

Spatio-temporal Trends of Air Quality in Southwestern Pennsylvania in the 2000s

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Introduction

Air quality throughout Southwestern Pennsylvania has improved immensely over the last half century, though the majority of Greater Pittsburgh and surrounding 10 counties remain under nonattainment for at least one criteria pollutant NAAQS designation. Currently, the Pittsburgh region maintains to be identified as having some of the worst air quality in the United States. Conversely, Pittsburgh has received equally polarizing accolades of "most livable city" status in the Nation. Therefore, Pittsburgh air quality presents an interesting dichotomy of historical improvement contended with overly complacent public perception. Air quality assessment as well as the aforementioned grading scale tend to focus on fine particulate matter (PM_{2.5}) and ozone (O₃). Human health effects from PM_{2.5} and O₃ are of greatest concern. Fine particulates and ozone concentrations encompass numerous source types and constituents, e.g., SO₂ and NO_x. In evaluating measured air pollution, source emissions contribution can help to disentangle causation and implement mitigation. Though air quality assurance remains an impediment, especially in the midst of a growth-impairing imbalanced economy.

Table 1. National Ambient Air Quality Standards Designations of Southwestern Pennsylvania Counties

8-Hour Ozone (1997Std.)	1-Hr Ozone Maint. ⁽¹⁾	CO Maint.	PM-10 Maint.	2006 PM-2.5 Nonatt.	1997 PM-2.5 Nonatt.	SO ₂ Nonatt.	SO ₂ Maint.
PGH-Beaver Valley Nonattainment 8-Hour Ozone Category/Classification: (1997 std.)							
Allegheny Co	Moderate	Partial ⁽²⁾	Moderate ⁽³⁾	Nonatt.	Nonatt.		Moderate ⁽⁵⁾
Armstrong Co	Moderate			Nonatt.	Nonatt.	Partial ⁽⁴⁾	
Beaver Co	Moderate			Nonatt.	Nonatt.		
Butler Co	Moderate			Nonatt.	Nonatt.		
Fayette Co	Moderate						
Washington Co	Moderate			Nonatt.	Nonatt.		
Westmoreland Co	Moderate			Nonatt.	Nonatt.		
Indiana Co Maintenance 8-hour Ozone Category/Classification: (1997 std.)							
Greene Co Maintenance 8-hour Ozone Category/Classification: (1997 std.)							
Indiana Co				Partial	Partial		
Greene Co				Partial	Partial		
Lawrence Co	No 8-hour Ozone Designation			Partial	Partial		

Objectives

- ❖ Apply spatio-temporal analysis to evaluate air pollution in comparison to regional and national trends over the previous decade with focus on fine particulate matter
- ❖ A comparative metric analysis of air pollution is intended to cover the core public health functions:
 - Assessment
 - Assurance
 - Baseline modeled data for epidemiological studies
- ❖ Evaluate the resultant air quality standing in context of general public perception

Methods

- ❖ NAAQS designations and proposed standards were evaluated over a ten county region of Southwestern Pennsylvania (Allegheny, Armstrong, Beaver, Butler, Fayette, Greene, Indiana, Lawrence, Washington, and Westmoreland)
- ❖ Absolute measures comparisons of air pollution constituents data were focused on fine particulate matter monitoring across varying spatial and temporal extents
- ❖ Absolute and relative measures comparisons utilized national USEPA Design Values over the 2000s
- ❖ Point source emissions trends were limited to volatile organic chemicals (VOCs), oxides of nitrogen (NO_x), sulfur dioxide (SO₂), and carbon monoxide (CO) from 1999 through 2007

