

Impacts of the xAI Colossus 1 Data Center on the Air Quality and Temperature in Southwest Memphis

Chunrong Jia, Ph.D., MS

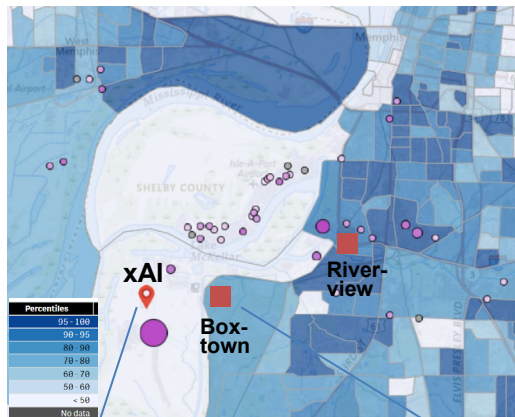
Professor of Environmental Health

School of Public Health

University of Memphis



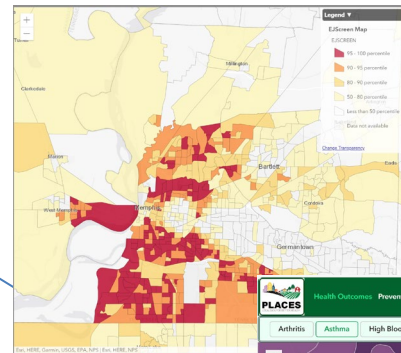
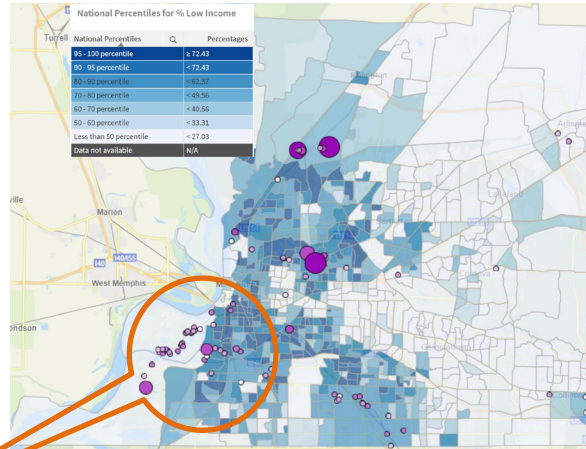
xAI Colossus 1 in Southwest Memphis



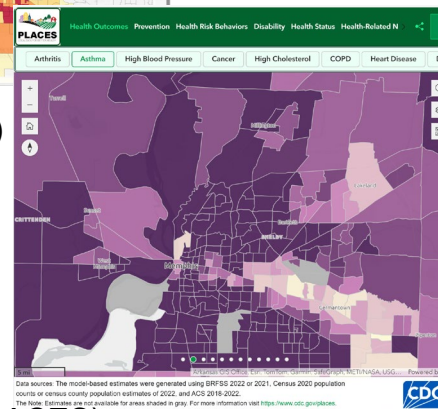
(Source: EJ Screen)



(Source: [actionnews5](https://www.actionnews5.com))



(Source: EJ Screen)



(Source: CDC PLACES)

- xAI
 - Constructed in 2024
 - Power demand: 300 MW
 - In the US, power demands of 2,132 data centers range from 0.04 to 325 MW (Guidi et al., 2024)
- Southwest Memphis (Zip 38109 as an example)
 - In and near the industry cluster of Memphis
 - AA%: 95%
 - Poverty rate: 32%
 - Life expectancy: 69 to 71.5 years

Emissions of air pollutants from xAI gas turbines

- Total power demand: 300 MW
 - 150 MW of grid power from MLGW/TVA
 - 150 MW from 15 on-site gas turbines
 - 35 turbines on site
 - Operations started 9/1/2024
- Air pollutant emissions (15 turbines combined)



(Source: [Inside Climate News](#))

