



ARE WE BREATHING CLEANER AIR? ILLINOIS VS. OHIO: A 2009-2026 ANALYSIS AND FORECAST

BADM 557

Group 4: Ruochen Lyu, Kumari Neha
Priya, Yiyuan Tang, Sicong Li



FRAMEWORK

BUSINESS UNDERSTANDING

DATA UNDERSTANDING

DATA PREPARATION

MODELING

EVALUATION

DEPLOYMENT



DATA SOURCE

- U.S. Pollution Data 2000 – 2023
- CO, NO₂, O₃, and SO₂ pollution data in the USA between 2000-2023 from the EPA

The foundation of this dataset lies in the data provided by the U.S. Environmental Protection Agency (EPA). Significant contributions have also been made by Kagglers BrendaSo and ANGELA KIM, enriching its scope and utility.

- Our team utilized a subset of this dataset, specifically all data for Illinois (IL) and Ohio (OH) between 2009 and 2023.

pollution_2000_2023.csv (102.46 MB)

Detail Compact Column

10 of 22 columns

#	Date	Address	State	County
Index	Date: Year-Month-Day	Address of Recorded data	USA State	Local Administration Name
279473.46 - 292781.72 Count: 13,308	665k	1999-12-31	2023-09-29	5888 MISSION BL...
0	665k	1999-12-31	2023-09-29	2% California
				1630 N MAIN ST, L... 2% Contra Costa
				Other (636343) 96% Other (410028) 62% Other (602741) 91%



Annual Death Toll: According to the World Health Organization (WHO), approximately 7 million people globally die prematurely each year due to exposure to air pollution, primarily from cardiovascular and respiratory diseases.



Children's Health Risks: Long-term exposure to air pollution can reduce lung development in children by 20%-30% and significantly increase the risk of asthma.



Economic Costs: In the United States alone, air pollution is estimated to cause over \$15 billion in economic losses annually, mainly due to healthcare expenses.



Cardiovascular Impact: For every 10 $\mu\text{g}/\text{m}^3$ increase in PM2.5 exposure, the risk of heart attacks may rise by 8%-18%.

The Alarming Toll of Air Pollution: Lives, Health, and Economy



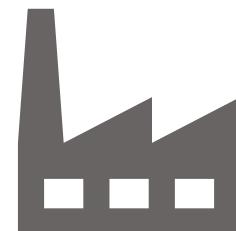
WHY ILLINOIS AND OHIO?



Geography and Climate:

Both states are located in the U.S. Midwest with a temperate climate and distinct seasons.

Similar seasonal pollution patterns, such as winter fuel emissions and summer ozone peaks.



Industrial Base and Economy:

Both have strong industrial economies, particularly in manufacturing and energy production (coal, natural gas).

Residents in both states face health risks from air pollution, including respiratory and cardiovascular diseases, and asthma.



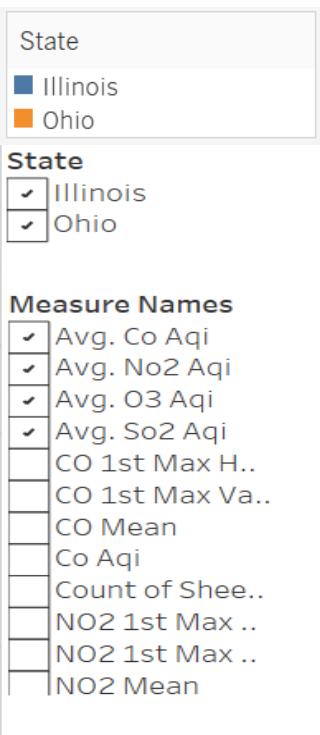
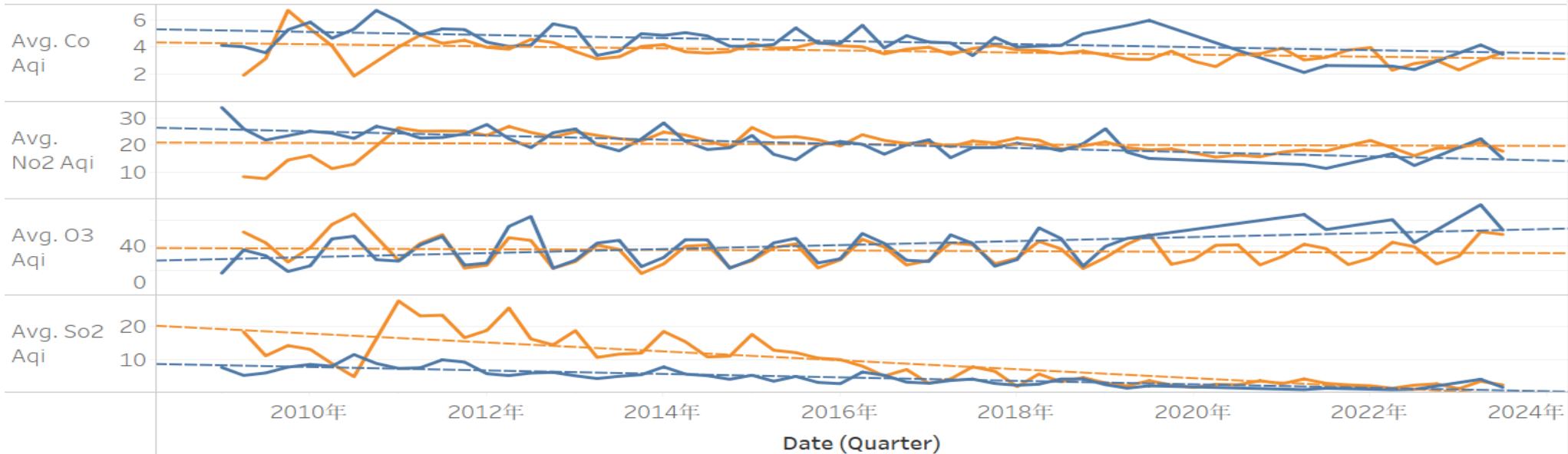
DATA VISUALIZATIONS & ANALYSIS



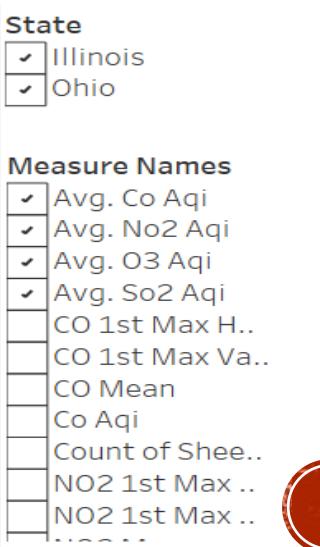
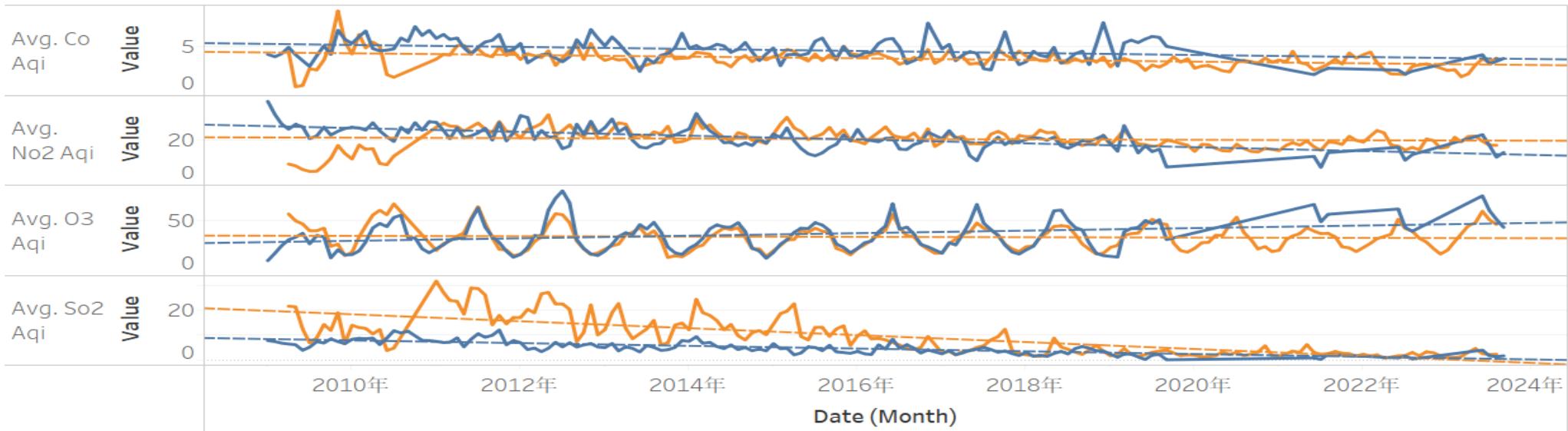
- (Analysis approaches we are using.....)
- Story Point 1+2+3+5 (Overview Trends + State Regional Analysis + County/City Regional Analysis + Forecasting)
[https://public.tableau.com/views/storypoint13/Story?:language=zh-CN&publish=yes&:sid=&:redirect=auth&:display_count=n&:origin=viz share link](https://public.tableau.com/views/storypoint13/Story?:language=zh-CN&publish=yes&:sid=&:redirect=auth&:display_count=n&:origin=viz_share_link)
- Story Point4 (Health and Environmental Impacts) [StoryPoint4 | Tableau Public](#)