Results

- ❖ PM_{2.5} annual design value (DV) mass concentration decreased an average of 2.8 µg/m³, 24-hour DV decreased by 7.8 µg/m³ in Southwestern Pennsylvania
- ❖ Nationally, fine particulate decreased by 2.7 µg/m³ (774 monitors) ~ 23%
- ❖ Five of the thirteen local monitors had greater absolute PM decreases, only the Clairton long-term monitor displayed a concentration change greater than 20%
- ❖ Eleven of the thirteen continuous PM monitors regressed in national ranking by an average of +9.4% in 3-year design value percentile rank
- ❖ Nine of the thirteen continuous PM monitors of Southwestern Pennsylvania are of the worst 25%, while 6 are of the worst 11% in the nation
- ❖ The Northeastern States of the U. S. Census Bureau and CAIR States displayed an average -31.8%, and -34.5% rank decrease over the decade, respectfully
- ❖ Emissions reduction of sulfur dioxide (SO₂) within Southwestern PA were 9.9% compared to 30% from all facilities in PA, OH, and WV, and 16.0% nationally
- ❖ Time series displays regional congruency of pollution measurements, evidence by similar troughs and peaks of Figure 3.
- ❖ The Liberty monitor clearly indicates impact from local pollution episodes

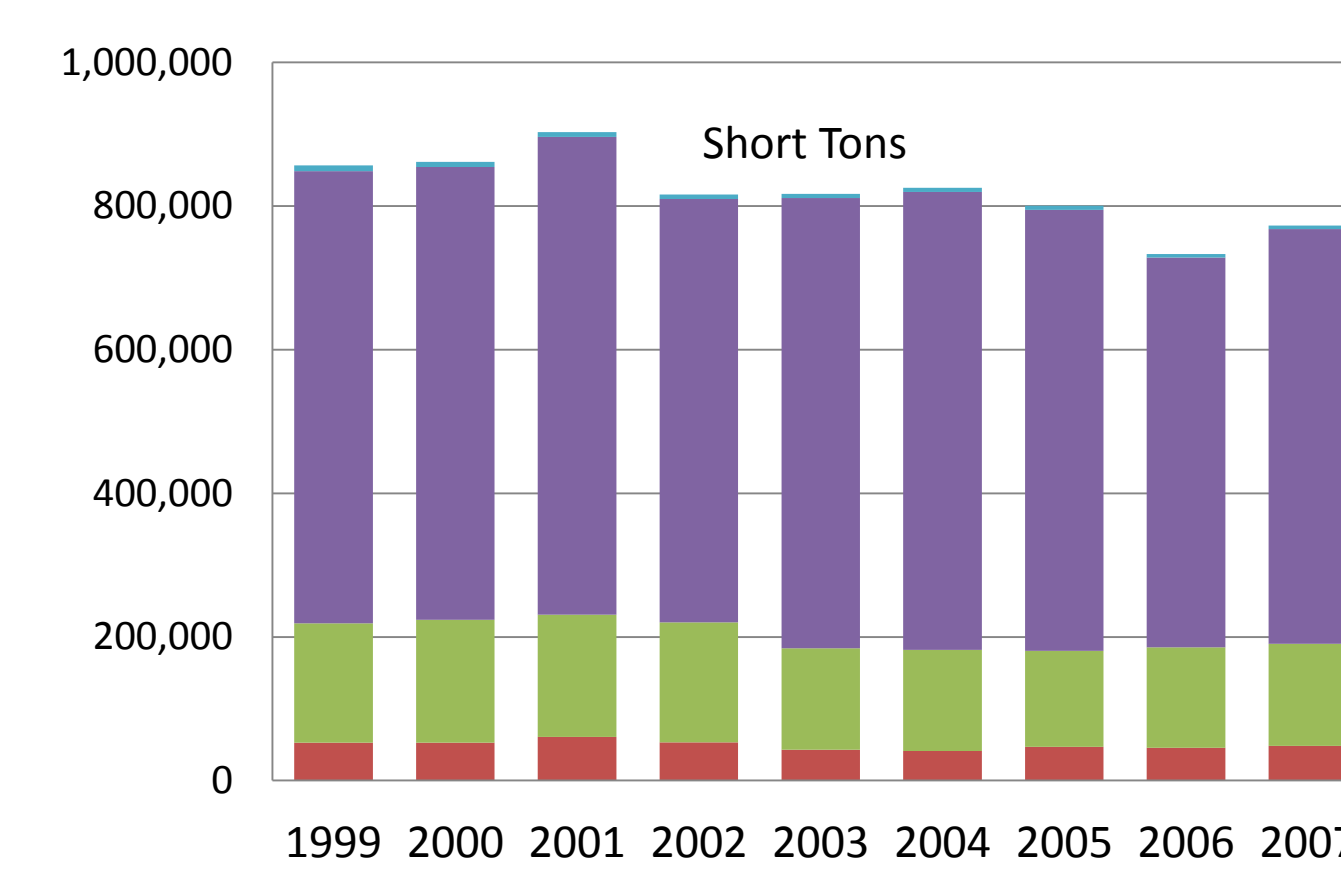


Figure 1. Southwestern PA Emissions Trends (TPY)

