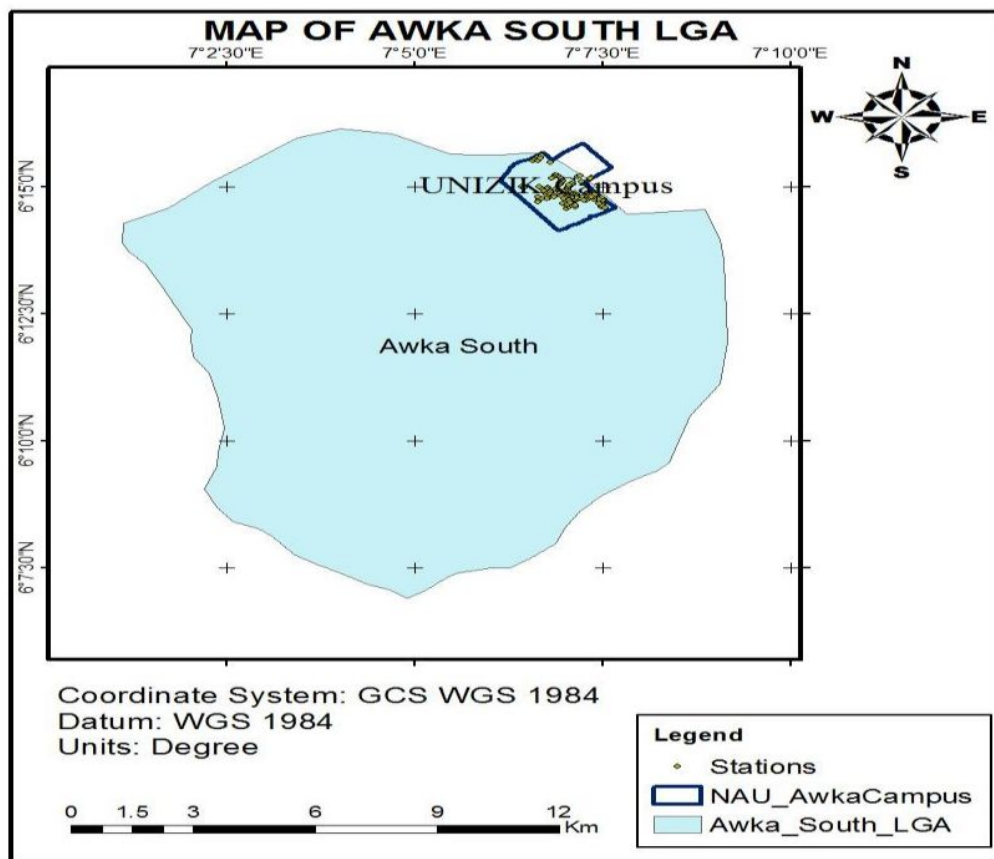


Fig 4. Picture Showing The Map Of Awka South L.G.A

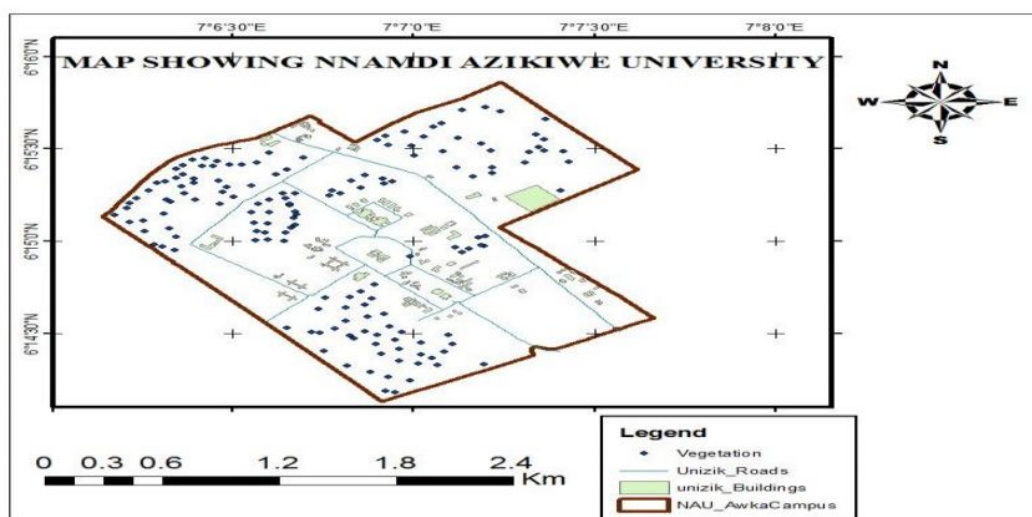


Fig 5. Map showing Nnamdi Azikiwe University, Awka

4. Conclusion and Recommendations

The Application of GEOGRAPHICAL INFORMATION SYSTEM(GIS) in mapping out Air Quality Index in Nnamdi Azikiwe University, Awka expanded the knowledge in using the GIS tools in mapping. It was able to point out the areas with High, Medium and Low concentration of the parameters observed. This should educate the school authority, all environmental bodies/departments and concerned people about the dangers of Air Pollution in the School Environment by implementing factors in reducing Air Pollution in the study in the study area. The achievement of sustainable development demands the integration of environment and development. To achieve sustainable development requires a close collaboration and cooperation between environmentalist and decision makers. Environmental Impact Assessment (EIA) has become a management tool for achieving acceptable forms of environmentally sound development and sustainability; at best it is proving nothing more than a permit to move a project ahead. As man's knowledge of his environment increased, there has been a desire for more comfortable way of living. As the number of people increased, more & more natural resources were consumed in the process of satisfying the rapidly growing needs of the habitat. Every developmental activity has some impact on the development. Consequently, there is a need to harmonize development activities in such a way that environment is polluted a least. To be sustainable, development must possess both economical & ecological sustainability.

Recommendations.

From the processes undertaken and the experiences acquired during the course of the project, the following recommendation was made:

1. Tree planting campaigns should be stepped at national, state, local government and community levels. Trees have been proven to be very effective response to climate change and do not require much cost to be undertaking. Trees act as sinks for carbon dioxide. Some trees can be planted as energy feed stock as well as for environmental protection. These plants can be effectively used as bio indicators of urban air quality as well as a beautification agent. Since plant organs are exposed to the atmosphere and the leaves continuously exchange gases, a pollutant is reflected on the plant health.
2. Measures to reduce transport-related air pollution include retrofitting of old vehicles or encouraging them scrapping. Incentives can be offered to promote the adoption of better and more environmentally friendly transport (e.g., walking, cycling, car-pooling, public transport etc.) or in the case of private vehicles, to encourage the use of smaller engines and hybrid engines.
3. Awareness creation, such as enforcement of relevant regulations on air pollution control. Production and distribution of information, education and communication (IEC) materials on air pollution control, noise control in public places. Public information campaigns and

voluntary schemes can help disseminate information to the public on air pollution abatement schemes.

4. A sensitization program should be created geared towards educating the public that smoking vehicles contribute a lot to our environment and that particulate matter is injurious to health. The major component of the educational program is that keeping vehicles in good repair can prevent smoking vehicles.
5. Other research on evaluation of air quality levels in Unizik should include particulate matters, and Sulphur dioxide for measurement.

