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In this project, we aim to build a simple, R‑powered AQI monitoring system for Nigeria despite the absence of a native dataset. By leveraging publicly available Indian air‑quality data (2015–2020) from Kaggle, we demonstrate how the same workflow—data ingestion, cleaning, AQI calculation via the US‑EPA formula, time‑series visualization with ggplot2, and trend forecasting—could be applied if Nigerian sensor data were obtainable. We review prior Nigerian studies on PM‑based AQI, outline our R methodology, summarize key findings and risk considerations, and conclude with recommendations and future directions.

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## 

## **Aim and Objective**

In this project, we aim to build a simple, R‑powered AQI monitoring system for Nigeria despite the absence of a native dataset. By leveraging publicly available Indian air‑quality data (2015–2020) from Kaggle, we demonstrate how the same workflow—data ingestion, cleaning, AQI calculation via the US‑EPA formula, time‑series visualization with ggplot2, and trend forecasting—could be applied if Nigerian sensor data were obtainable. We review prior Nigerian studies on PM‑based AQI, outline our R methodology, summarize key findings and risk considerations, and conclude with recommendations and future directions.

## **Previous Research**

### **Nigerian AQI Studies**

* **Abuja PM‑Based AQI:** Kanee et al. computed daily PM2.5 and PM10 AQI in Abuja, finding seasonal “good” air quality in the wet season but ratios exceeding WHO guidelines (PM2.5/PM10 ratio 1.06–1.79) [SCIRP](https://www.scirp.org/journal/paperinformation?paperid=100552&utm_source=chatgpt.com).
* **Multi‑City Assessment:** Lala et al. evaluated AQI in Lagos, Abuja, Osogbo, Anyigba, and Benin City from May 2021–April 2023; Benin City faced “unhealthy” to “hazardous” PM2.5 days [ScienceDirect](https://www.sciencedirect.com/science/article/pii/S2666016422001104?utm_source=chatgpt.com).
* **Health‑Risk Assessment:** An MDPI study used portable sensors and HYSPLIT modelling to link PM2.5 hotspots in Abuja to long‑range transport, estimating AQI up to 280.8 and highlighting health risks [MDPI](https://www.mdpi.com/2073-4433/11/8/817?utm_source=chatgpt.com).

## **Methodology**

* **Data Collection**
  + **Manual CSV Creation:** The Nigeria AQI Data.csv was compiled by manually extracting daily AQI readings for 11 states (out of Nigeria’s 36) from the online dashboard at https://www.aqi.in/dashboard/nigeria. This sample may not fully represent the entire country and may not be 100% accurate.
  + Extracted City and AQI columns as the basis for analysis and projection.
* **Data Cleaning & Preparation**
  + Renamed City → state and AQI → current\_AQI; filtered out missing values.
  + Converted state to a factor for ordered plotting.
* **Projection Calculation**
  + Derived a projected AQI for 2045 by applying a 17% increase (blended from historical + modeled trends).
  + Formula:
  + projected\_AQI <- round(current\_AQI \* 1.17)
* **Reshaping & Visualization**
  + Pivoted current vs. projected AQI into “long” format.
  + Created a horizontal dodged‐bar chart with distinct fill colors to compare present-day and 2045 AQI by state.
* **Contextual Research**
  + Investigated primary sources of PM₂.₅ and PM₁₀ in Nigerian cities (transport, industry, generators, biomass burning, dust).
  + Reviewed international policy interventions (China’s Air Quality Action Plan; USA’s Clean Air Act; EU Zero Pollution targets; India’s NCAP) for best practices in AQI reduction.

## **Project Development Phases**

* **Planning & Scoping**: Defined target states, data requirements, and projection scenario.
* **Data Ingestion**: Automated CSV import and column standardization in R.
* **EDA & AQI Module**: Calculated state-level AQI averages and established projection logic.
* **Visualization**: Built comparative bar charts using ggplot2; prepared scripts for reproducible reporting.
* **Contextual Research**: Gathered causative factors and benchmarked global interventions.
* **Validation & Documentation**: Cross‑checked against satellite/trend reports; documented methodology in a findings report.
* **Stakeholder Engagement**: Designed next steps for policy briefs and dashboard integration (e.g., R Shiny).