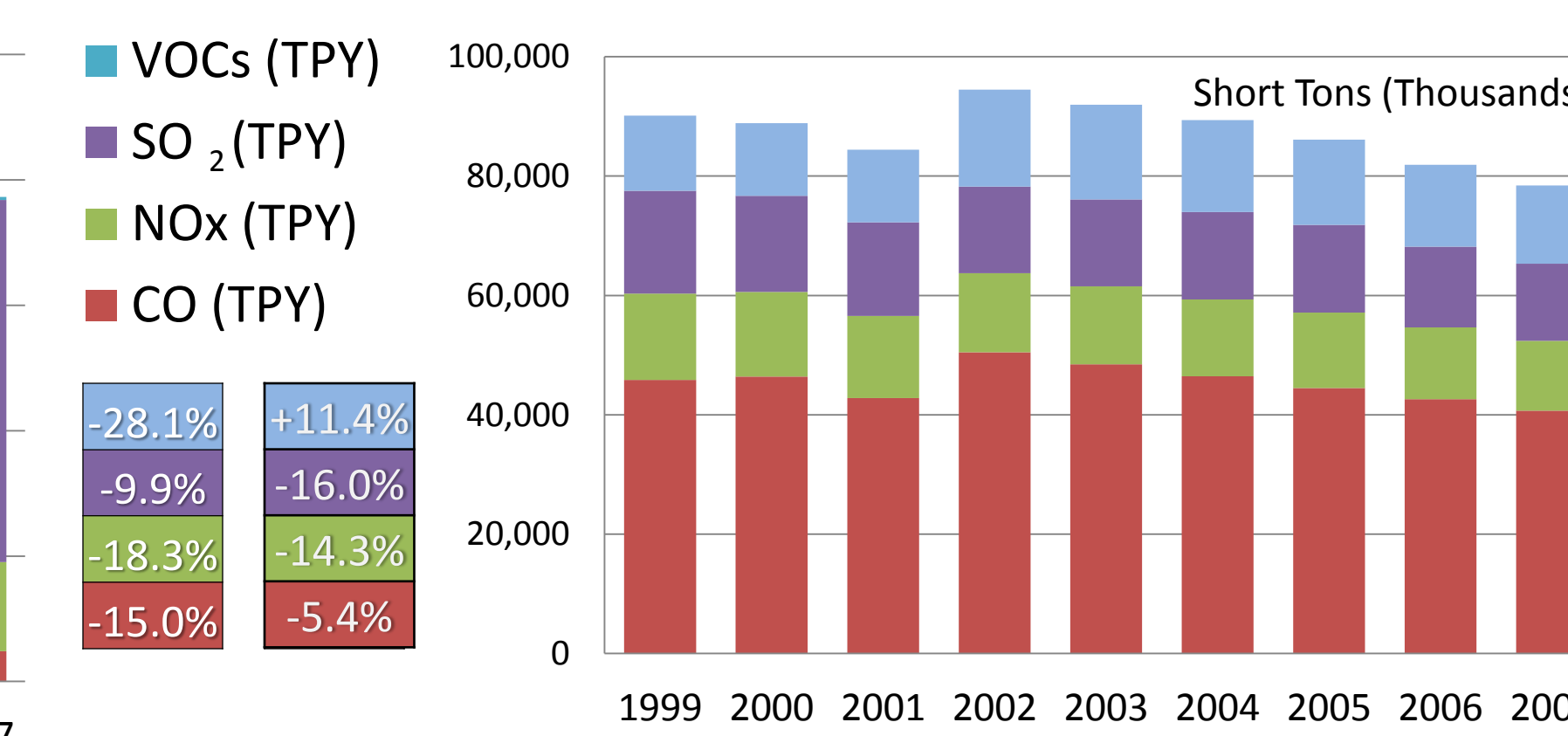


Figure 2. National PA Emissions Trends (TPY thousands)