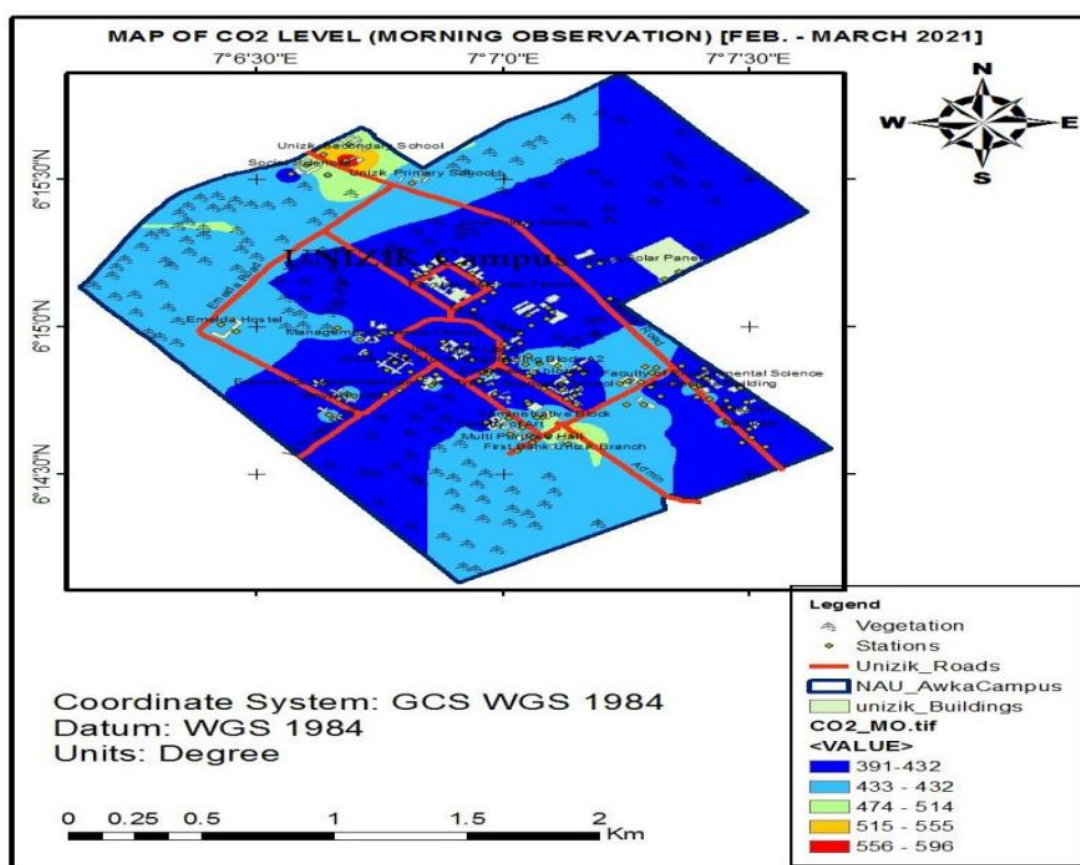


Fig 6. Morning observations analysis of CO₂ level.

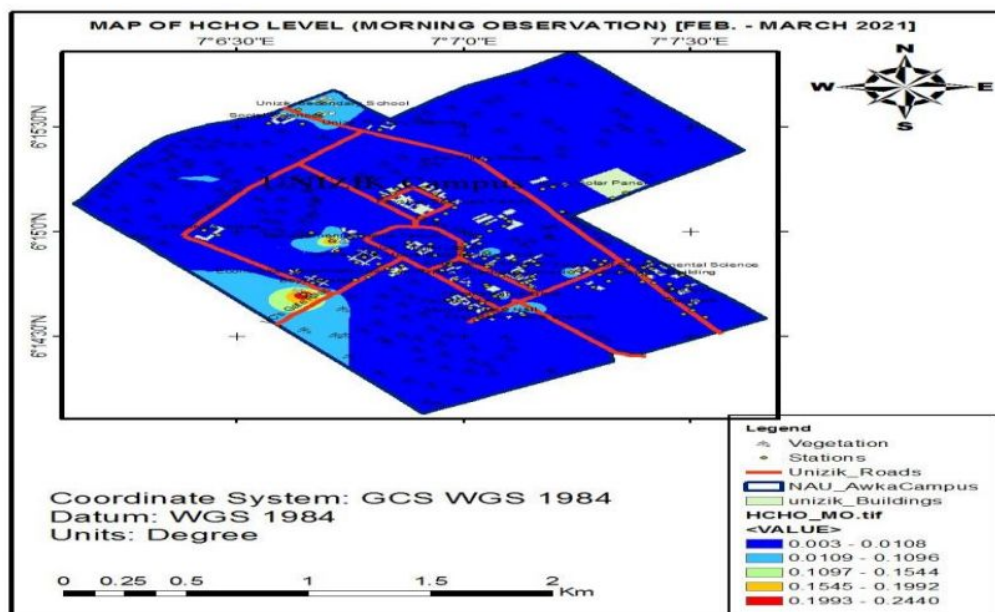


Fig 7. Morning analysis of hcho level observation.