STORYPOINT 1: Overview of Air Quality Trends

Trends of 4 Elements in IL and OH by Quarter

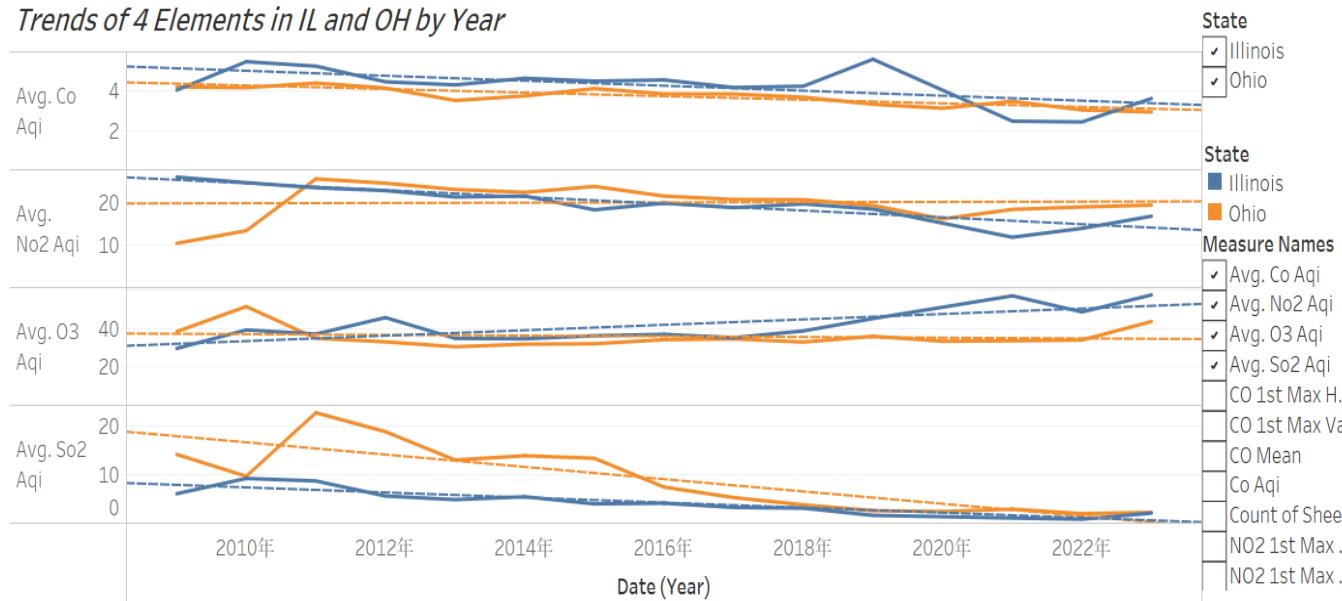


Trends of 4 Elements in IL and OH by Month

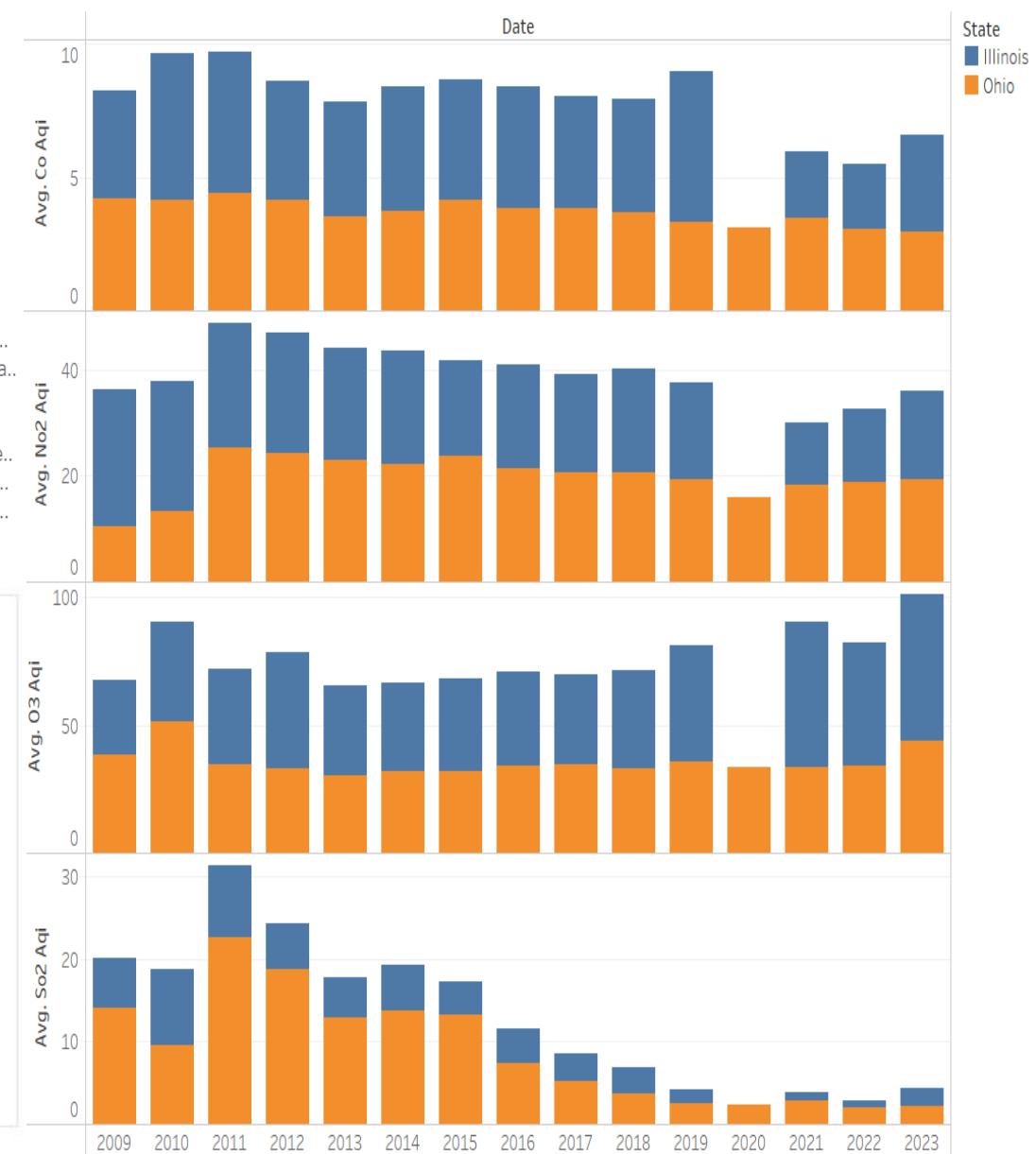


STORYPOINT 2: Regional Analysis of Pollution (State Level)

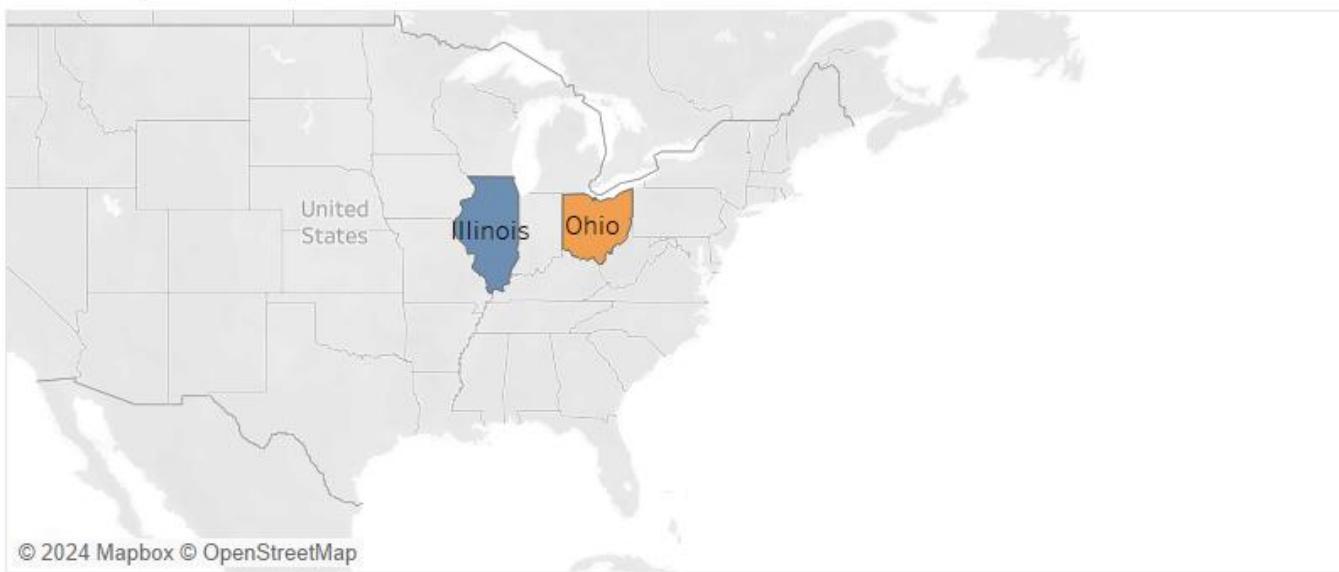
Trends of 4 Elements in IL and OH by Year