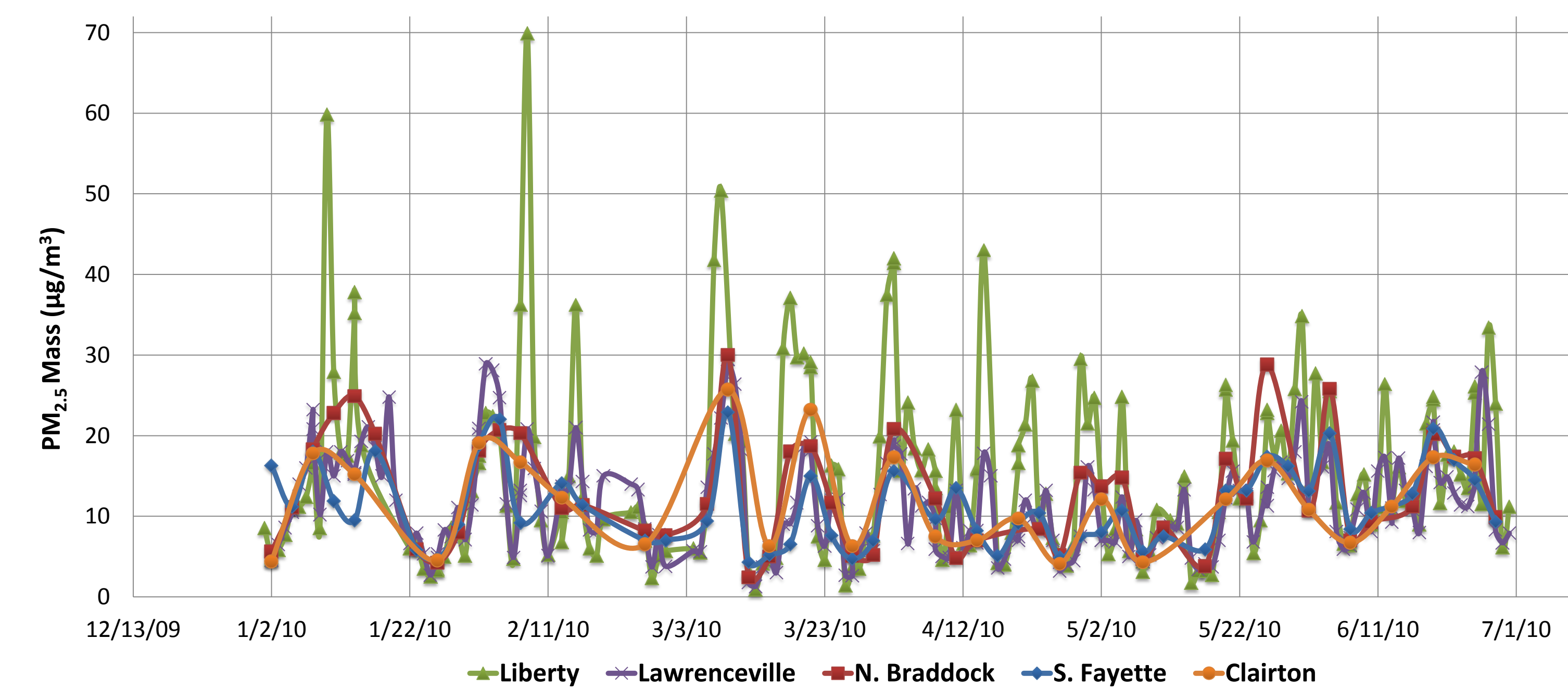


Figure 3. Time series of five Southwestern Pennsylvania PM_{2.5} long-term FRM over the first six months of 2010