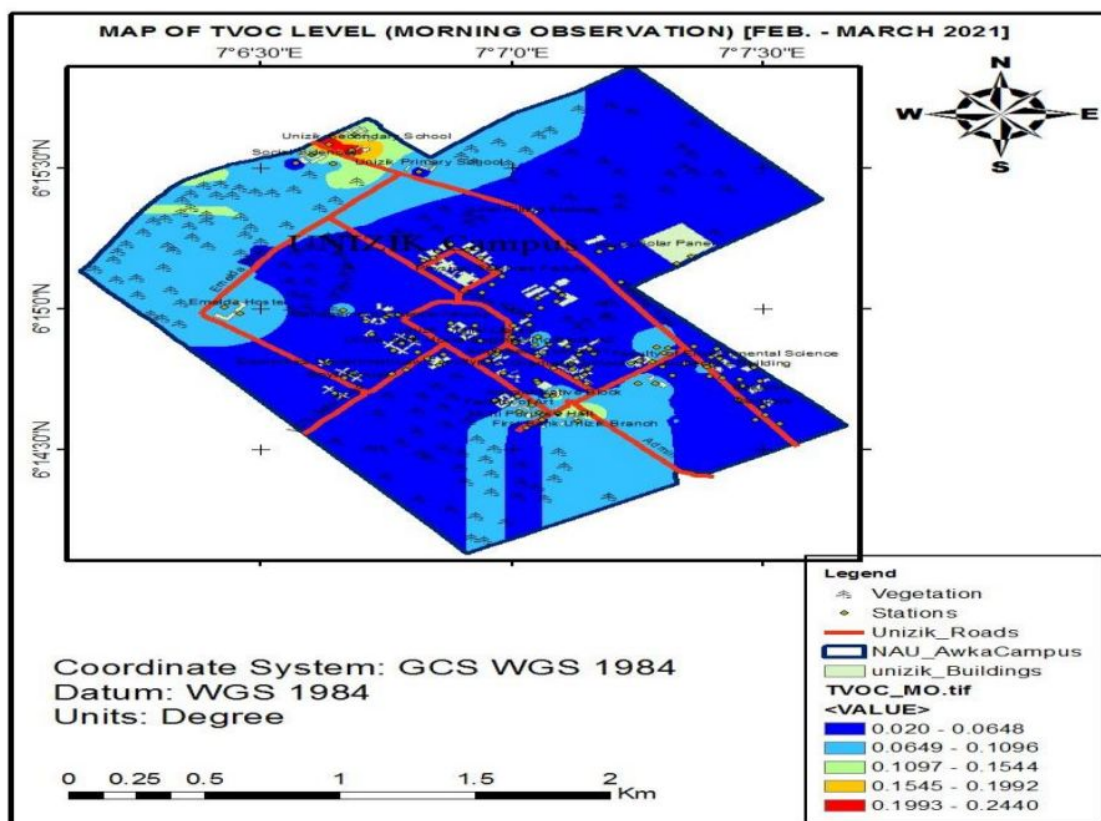


Fig 8. Morning Analysis of TVOC Level Observations.