Average Pollutant Levels by Year and State



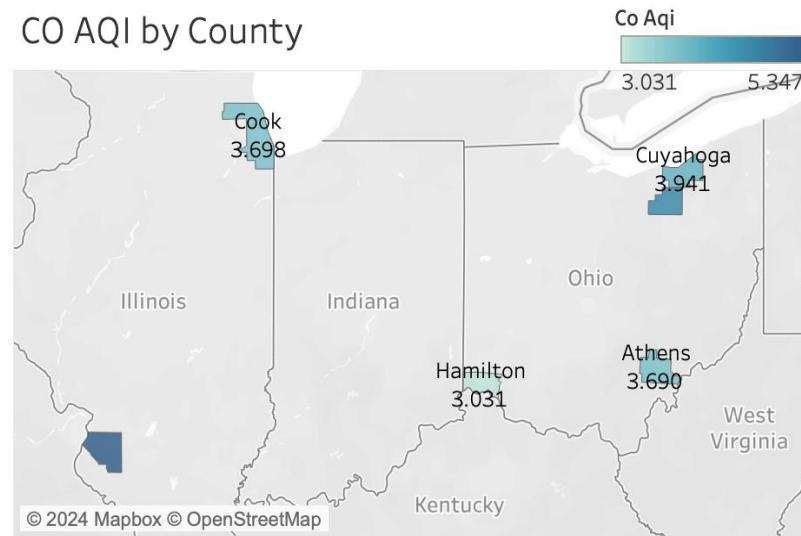
US Map state pollutants level



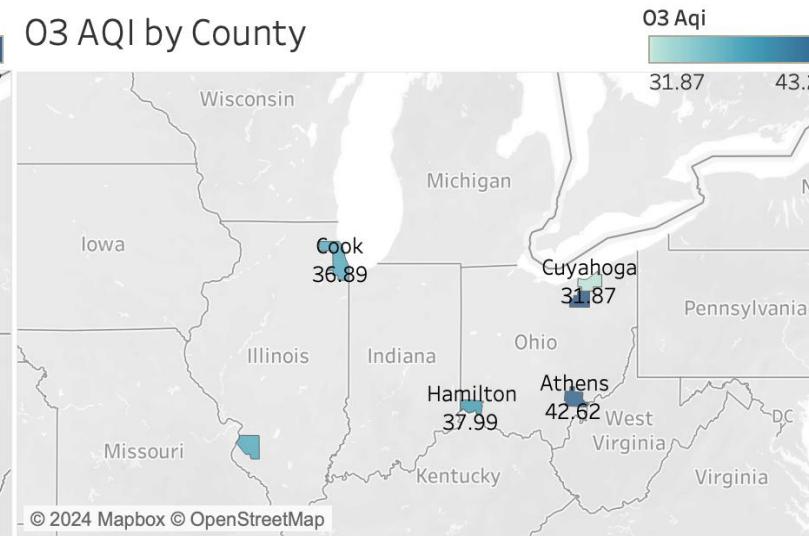
STORYPOINT 3: Regional Analysis of Pollution (County Level)

County Level Analysis of Pollution

CO AQI by County



03 AQI by County

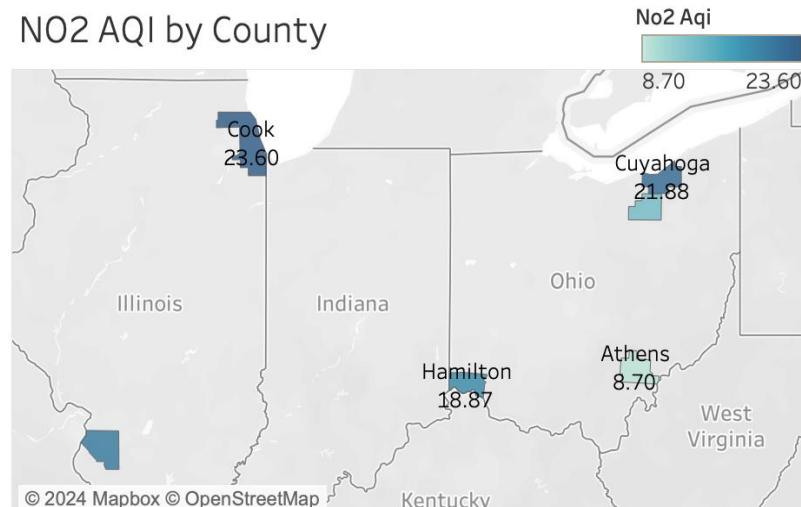


State	IL	OH
County	Saint Clair, Cook	Medina, Cuyahoga, Athens, Hamilton

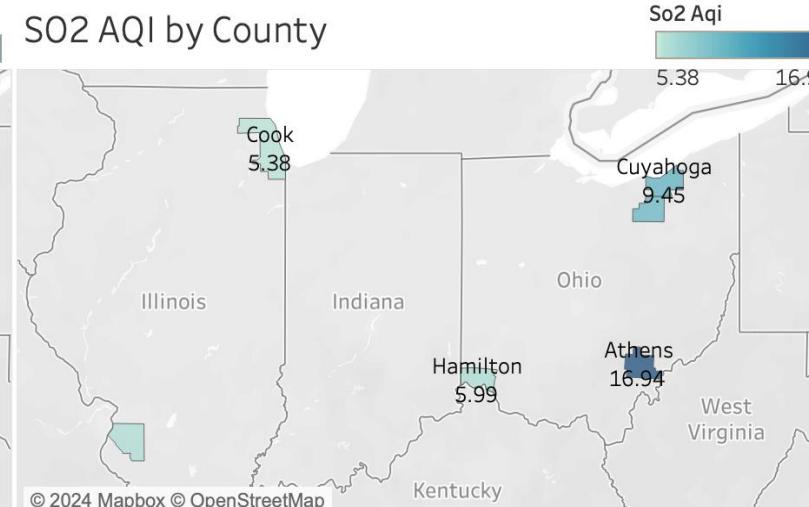
Measure Names

- Co Aqi
No2 Aqi
O3 Aqi
So2 Aqi

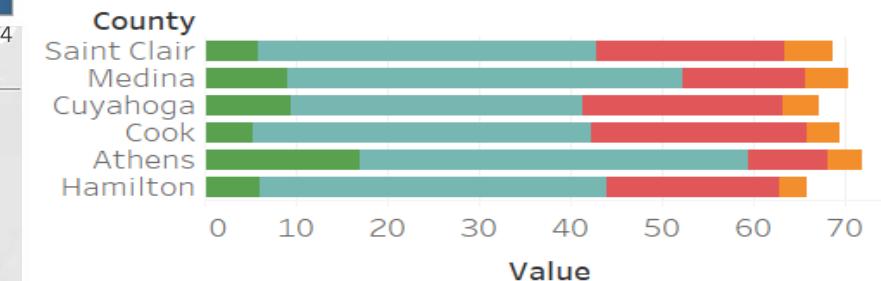
NO₂ AQI by County



SO2 AQI by County



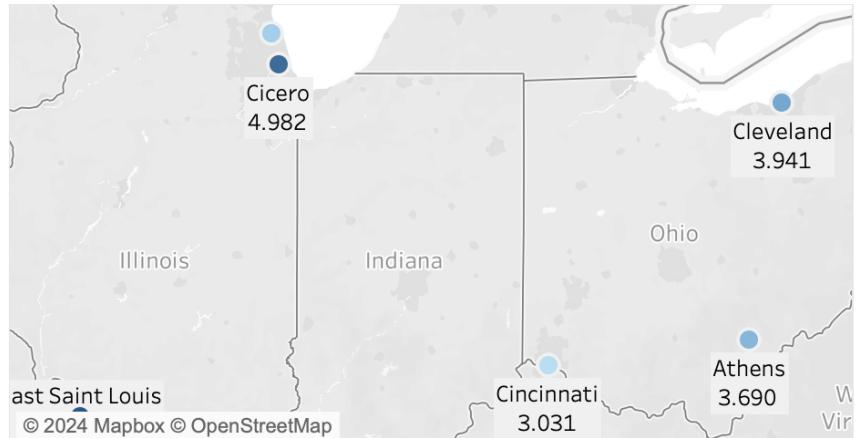
4 Elements AQI by County



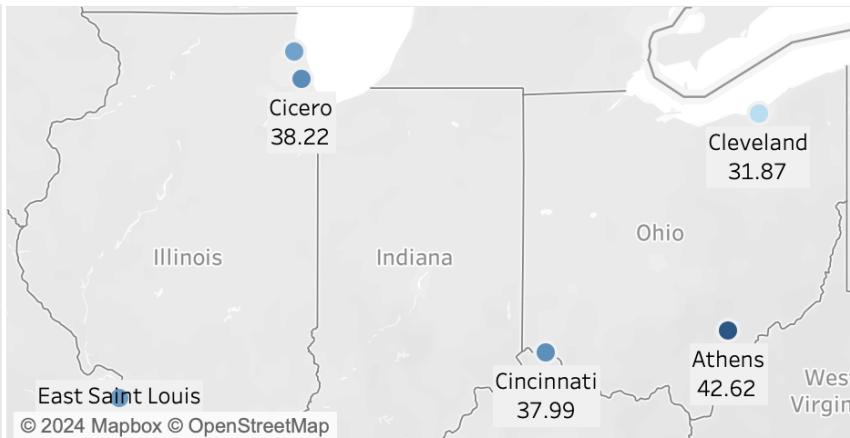
STORYPOINT 3: Regional Analysis of Pollution (City Level)