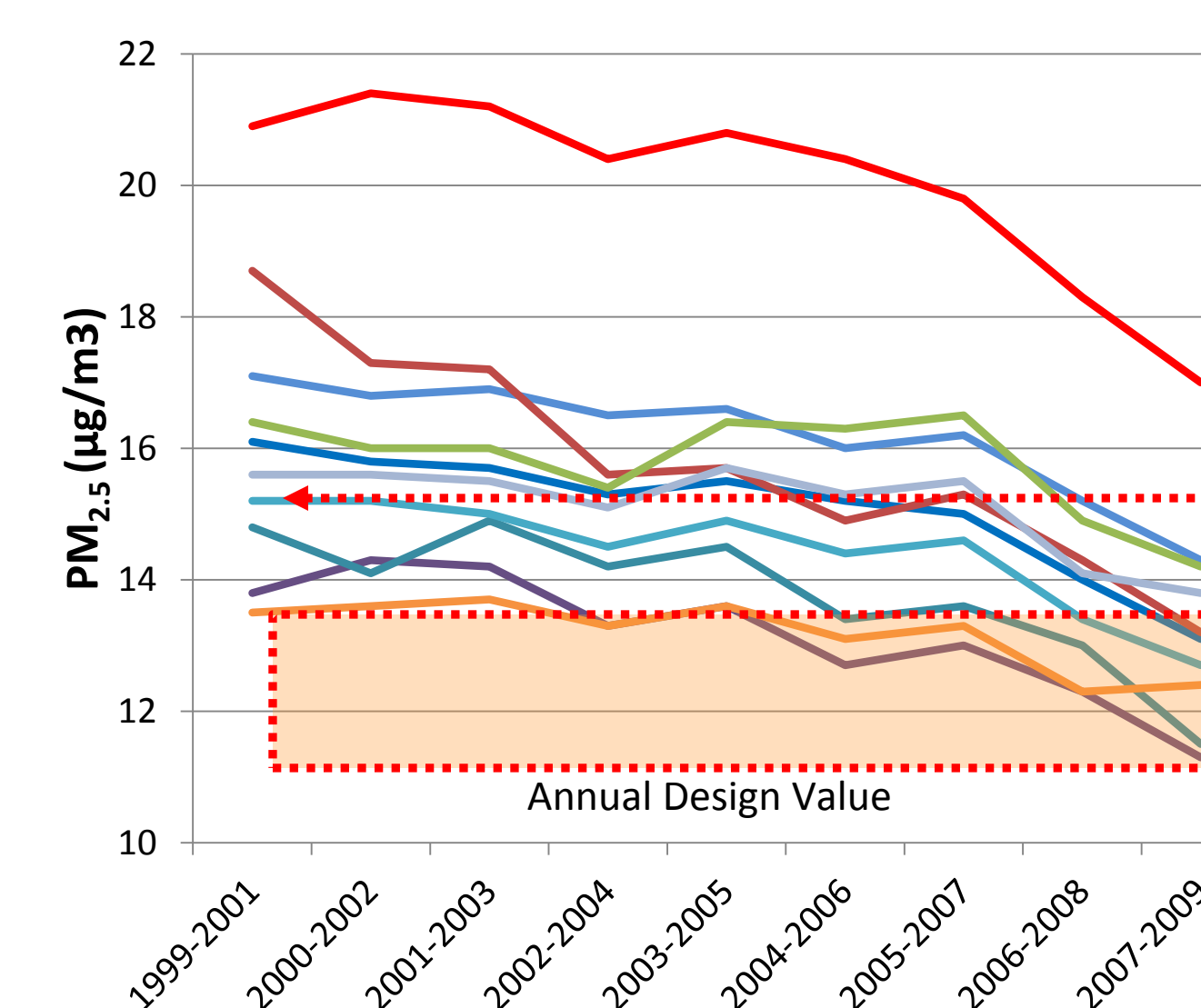


Figure 4. Annual PM_{2.5} design value trend with current and proposed NAAQS