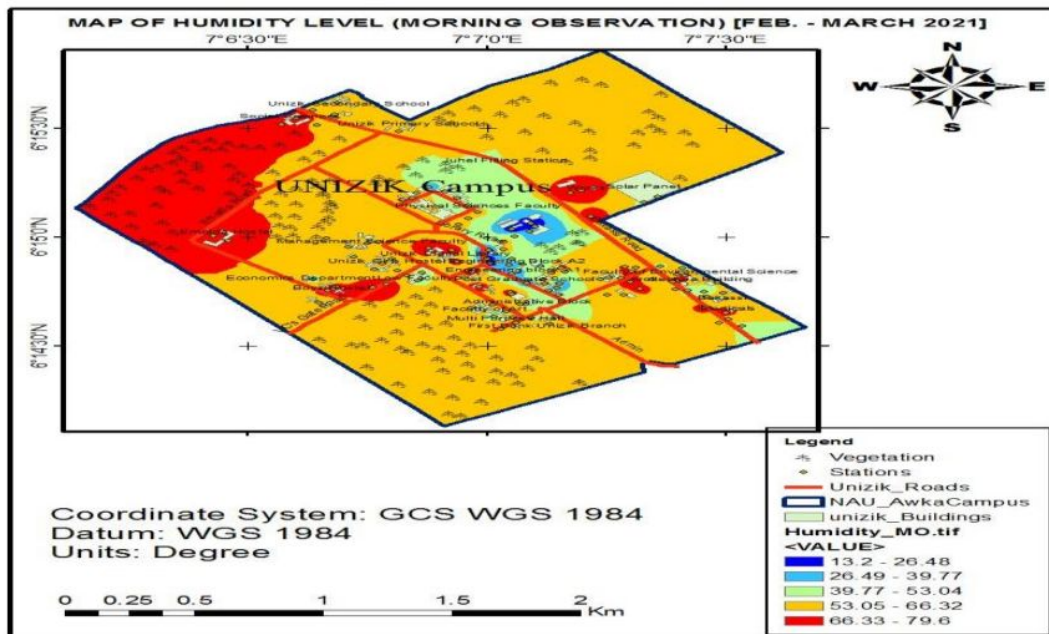


Fig 9. Morning analysis of humidity observations

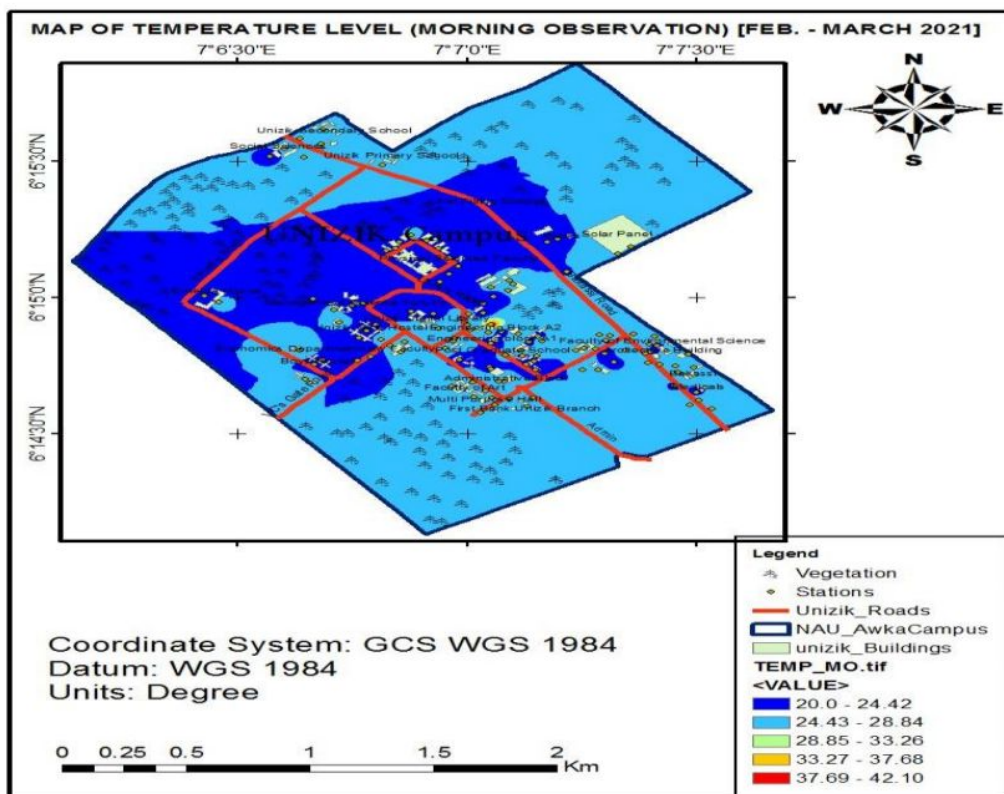


Fig 10. Morning analysis of temperature observations

REFERENCES

- Adnan YAZICI1 and Kemal AKKAYA...Conceptual Modeling of Geographic Information System Applications
- Air Quality Analysis and Forecast for Environment and Public Health Protection: A Case Study in Beijing, China.
- Akintuyi, A. O; Raji, S. A. Adewuni, D. and Wunude, E. O. (2014) Gis-based assessment and mapping of noise pollution in Bariga area of Lagos state, Nigeria.
- Amrit Kumar, Rajeev Kumar Mishra and S. K. Singh GIS Application in urban Traffic Air Pollution Exposure Study: A research Review.
- Awkash Kumar, Indrani Gupta, Jørgen Brandt, Rakesh Kumar, Anil Kumar Dikshit & Rashmi S. Patil Air quality mapping using GIS and economic evaluation of health impact for Mumbai City, India
- Ayşe Emel Onal et al, (2013 and 2015), Evaluation of Air Quality in the City of Istanbul during the Years 2013 and 2015.
- Benson, P. E., 1992, A review of the development and application of the CALINE3 and CALINE4 models. *Atmospheric Environment*, 26B, 379± 90.
- Bezuglaya, E.Y., Shchutskaya, A.B., Smirnova, I.V. (1993) Air Pollution Index and Interpretation of Measurements of Toxic Pollutant Concentrations. *Atmospheric Environment* 27, 773-779.
- Bhatia (2009), Ambient Air Quality Monitoring in Metropolitan City of Lagos, Nigeria
- Chen et al. (2016) air quality analysis and forecast for environment and public health protection: a case study in Beijing, China.
- Colin, C., 2004. Interpolating surfaces in ArcGIS Spatial Analyst. ArcUser, ESRI Education Services. www.esri.com
- Dehalwar, K., & Sharma, S. N. (2023). Fundamentals of Research Writing and Uses of Research Methodologies.
- Duh, J.-D., V. Shandas, H. Chang, and L.A. George. 2008. Rates of urbanization and the resiliency of air and water quality. *Sci. Total Environ.*
- Ernest Obienusi, Bernard Osuiwu and Nwabueze Igu (2011). Essentials of Geography and