## **Risk Assessments**

* **Data Representativeness**: Only 11 states analyzed; may not capture Nigeria’s full spatial heterogeneity.
* **Projection Uncertainty**: The 17% factor blends disparate sources; real-world trajectories could diverge under new policies or shifting emissions.
* **Model Assumptions**: Linear scaling of AQI may oversimplify pollutant dynamics (e.g., non‐linear chemistry, episodic events).
* **Policy & Enforcement**: Projections assume no new regulations—strong policy adoption could flatten or reverse trends.
* **Health Impact Modeling**: Further work needed to translate AQI changes into morbidity/mortality outcomes (e.g., integrating AirQ+ analyses).

By coupling this reproducible R‑based workflow with targeted policy action—emulating proven global successes—Nigeria can move from projected deterioration toward sustained air‑quality improvement by 2045.

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## **Conclusions**

## Executive Summary

Over the past two decades, Nigeria’s air pollution—driven by vehicular traffic, industrial activities, diesel generators, biomass burning, and seasonal dust incursions—has worsened by roughly 15% in population‑weighted PM₂.₅ levels, cutting average life expectancy by nearly four months ([aqli.epic.uchicago.edu](https://aqli.epic.uchicago.edu/wp-content/uploads/2022/06/Nigeria_2022.pdf?utm_source=chatgpt.com)). Our state‑level AQI data (11 states) shows current indices ranging from 18 to 24, and under a business‑as‑usual trajectory, we project a further 17% rise by 2045 (AQI × 1.17) across all states. International case studies (China, USA, EU, India) demonstrate that comprehensive regulation, technology upgrades, and targeted action plans can reverse such trends, offering a proven blueprint for Nigeria’s clean‑air strategy.

## Observed Trends in Nigerian Air Quality

### Historical Increase

Since 2000, the average annual PM₂.₅ concentration in Nigeria climbed by almost 15%, reducing life expectancy by approximately 0.3 years ([aqli.epic.uchicago.edu](https://aqli.epic.uchicago.edu/wp-content/uploads/2022/06/Nigeria_2022.pdf?utm_source=chatgpt.com)).

### State‑Level AQI Snapshot

Our CSV contains 11 states whose current AQI values span:

| **State** | **Current AQI** |
| --- | --- |
| Borno | 23 |
| Cross River | 18 |
| Delta | 21 |
| Edo | 22 |
| Federal Capital Territory | 21 |
| Kano | 24 |
| Kebbi | 19 |
| Kwara | 22 |
| Lagos | 24 |
| Osun | 22 |
| Rivers | 23 |

These reflect predominantly “Good” to “Moderate” categories but mask episodic spikes during harmattan dust events and peak combustion seasons.

## Calculation of Projected AQI

To estimate AQI in 2045, we applied a 17% increase to current values, based on:

* An 18% historical rise in PM₂.₅ from 1998–2021 in Nigeria ([sciencedirect.com](https://www.sciencedirect.com/science/article/abs/pii/S0169809519312943?utm_source=chatgpt.com)).
* A 16% sub‑Saharan PM₂.₅ increase by 2050 under a high‑emission scenario (UNEP Baseline) ([unep.org](https://www.unep.org/resources/policy-and-strategy/air-quality-policies-nigeria?utm_source=chatgpt.com)).

projected\_AQI = round(current\_AQI \* 1.17)

| **State** | **Current AQI** | **Projected AQI (2045)** |
| --- | --- | --- |
| Borno | 23 | 27 |
| Cross River | 18 | 21 |
| Delta | 21 | 25 |
| Edo | 22 | 26 |
| Federal Capital Territory | 21 | 25 |
| Kano | 24 | 28 |
| Kebbi | 19 | 22 |
| Kwara | 22 | 26 |
| Lagos | 24 | 28 |
| Osun | 22 | 26 |
| Rivers | 23 | 27 |

## Causes of Poor Air Quality in Nigerian States

### Road Transport & Traffic Congestion

Vehicle exhaust and road dust contribute heavily to PM₂.₅ and PM₁₀ levels, particularly in megacities like Lagos and Kano, due to aging fleets and stop‑start traffic ([sciencedirect.com](https://www.sciencedirect.com/science/article/abs/pii/S0169809519312943?utm_source=chatgpt.com)).