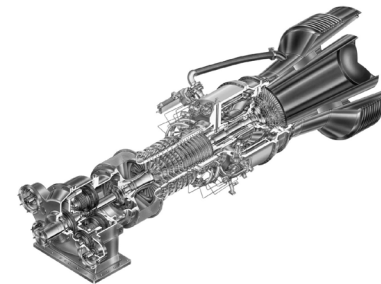
Criteria Air Pollutants	Emission rate (tons/y)
PM10	72.95
SO ₂	29.58
CO	93.96
NO _x	87.14

Hazardous Air Pollutants	Emission rate (tons/y)
VOCs	84.82
HAPs	13.71
Acetaldehyde	0.55
Acrolein	0.08
Benzene	0.17
Ethylbenzene	0.44
Formaldehyde	9.79
Xylenes	0.88
Toluene	1.79

Pollutant category	Major source threshold
Any criteria air pollutant	≥100 tons/year (tpy)
Any single HAP	≥10 tpy
Combined HAPs	≥25 tpy

Solar Turbines
A Caterpillar Company

SOLAR® MOBILE TURBOMACHINERY
SMT130 - Powered by Titan™ 130



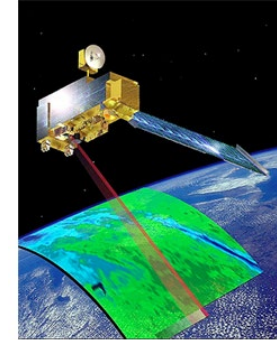
(Source: The manufacturer's website)



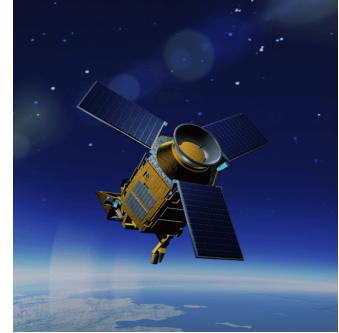
(Source: [The Conversation](#))

Pre- and post- comparisons

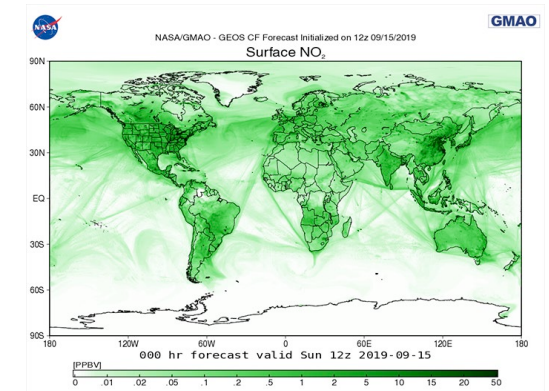
- There are **NO** field monitoring data for air quality in Southwest Memphis.
- Thus, air quality before and after the xAI launch was compared using **satellite data**.
 - Communities of concern: Boxtown and Riverview
 - Satellite data: PM_{2.5}, NO₂, SO₂, CO, O₃, formaldehyde, and temperature.
 - Calibration: The satellite data were calibrated with the actual air quality data collected at local monitoring stations.
 - Pre-operational: 09/01/2023 – 08/31/2024
Operational: 09/01/2024 – 08/31/2025



(MODIS,
Source:
NASA)