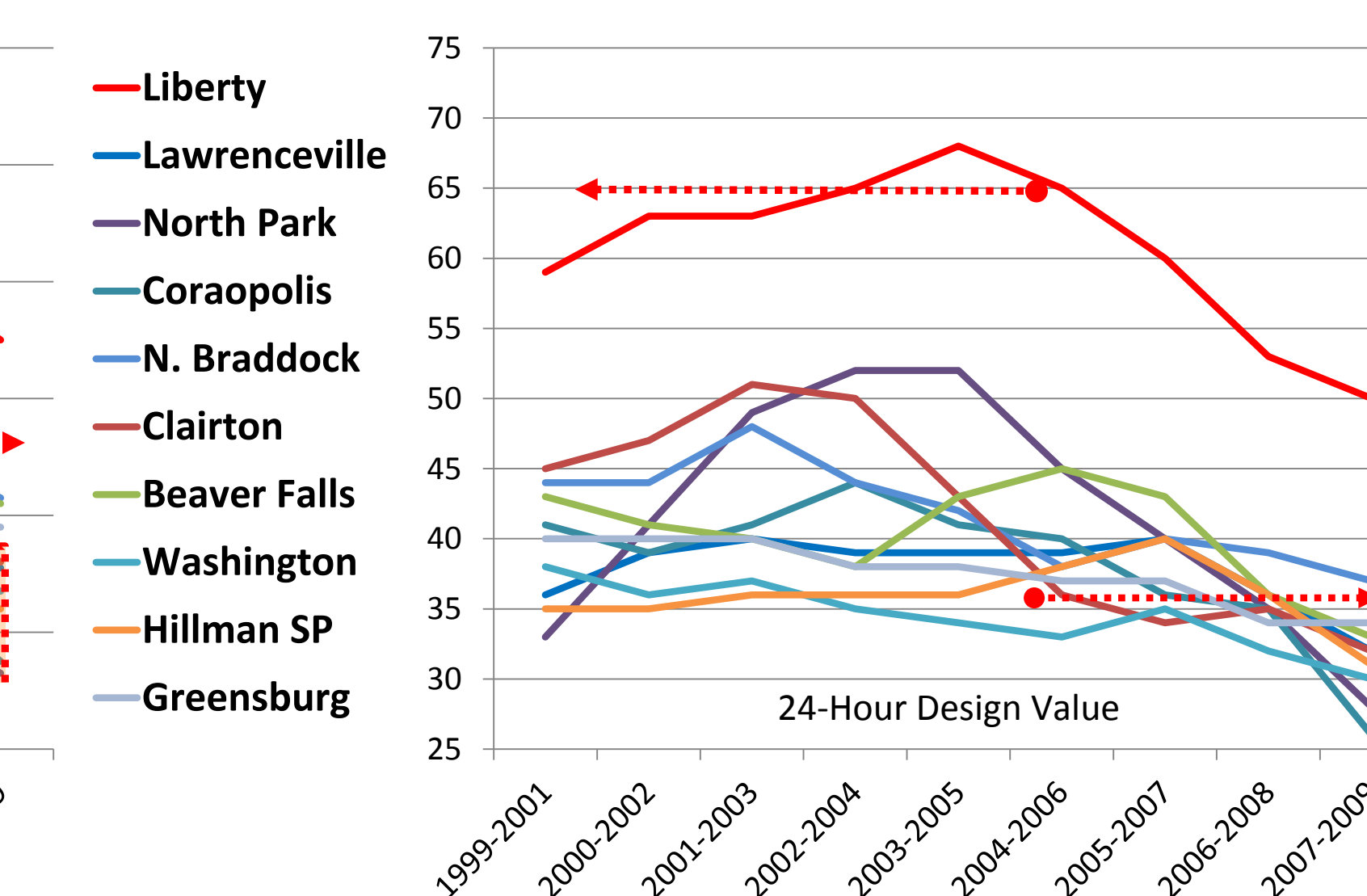


Figure 5. 24-hour PM_{2.5} design value trend with current NAAQS

Results Cont.