City Level Analysis of Pollution

CO AQI by City



O3 AQI by City

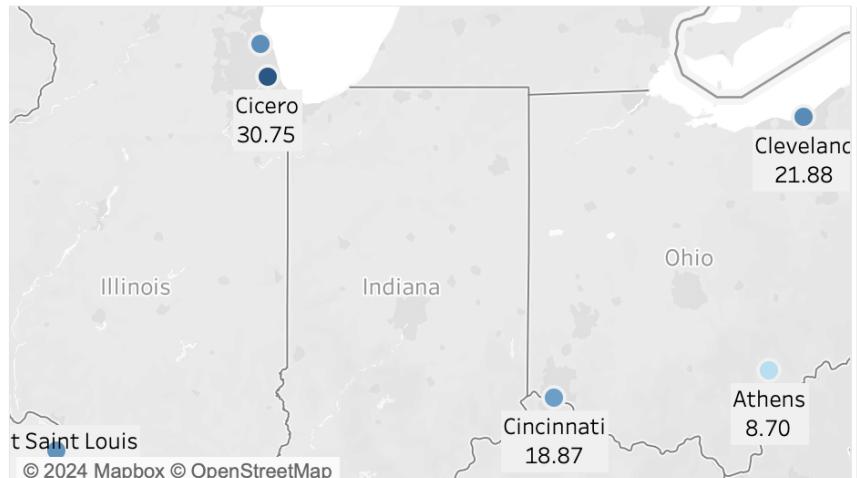


State	IL	OH
City	Cicero, East Saint Louis, Northbrook	Athens, Cincinnati, Cleveland

Measure Names

- Co Aqi
- No2 Aqi
- O3 Aqi
- So2 Aqi

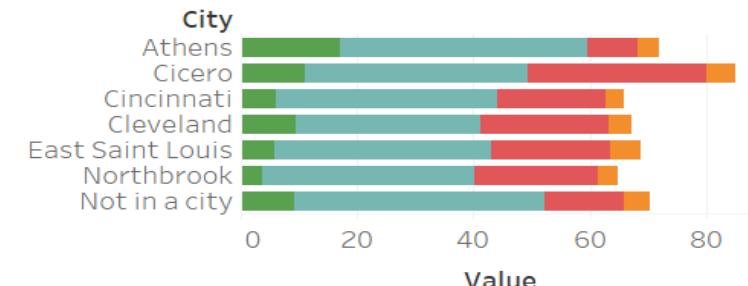
NO2 AQI by City



SO2 AQI by City



4 Elements AQI by City



STORYPOINT 4: Health and Environmental Impacts

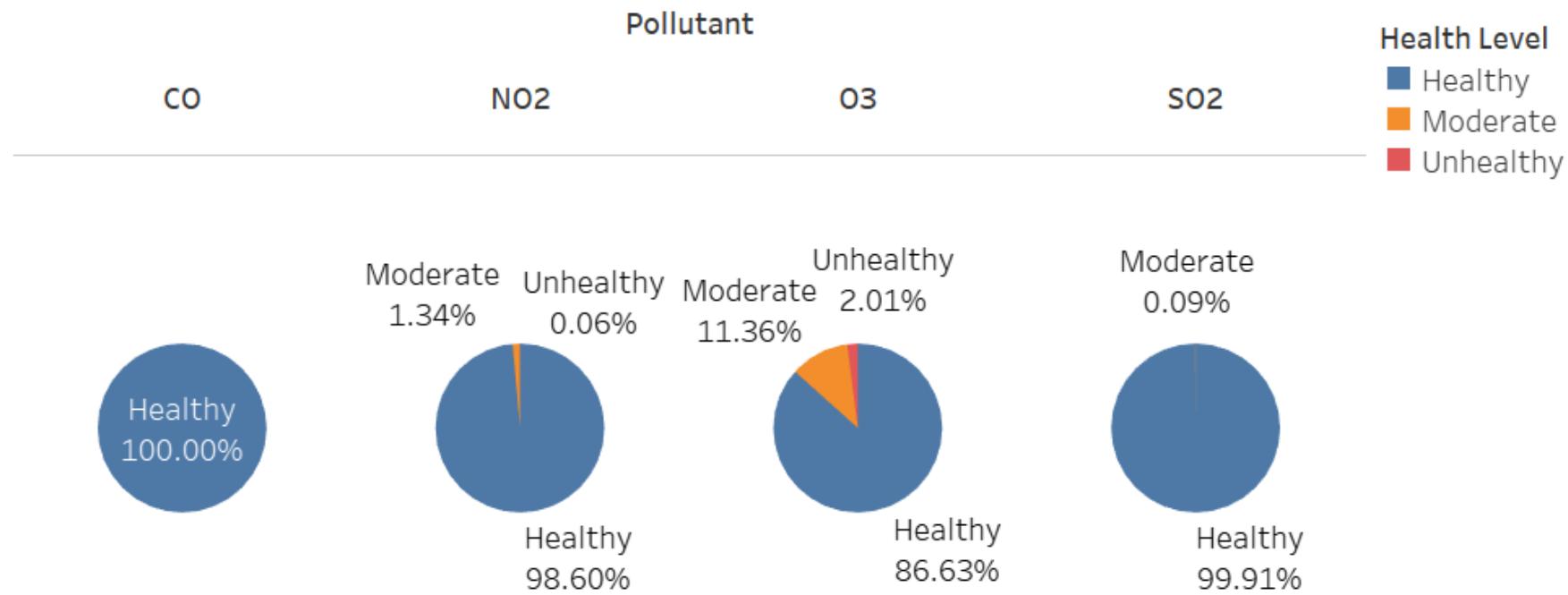
RANGE OF AQI

Air Quality Index	Protect Your Health
Good (0-50)	No health impacts are expected when air quality is in this range.
Moderate (51-100)	Unusually sensitive people should consider limiting prolonged outdoor exertion.
Unhealthy for Sensitive Groups (101-150)	<p>The following groups should limit prolonged outdoor exertion:</p> <ul style="list-style-type: none">• People with lung disease, such as asthma• Children and older adults• People who are active outdoors
Unhealthy (151-200)	<p>The following groups should avoid prolonged outdoor exertion:</p> <ul style="list-style-type: none">• People with lung disease, such as asthma• Children and older adults• People who are active outdoors <p>Everyone else should limit prolonged outdoor exertion.</p>
Very Unhealthy (201-300)	<p>The following groups should avoid all outdoor exertion:</p> <ul style="list-style-type: none">• People with lung disease, such as asthma• Children and older adults• People who are active outdoors <p>Everyone else should limit outdoor exertion.</p>