### Industrial Emissions & Generators

Manufacturing plants and persistent power outages drive reliance on diesel generators; both emit NO₂, SO₂, CO, and fine particulates, often exceeding emissions from heavy trucks ([dicf.unepgrid.ch](https://dicf.unepgrid.ch/nigeria/pollution?utm_source=chatgpt.com)).

### Biomass, Waste & Agricultural Burning

Open burning of agricultural residues, municipal waste, and biomass for cooking adds organic carbon and black carbon to ambient air, especially in peri‑urban regions ([sciencedirect.com](https://www.sciencedirect.com/science/article/abs/pii/S0169809519312943?utm_source=chatgpt.com)).

### Harmattan & Construction Dust

Seasonal Sahara dust incursions (December–February) and urban construction projects elevate PM₁₀ concentrations, triggering acute respiratory episodes ([sciencedirect.com](https://www.sciencedirect.com/science/article/abs/pii/S0169809519312943?utm_source=chatgpt.com)).

## International Success Stories in AQI Improvement

### China: National Air Quality Action Plan

Launched in 2013, China invested US $270 billion to cut PM₁₀ by 10% by 2017. By 2020, major cities saw a 25% reduction in PM₂.₅ days through coal‑to‑gas conversions and stringent vehicle standards ([aqli.epic.uchicago.edu](https://aqli.epic.uchicago.edu/policy-impacts/china-national-air-quality-action-plan-2014/?utm_source=chatgpt.com), [acp.copernicus.org](https://acp.copernicus.org/articles/19/11303/2019/?utm_source=chatgpt.com)).

### United States: Clean Air Act

Since 1970, the Clean Air Act has driven a 62% drop in aggregate airborne pollutants, delivering vast health benefits via mandated emissions controls on vehicles and industry ([aqli.epic.uchicago.edu](https://aqli.epic.uchicago.edu/policy-impacts/united-states-clean-air-act/?utm_source=chatgpt.com), [epa.gov](https://www.epa.gov/transportation-air-pollution-and-climate-change/accomplishments-and-successes-reducing-air?utm_source=chatgpt.com)).

### European Union: Zero Pollution Action & Local Measures

Between 2005 and 2022, EU member states cut PM₂.₅‑related mortality by 45%, employing traffic‑management schemes, low‑emission zones, and real‑time monitoring under the 2030 zero‑pollution vision ([eea.europa.eu](https://www.eea.europa.eu/en/topics/in-depth/air-pollution?utm_source=chatgpt.com)).

### India: National Clean Air Programme (NCAP)

Since 2019, India’s NCAP targets 132 non‑attainment cities, aiming for a 40% PM₁₀ reduction by 2026 through stakeholder engagement and city‑level action plans; initial data show a 13% AQI drop from 2019 to 2023 ([pib.gov.in](https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1909910&utm_source=chatgpt.com), [sciencedirect.com](https://www.sciencedirect.com/science/article/abs/pii/S1352231024006496?utm_source=chatgpt.com)).

**Recommendations for Nigeria:** Adopt binding emission standards, phase out old diesel generators, expand clean‑energy access, and implement city‑level action plans modeled on NCAP—with robust monitoring and enforcement—to stabilize or reverse AQI trends by 2045.

## **Future Works**

* **Local Data Integration:** Ingest real‑time feeds from CAR‑NASRDA or low‑cost sensor networks in Lagos, Abuja, and Port Harcourt.
* **Enhanced Forecasting:** Implement ARIMA, Prophet, or machine‑learning models for more accurate short‑term AQI forecasts.
* **Health Impact Module:** Integrate AirQ+ (WHO tool) to quantify morbidity/mortality impacts from pollutant exposure [Wikipedia – Die freie Enzyklopädie](https://de.wikipedia.org/wiki/AirQ%2B?utm_source=chatgpt.com).
* **Mobile App Development:** Wrap the Shiny dashboard in a mobile‑friendly interface to broaden public access.
* **Policy Simulation:** Model emission‑control scenarios (e.g., traffic restrictions) to project AQI improvements.