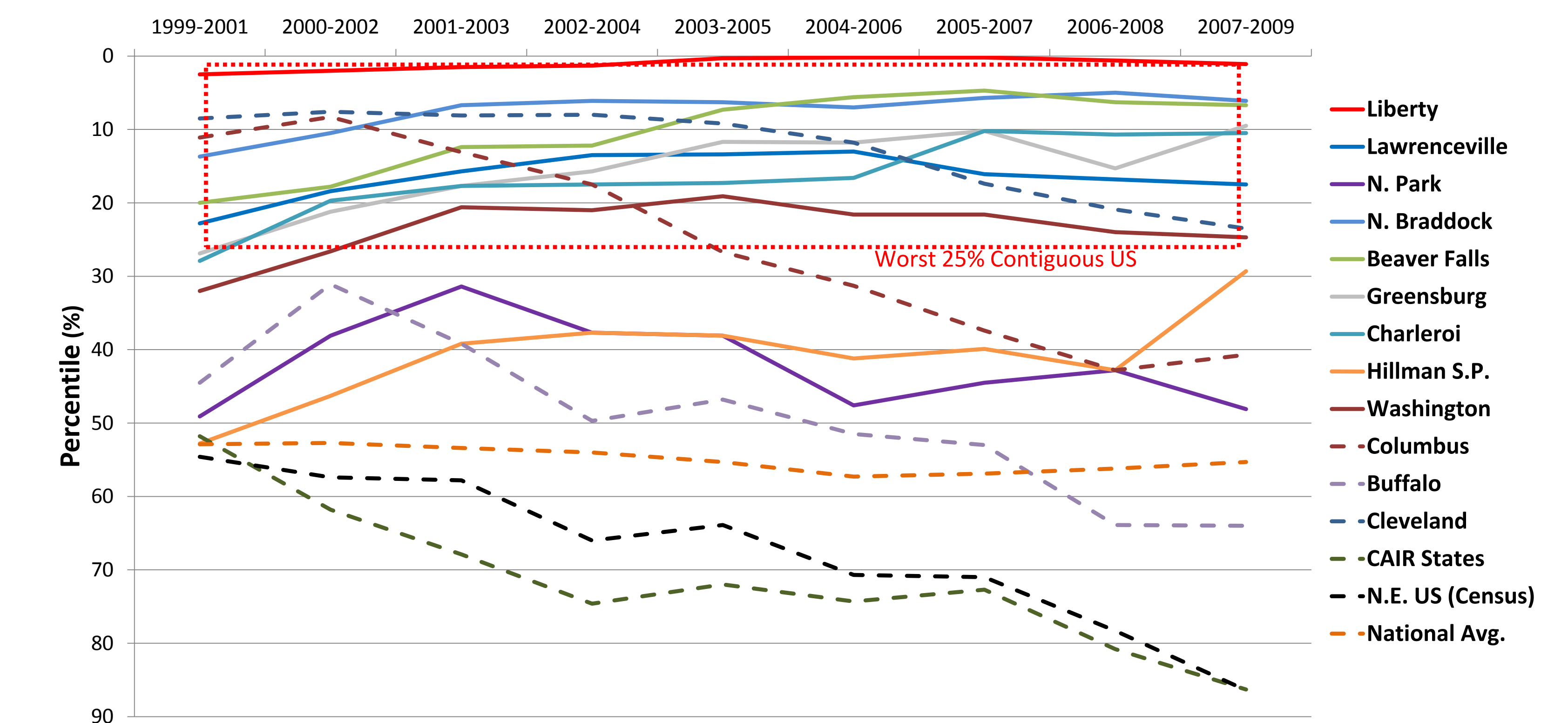


Figure 6. Annual PM_{2.5} design value national percentile ranking of selected local and regional monitors and grouped comparisons. Red highlighted area represents the top 25th percentile compared nationally.

Conclusion

Decreases of absolute concentrations of air constituents, specifically fine particulate matter and ozone, are significant throughout the Southwestern Pennsylvania region, however, relative percentage changes are not congruent with national and regional improvements. Air pollution levels of PM_{2.5} and O₃ throughout Pittsburgh remain some of the highest in the nation. Local point source emissions of SO₂ are lacking comparable to regional reductions. This comparison is a testament to the historically high concentrations of air pollution, and also a lacking of local emissions reductions. A unique paradigm of air quality perception seems to exist throughout the Pittsburgh region, both internally and externally. More stringent NAAQS will maintain nonattainment designation the majority of the study area and may include borderline areas for PM, O₃, NO_x and SO₂.

Public Health Implications

Approximately 2.3 million residents of Southwestern Pennsylvania reside in an area of nonattainment for PM_{2.5} and Ozone National Ambient Air Quality Standards. Primary standards are established to protect human health, particularly high risk populations, while secondary standards minimize damage to animals, crops, vegetation and buildings. The Pittsburgh Metropolitan region and surrounding counties remain in nonattainment for primary and secondary standards, directly effecting human health and the regions well-being. The public health communication message must change to combat perceptual complacency.

Data References

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