Meteorology.

ESRI GIS Fundamentals: Introduction to GIS, Digitizing in Arcgis Pro (Page 1-7)

ESRI How To: Import XY data tables to ArcMap and convert the data to a shapefile using ArcMap 10.5 and previous versions

Evaluation of Air Quality in the city of Istanbul during the Years 2013 and 2015.

F. Patania, A. Gagliano, F. Nocera & A. Galesi (2009) The application of GIS to air quality analysis in Enna City (Italy).

Gavin Powell 2006 Beginning Database Design

GIS based mapping and statistical Locational Analysis of facilities in Nnamdi Azikiwe University Awka, Nigeria using GIS Approach.

Joanna Badach A, Dimitri Voordeckers B, LucynaNyka A, Maarten Van Acker b (2020) Air Quality Management Zones - Useful GIS-based tool for urban planning: Case studies in Antwerp and Gdańsk

Joshi and Chauhan, (2008), Impact of industrial air pollutants on some biochemical parameters some yield in wheats and mustard plants

Joshi et al., (2009). The air pollutants emitted from the different industries into the atmosphere are either gaseous or particulates.

Khitoliya 2004, Political Economy of Gas Flaring and Sustainable Development in Nigeria

Khitoliya, R. K. (2004). Environmental pollution, management and control for sustainable development. New Delhi: S.Chandand Company Ltd.

Maantay, 2007; Sohrabinia and Khorshiddoust, 2007; van Westen, 2004; Jensen et al., 2001; Marquez and Smith, 1999 Air quality mapping using GIS and economic evaluation of health impact for Mumbai City, India.

MamtaPandeya, Varun Singha, R. C. Vaishyaa, Anoop Kumar Shukla (2013) Analysis & Application of GIS Based Air Quality Monitoring- State of Art

Mandal, T., Gorai, A.K., Pathak, G. (2012) Development of fuzzy air quality index using soft computing approach. Environmental Monitoring and Assessment 184, 6187-6196.

NASA 2000 Application of Remote Sensing and GIS in Urban Planning

- Nuckols *et al.*, 2004 Using Geographic Information Systems for Exposure Assessment in Environmental Epidemiology Studies.
- Oji, S. and Adamu, H.*(2020) Air Pollution Exposure Mapping by GIS in Kano Metropolitan Area.
- Ott, W.R., Hunt, W.F. Jr. (1976) A Quantitative Evaluation of the Pollutant Standards Index. Journal of the Air Pollution Control Association 26, 1050-1054.
- Oweifighe, WJ. (2017) Evaluation of Air Quality Levels in Heavy Traffic Areas in Enugu Urban, Enugu state, Nigeria.
- Pant and Roy, (2012) Estimation of the contribution of road traffic emissions to particulate matter concentrations from field measurements: A review.
- Pope and Dockery, 2006; Krewski and Rainham, 2007; Lai et al., 2012. Inhalation Transfer Factors for Air Pollution Health Risk Assessment.
- S. Aronoff, "Geographic Information Systems, a Management Perspective.
- Scoggins *et al.* (2004) Spatial analysis of annual air pollution exposure and mortality.
- Shahab Fazal, GIS BASIC (2008), New age International(P) Ltd, publishers
- Star, J. ve Estes, J., 1990. Geographic Information Systems: An Introduction by Star, Jeffrey, Estes, John (1990)
- Taylor & Francis. Gupta, I., and R. Kumar. 2006. Trends of particulate matter in four cities in India. Atmos. Environ.
- Thill, 2000 Geographic Information Systems for Transportation in Perspective
- Yan *et al.* (2009), Ryttonen et al. (2004) and Hammond et al. (2011) Not all maps are equal: GIS and spatial analysis in epidemiology.