STORYPOINT 4: Health and Environmental Impacts

Proportion of Pollutant Pollution Level

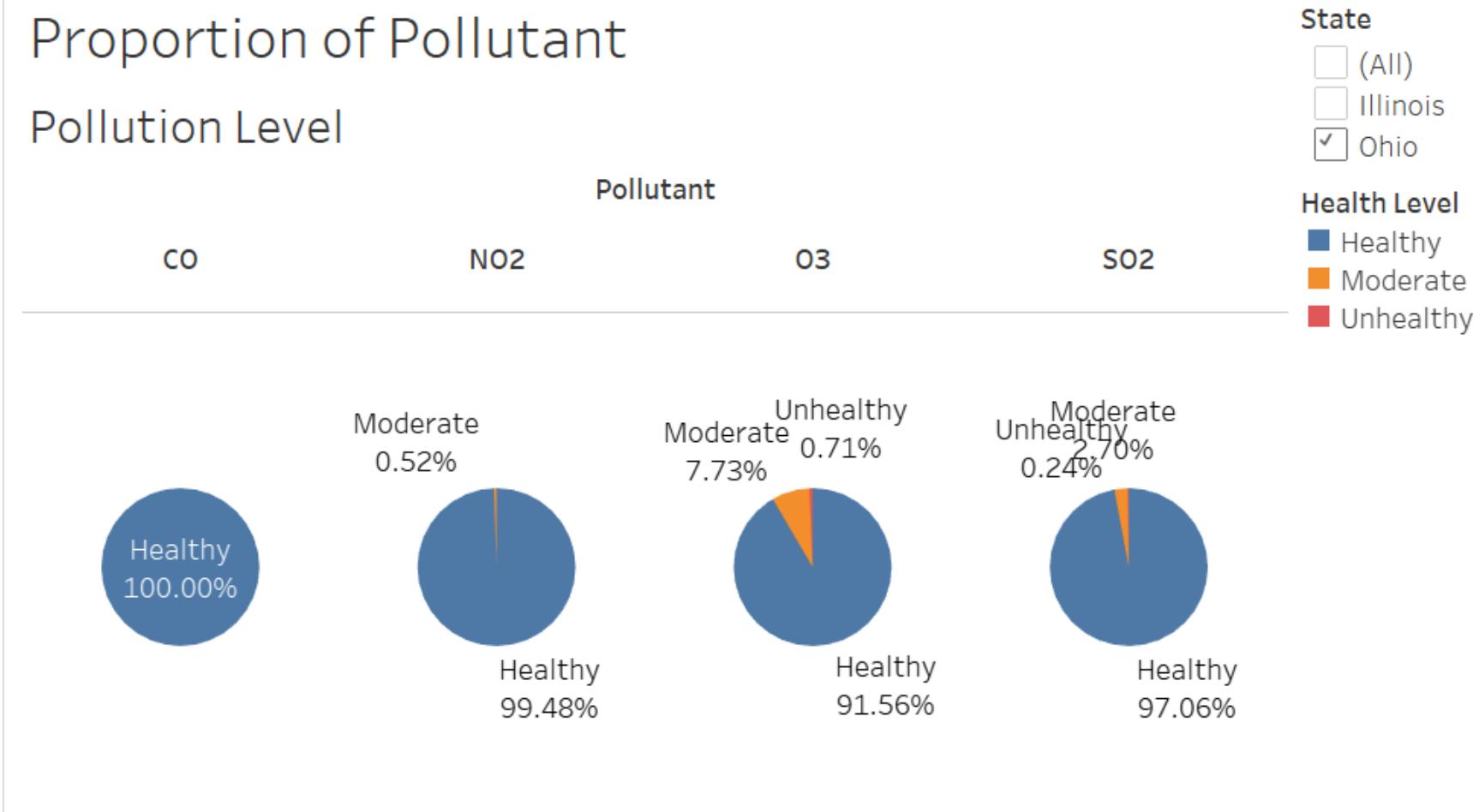


- The indicators are the AQI of various pollutants. It can be observed that for Illinois, the majority of cases fall under the "Healthy" category, with only ozone occasionally showing "Moderate" or even "Unhealthy" levels.



STORYPOINT 4: Health and Environmental Impacts

Proportion of Pollutant Pollution Level



- NO₂ and O₃ pollution in Ohio are slightly less severe compared to Illinois, while SO₂ pollution is slightly more severe. If anything needs to be highlighted, it's ozone that requires attention.



POSSIBLE EFFECTS OF EXCESSIVE OZONE

To Health

- **Irritates Respiratory System:** Causes coughing, throat irritation, and chest discomfort.
- **Reduces Lung Function:** Makes breathing more difficult during exercise or exertion.
- **Inflames Lung Tissues:** Damages lung lining, similar to sunburn on skin.
- **Triggers Asthma:** Increases frequency and severity of asthma attacks.
- **Aggravates Chronic Diseases:** Worsens bronchitis, emphysema, and other lung diseases.
- **Causes Long-term Lung Damage:** Leads to reduced lung function over time.
- **Increases Hospital Visits:** More emergency cases for lung issues during high ozone levels.

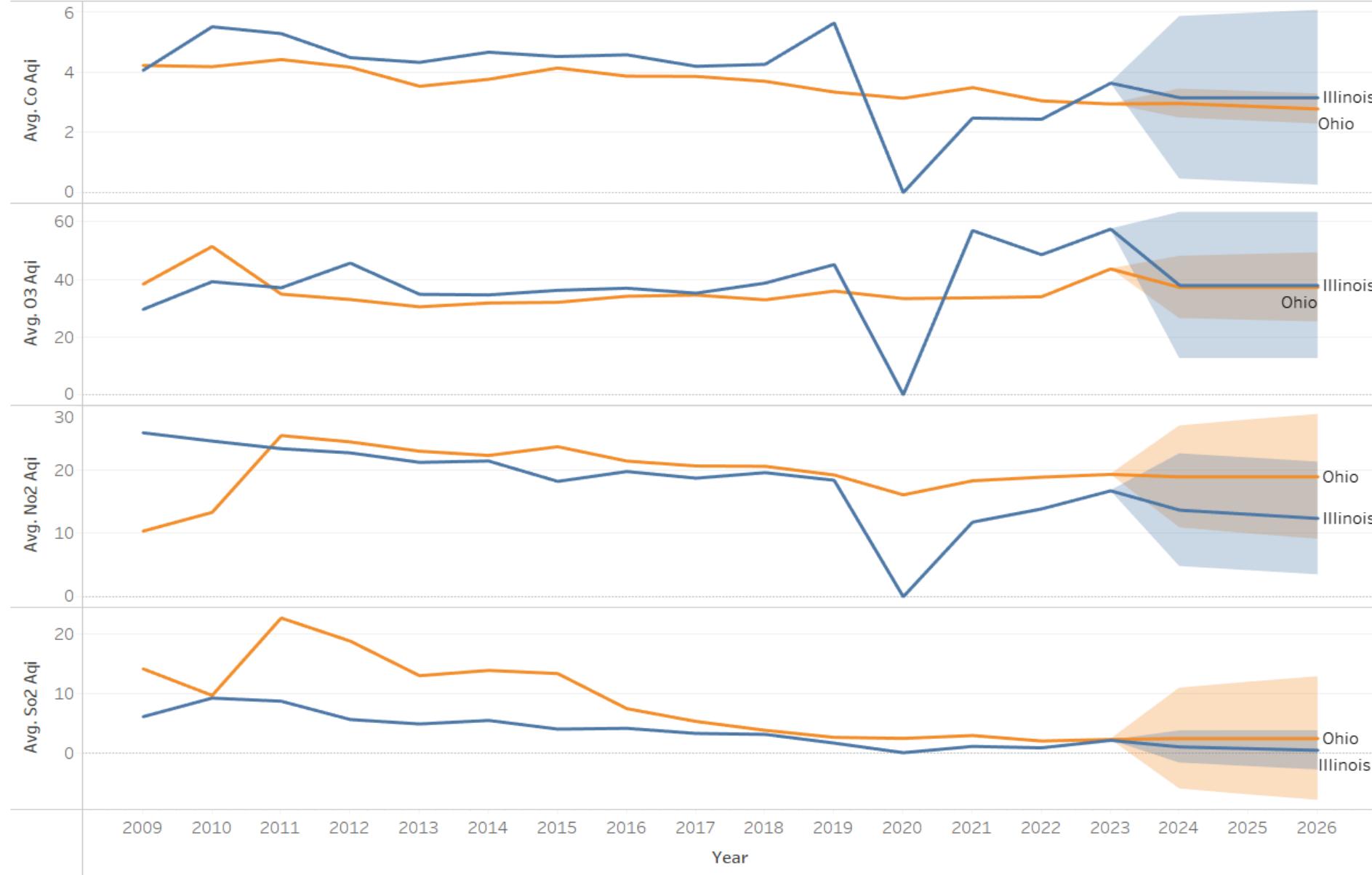
To Environment

- **Damages Vegetation:** Reduces crop yields and harms forests.
- **Weakens Ecosystems:** Affects plant growth and biodiversity.
- **Forms Smog:** Ozone is a primary component of urban smog.
- **Interacts with Pollutants:** Reacts with NOx and VOCs, worsening air quality.



STORYPOINT 5: Forecasting Pollutant Levels

Forecast trend lines until 2026



State
 (All)
 Illinois
 Ohio

State
Illinois
Ohio

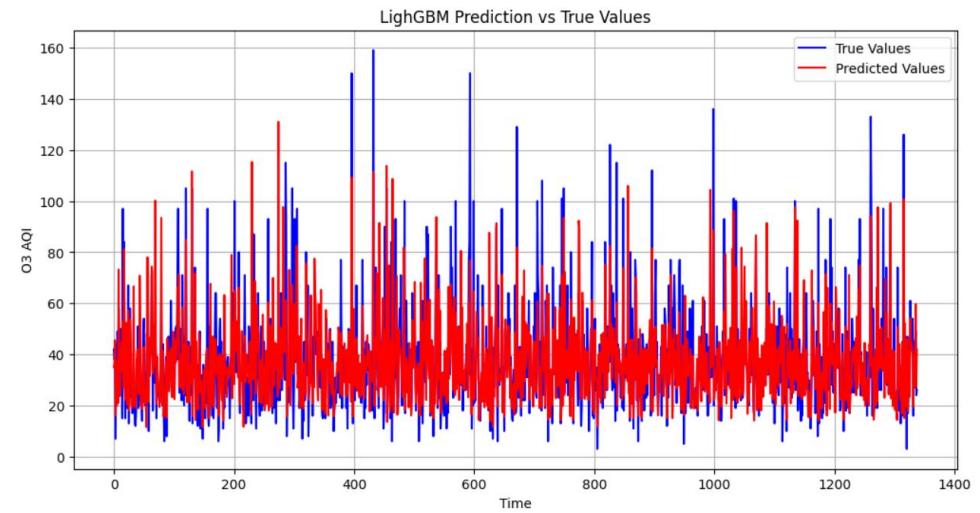
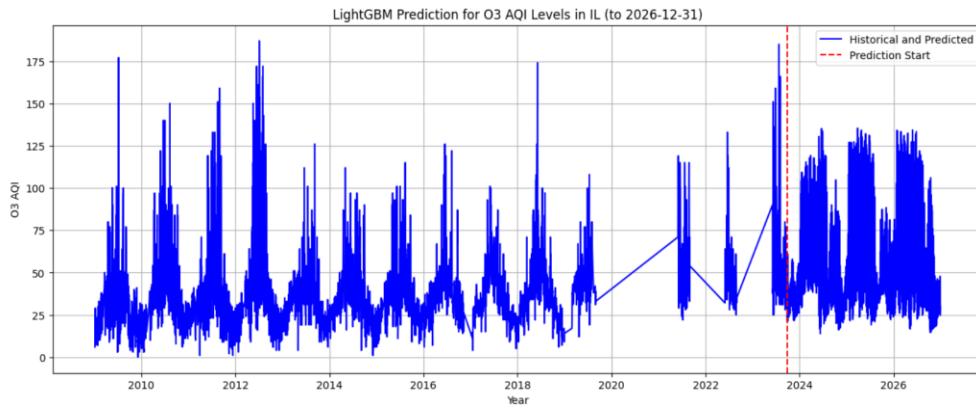
Highlight State
Highlight State



