

Introduction

- The Philadelphia Energy Solutions (PES) oil refinery in South Philadelphia was the largest refinery along the eastern seaboard prior to its closure.
- On June 21st, 2019, a corroded pipe resulted in a major explosion that forced the refinery to close permanently.
- Prior to the closure, the refinery accounted for 72% of toxic emissions in Philadelphia.
- The surrounding neighborhood to the refinery, Greys Ferry, is considered an environmental justice community because it is disproportionately black and low-income with high rates of asthma, cancer, and other chronic illnesses.

Our Goal:

- Determine if there was a *short-term increase* in pollutant levels immediately following the refinery explosion.
- Determine if there was a *long-term decrease* in pollutant levels after the refinery was permanently closed.

Methods

- All data was sourced from Environmental Protection Agency (EPA) AirData archives for 2015-2020 and analyzed using R.
- Data primarily used was collected at Ritner monitor, approx. 1 mile east of refinery fence line.
- Daily values of SO₂, PM_{2.5}, and volatile organic compounds (VOCs) were used as a proxy to measure emissions from the refinery.
- Study relied on 2 periods of interest: 2 months before the refinery closure (April 21st-June 20th) and 2 months after the refinery closure (June 21st-August 21st).
- To determine statistical significance, we created an interrupted time series model with the following linear regression:

$$Y_t = B_0 + B_1T + B_2X_t + B_3TX_t$$

where T is the time elapsed since the start of the study in the unit representing the frequency of which observations are taken, X_t is an indicator variable for the intervention, and Y_t is the outcome at time t , with the B elements coefficients of the same.



Image 1: PES Refinery

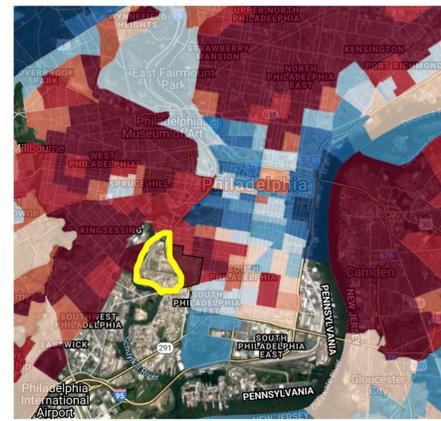


Image 2: Income Levels in Philadelphia (Yellow outline represents refinery, red indicates lowest income levels)

Results

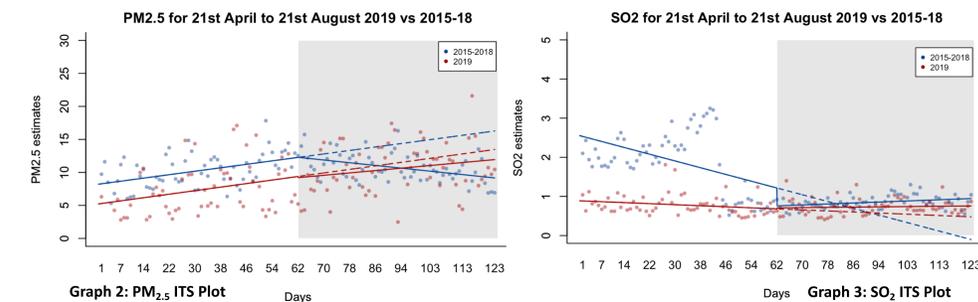
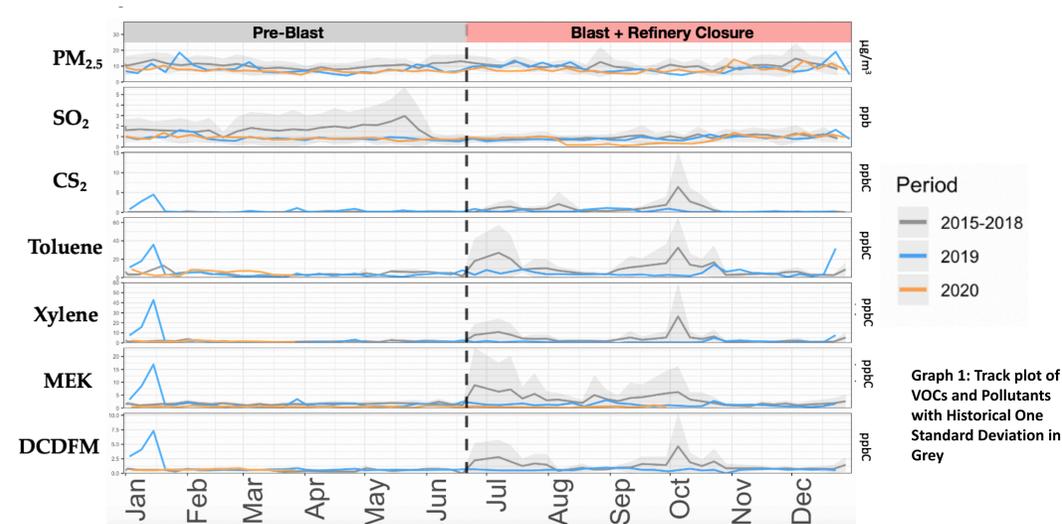