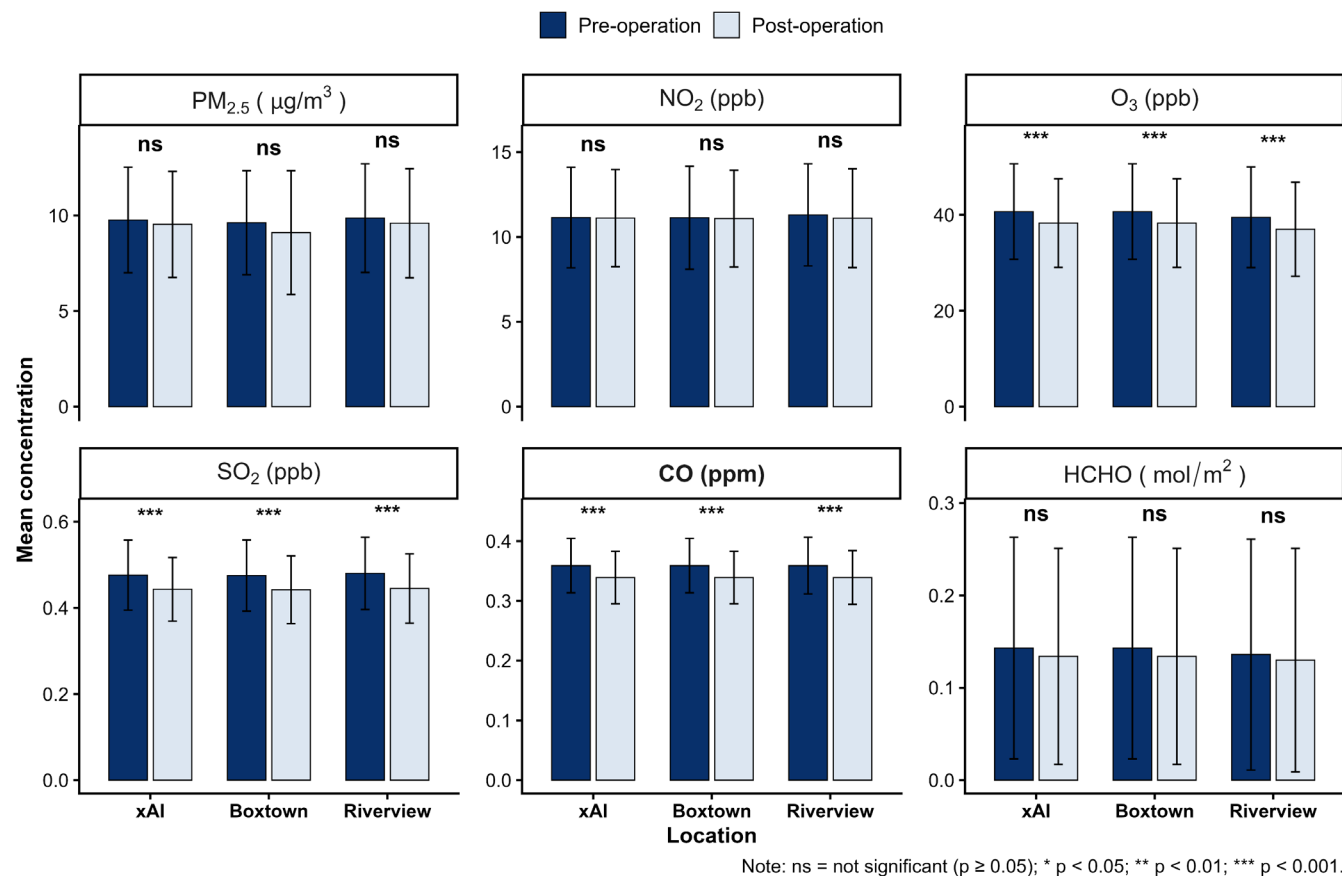
(TROPOMI,
Source:
<https://www.tropomi.eu/>)