MODEL EVALUATION

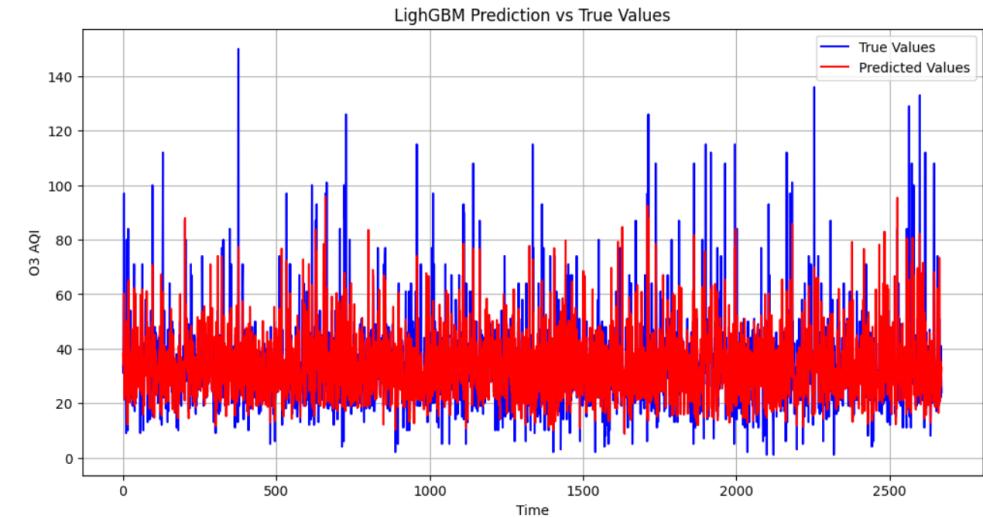
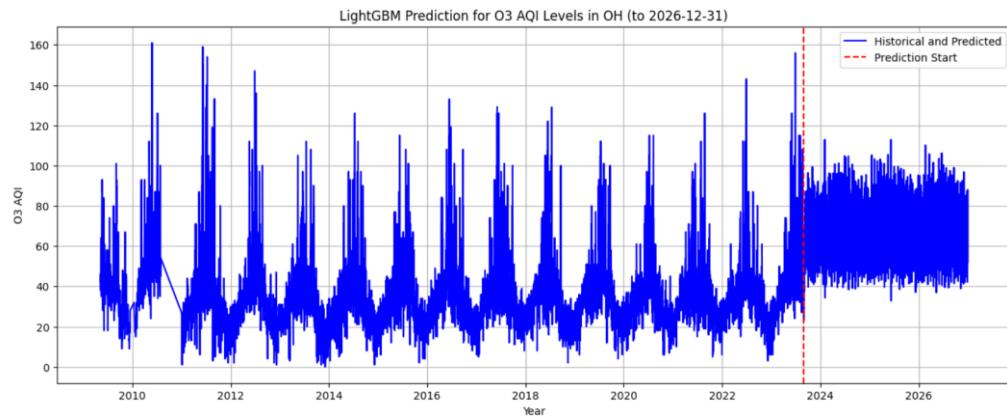
Illinois				Ohio		
	MSE					
	Random Forest	XGBoost	LightGBM	Random Forest	XGBoost	LightGBM
CO	1.58	0.96	1.86	1.53	0.77	1.51
NO2	6.72	3.79	8.07	7.85	4.39	7.37
SO2	4.36	2.75	5.74	10.88	6.57	10.07
O3	10.29	7.13	13.59	11.02	6.20	9.62





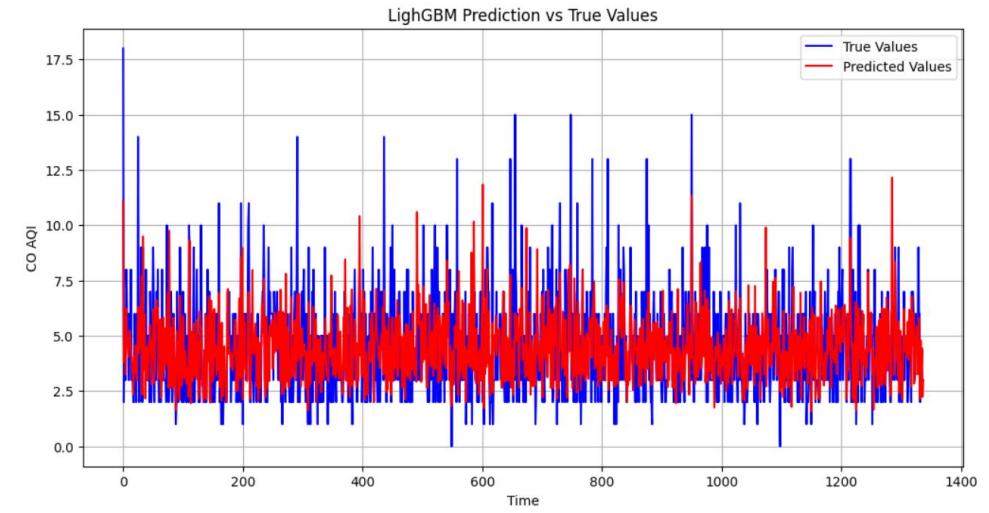
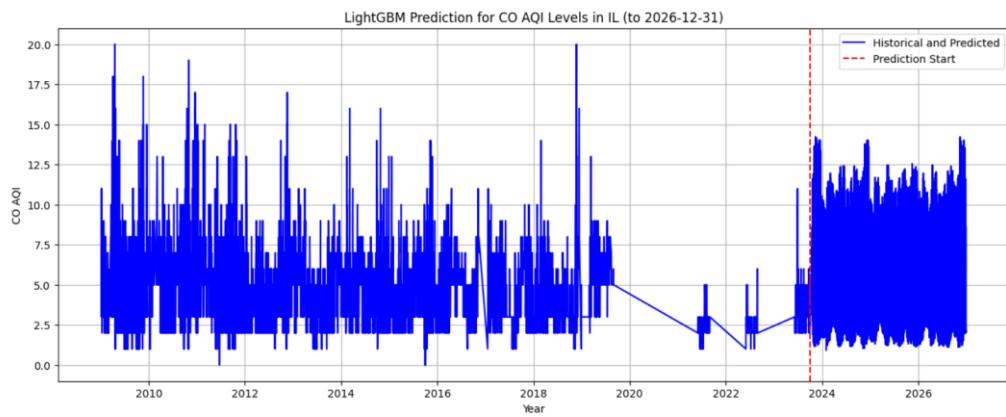
ACTUALS VS PREDICTIONS: OZONE ILLINOIS





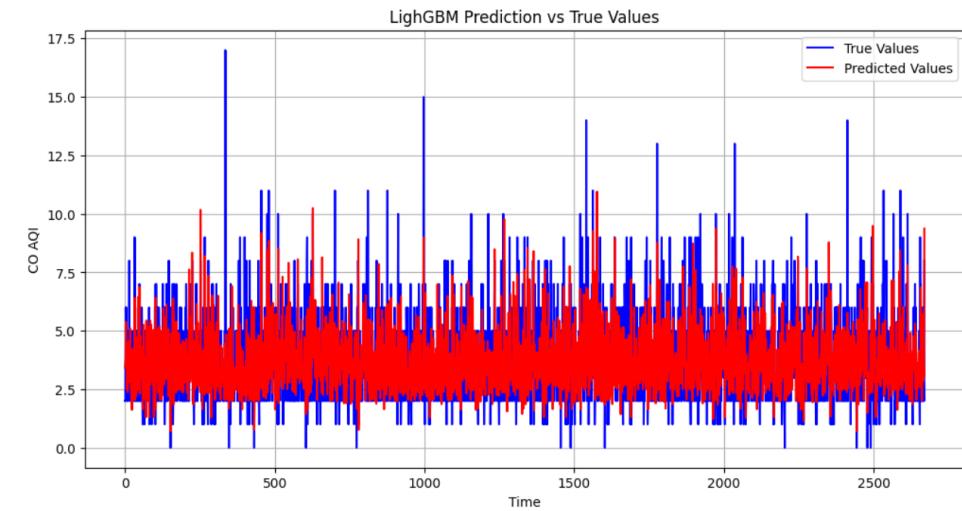
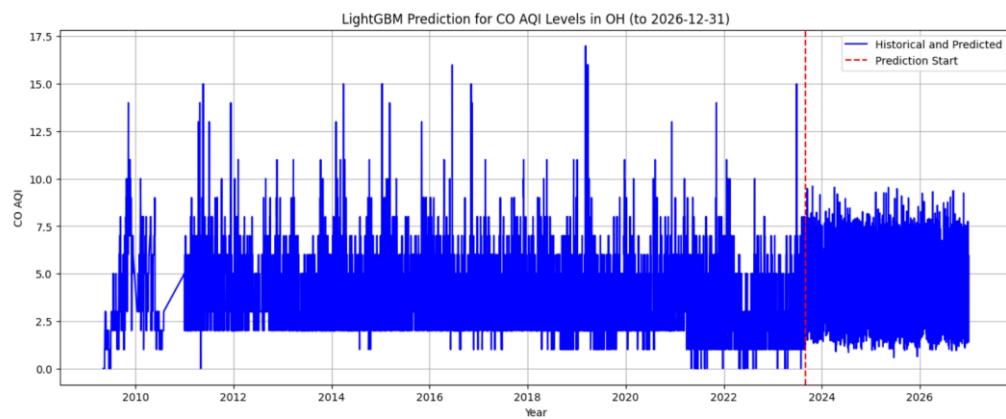
ACTUALS VS PREDICTIONS: OZONE OHIO