Table 1: ITS Coefficients and P-value

| PM _{2.5} | | SO ₂ | |
|------------------------------------|----------|------------------------------------|-----------------------|
| Coefficient | P-value | Coefficient | P-value |
| Year2019:refinery blast | 0.055077 | Year2019:refinery blast | 3.15x10 ⁻⁵ |
| No_of_days:year2019:refinery_blast | 0.033139 | No_of_days:year2019:refinery_blast | 0.000404 |

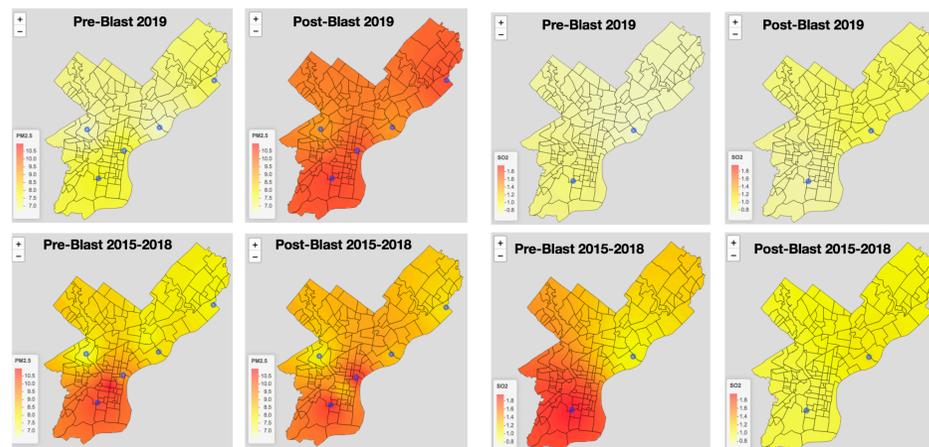


Image 3: PM_{2.5} Raster Image of Philadelphia

Image 4: SO₂ Raster Image of Philadelphia

- Both 2019 and 2020 weekly means for all pollutants do not fall outside 1 standard deviation from historical levels (Graph 1).
- PM_{2.5} levels decreased following the blast in 2019 while historically they increased after June 21st (Graph 2).
- SO₂ levels increased following the blast in 2019 while historically they decreased after June 21st (Graph 3).
- There is statistical significance in the change in PM_{2.5} levels in 2019 before & after the blast in comparison to the historical levels (p value = 0.03 < 0.05) (Table 1).
- There is statistical significance in the change in SO₂ levels in 2019 before & after the blast in comparison to the historical levels (p value = 0.0004 < 0.05).

Conclusions

- Expectations were to see a drop in pollution levels after the refinery was closed, but there was an increase observed.
- % difference for VOCs in 2019 were less than historical % differences but none were statistically significant.
- There is a lack of air quality monitoring in the city from which to get data: Only 1 AMS monitor near PES (Ritner). The monitor is not downwind of refinery and was not actively recording measurements the day of blast.
- Ritner monitor is 1 of only 2 monitors in the entire city that measure VOCs.
- City admin. & refinery cites there is no risk, but residents still complain of health issues long after closure.

Acknowledgments

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References

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