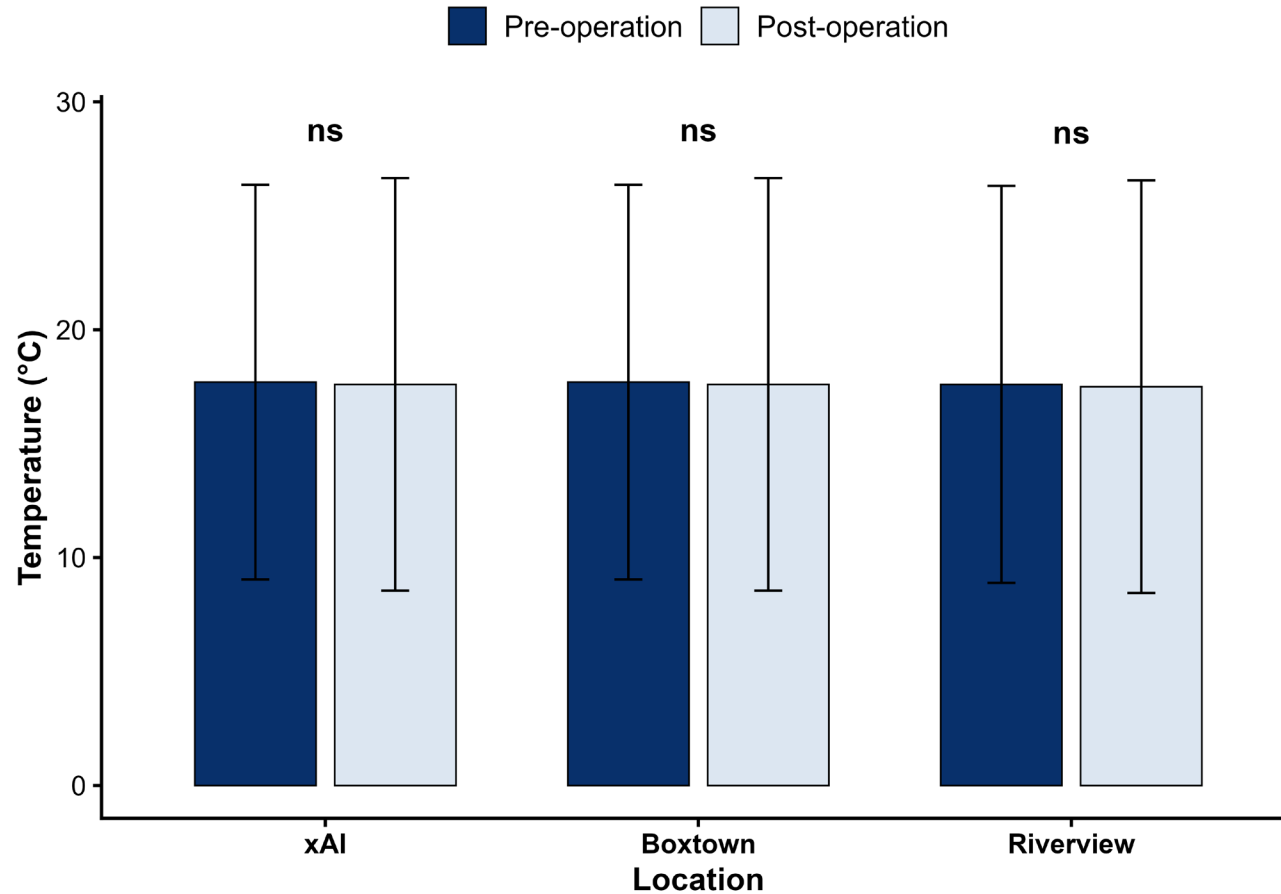
(GEOS-CF, Source: NASA)

Pre- and post- comparison results

- The post-operation concentrations generally decreased across all locations.
 - Significant reductions observed for O_3 , SO_2 , and CO ($p < 0.05$).
 - $PM_{2.5}$, NO_2 and formaldehyde showed no significant change ($p > 0.05$).



Changes in surface temperatures



Note: ns = not significant ($p \geq 0.05$).

After the launch of xAI on 9/1/2024, surface temperature slightly decreased but the change was insignificant in Boxtown and Riverview.

Limitations

- Limitations of satellite data for air quality assessment
 - Not direct measurements, but a proxy
 - Satellite pixels are still too large to resolve pollution gradients near individual sources
 - Strong dependence on weather and atmospheric conditions
- No health impact assessment due to the lack of health data in the potentially impacted area.

Conclusions

- After xAI started operating gas turbines on September 1, 2024
 - No significant deterioration in air quality in nearby neighborhoods
 - No significant increase in surface temperature in nearby neighborhoods
- Suggestions for further research for xAI-1, xAI-2, and all data centers planned in this region:
 - Local field air monitoring
 - Health assessment
 - Assessment of socioeconomic impacts

Study Team

- Dr. Chunrong Jia, Professor of Environmental Health, UofM SPH
- Dr. Abu Mohd Naser, Assistant Professor of Environmental Epidemiology, UofM SPH
- Mohammad Nayeem Hasan, Ph.D. student, UofM SPH
- Namuun Batbaatar, Ph.D. student, UofM SPH
- Dr. Ilias Kavouras, Professor of Environmental Health, UofM SPH
- Dr. Marco Tedesco, Lamont Research Professor, Columbia Climate School, Columbia University