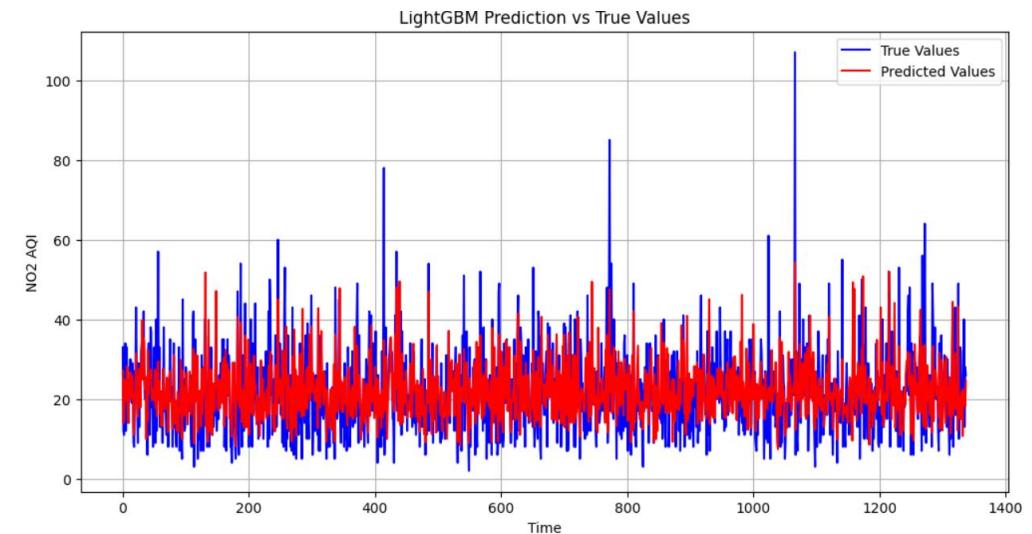
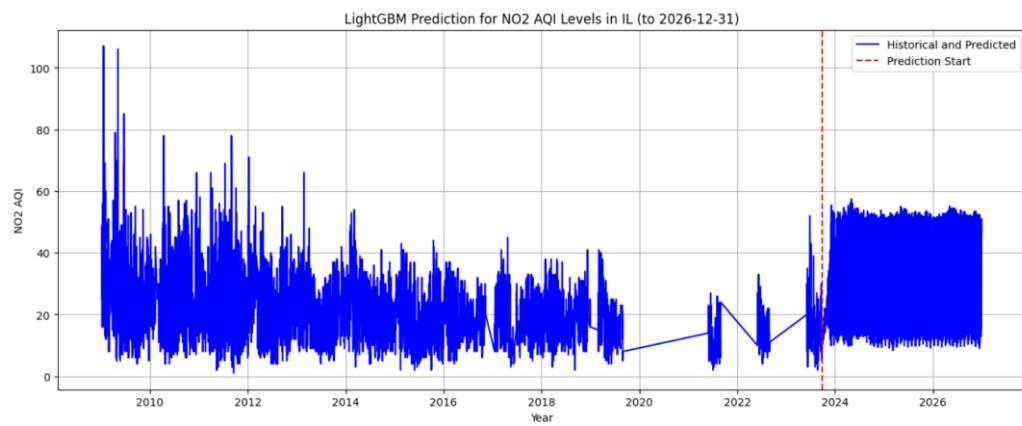
ACTUALS VS PREDICTIONS: CARBON MONOXIDE ILLINOIS





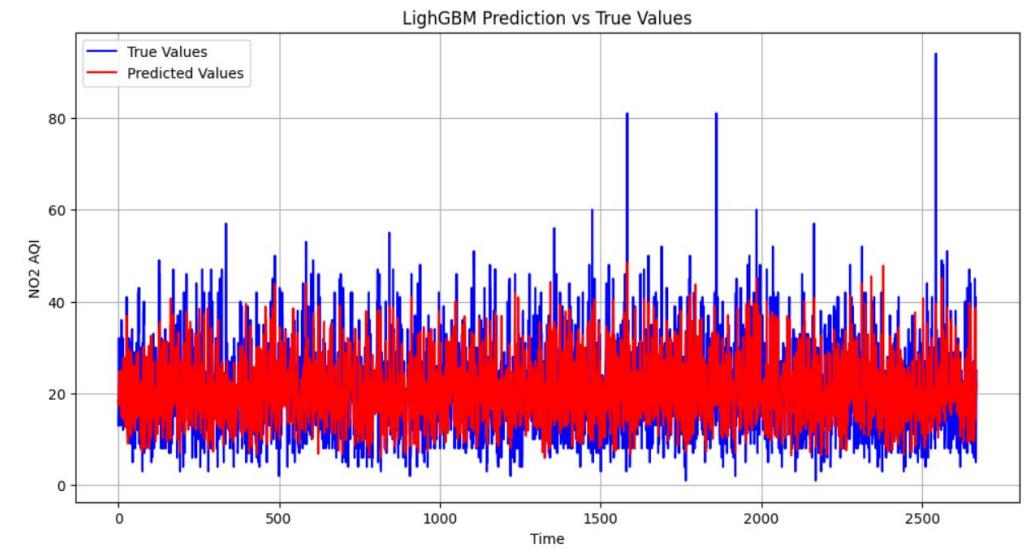
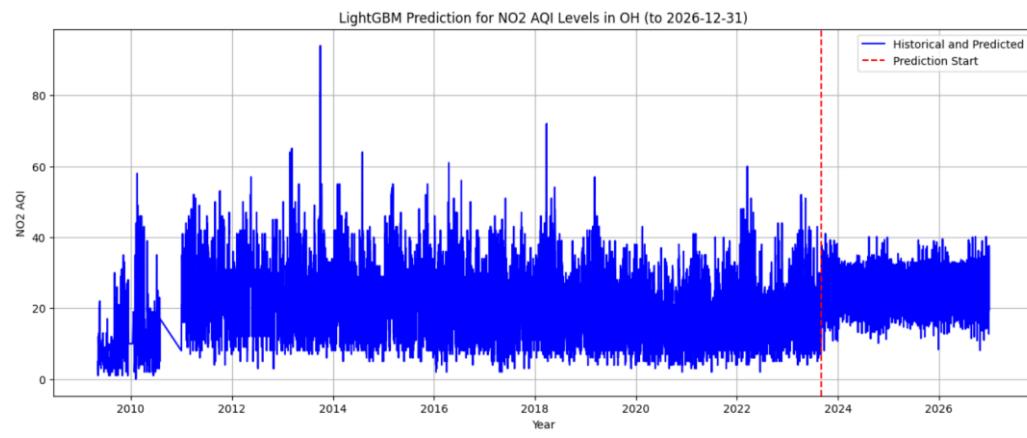
ACTUALS VS PREDICTIONS: CARBON MONOXIDE OHIO





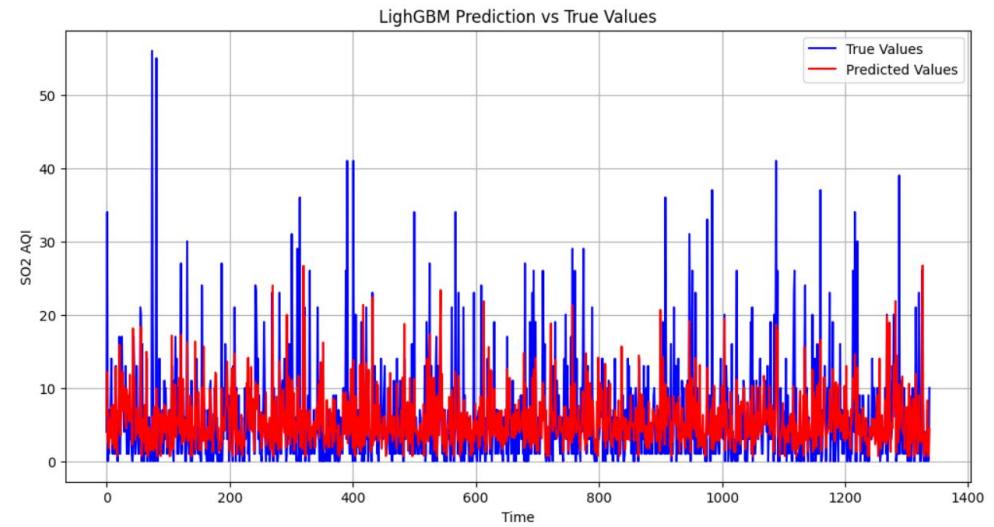
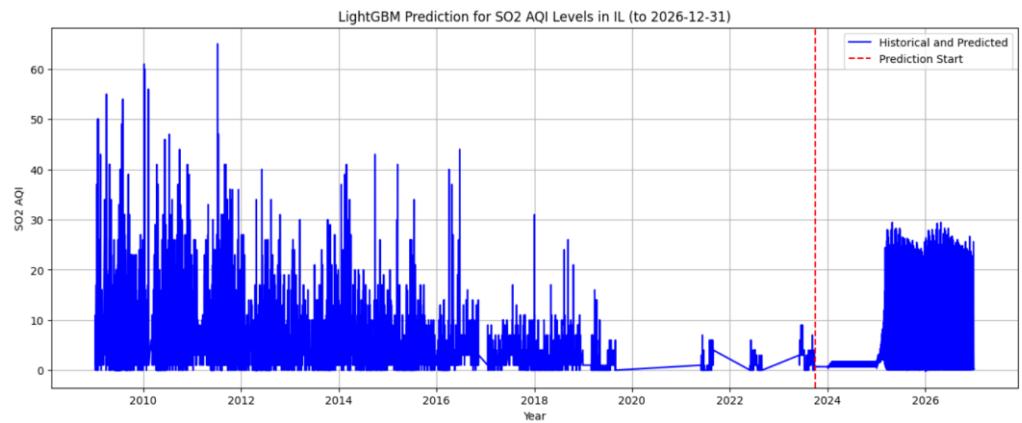
ACTUALS VS PREDICTIONS: NITROGEN DIOXIDE ILLINOIS





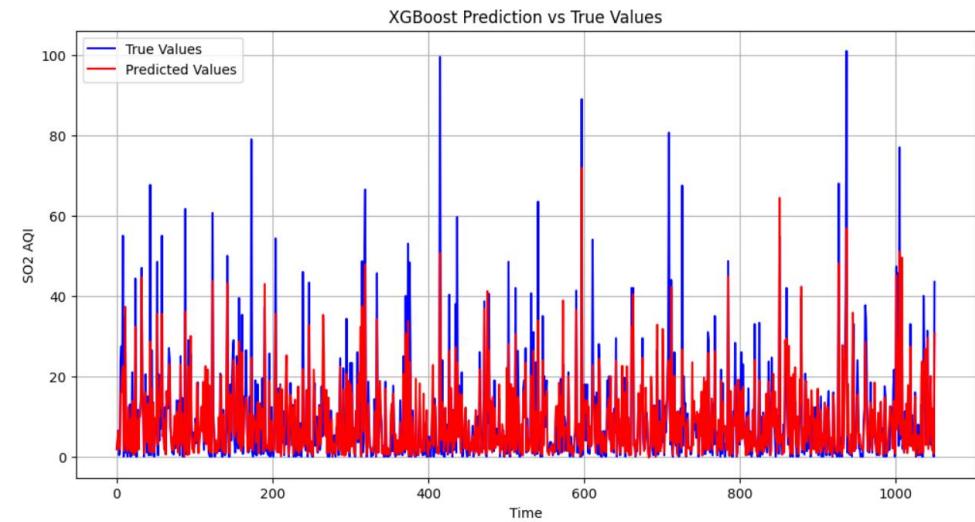
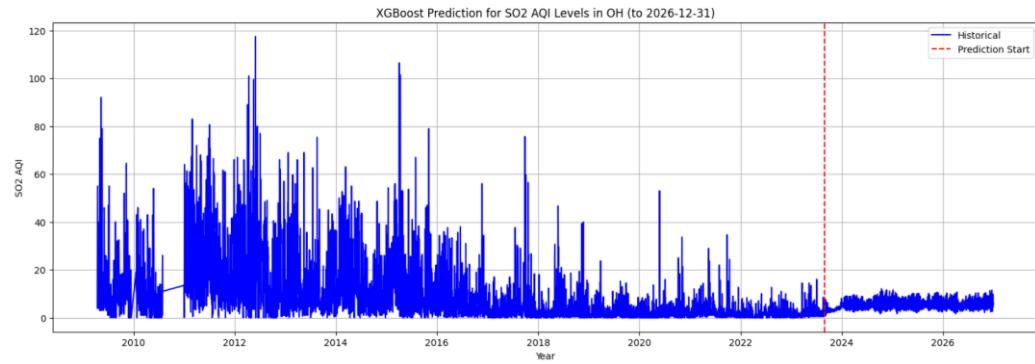
ACTUALS VS PREDICTIONS: NITROGEN DIOXIDE OHIO





ACTUALS VS PREDICTIONS: SULPHUR DIOXIDE ILLINOIS



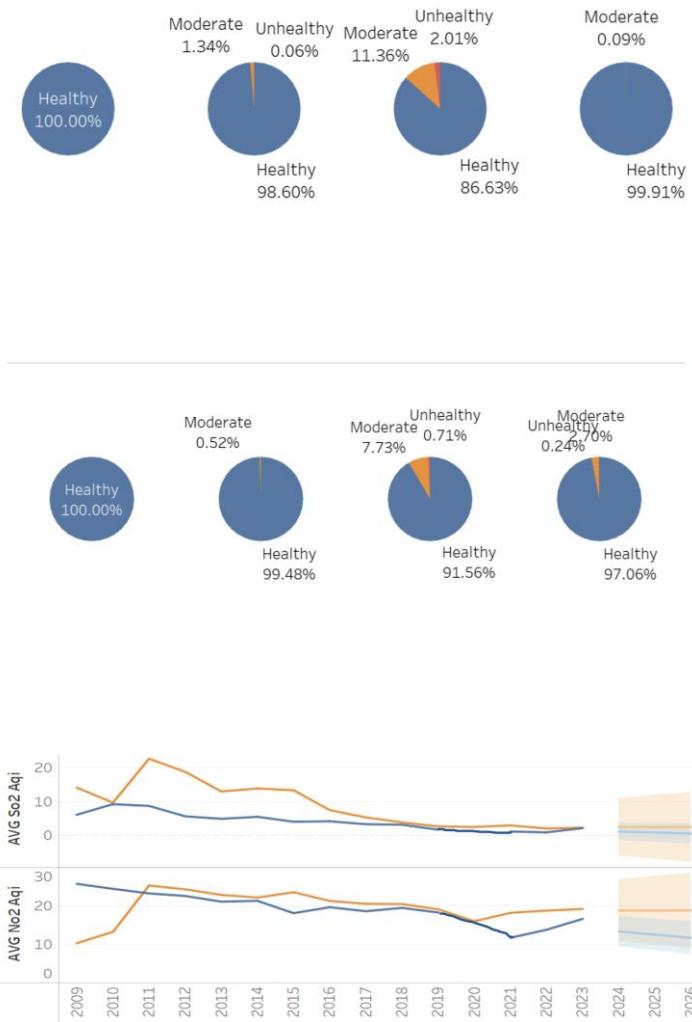


ACTUALS VS PREDICTIONS: SULPHUR DIOXIDE OHIO



INSIGHTS

- Illinois may need to focus on reducing **O₃** levels, while Ohio could prioritize reducing **SO₂** pollution.
- Both states show progress toward cleaner air but have specific areas requiring targeted policies and technological interventions to achieve further improvements.
- Both states demonstrate clear progress in controlling SO₂ and NO₂ pollution, with significant declines over the years.
- For most Toxic gases, AQI forecasts show stability with minor fluctuations, suggesting that current policies and technologies have been effective in maintaining air quality.



RECOMMENDATIONS



Target Seasonal Management

Winter: Cleaner heating methods → reduce NO₂ & CO

Summer: Reduce precursor emission → control Ozone



Enhance Vehicle Emission Policies

Strengthen statewide vehicle emission standards → sustain reductions in NO₂ levels

Support programs that promote cleaner vehicles and alternative commuting options



Expand and Maintain SO₂ Monitoring

Build robust county- and city-level monitoring systems → ensure low SO₂ levels

Encourage industries to adopt renewable energy and low-sulfur fuel technologies



Promote CO Reduction Initiatives

Develop statewide campaigns → educate residents on CO's risks and reduction actions

Offer incentives for clean energy adoption in households and commercial buildings



Green Travel, Clean Energy, Public Awareness In **most polluted areas**





THANK YOU



REFERENCES

- <https://la-solargroup.com/avoid-pollution-in-the-us/>
- <https://www.epa.gov/>
- <https://www.kaggle.com/datasets/guslovesmath/us-pollution-data-200-to-2022/data>