State of Air Quality in California's 39th Congressional District

Presented by

Congressman Mark Takano

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Executive Summary

Counties within the Inland Empire have some of the worst air quality in the United States. California's 39th Congressional District fails to meet the National Ambient Air Quality Standard for both fine particulate matter ($PM_{2.5}$) and ozone. $PM_{2.5}$ concentrations have decreased noticeably since 1999, however still exist at substantially higher concentration than they are nationally. Nationwide ozone concentrations have also decreased by 16 percent since 2000, however Riverside has not seen a similar improvement in ozone air quality. Within the congressional district, $PM_{2.5}$ concentrations peak in the fall and winter while ozone concentrations peak in the summertime.

Nationally, fuel combustion and industrial processes are the largest source of anthropogenic $PM_{2.5}$. Ozone is mainly derived from emissions from on-road vehicles and industrial processes. Industrial processes and transportation are also significant sources of pollution in California's 39th Congressional District. Riverside is unique in that a large source of pollutants are derived from the westerly sea-breeze that transports aerosols from Los Angeles to the Inland Empire. The Port of Los Angeles and the Port of Long Beach are major sources of emissions that ultimately travel towards the Inland Empire and get trapped in the region due to the natural topography that forms a basin. Activities such as ships travelling in and out of port, loading and unloading, drayage, and trucking activities emit large amounts of particulate matter and nitrous oxides, a precursor to ozone, which can end up in the Inland Empire.

The increasing concentration of warehouses within the district has led to a massive increase in transportation traffic, and thus vehicle emissions. From 2005 to 2022, more than 100,000,000 square feet of warehouse space was constructed along Interstate 215 around the March Air Reserve Base. Emissions from these warehouses disproportionately affect communities of color and have led to significant public health challenges for these populations, including an increased risk from COVID-19. In addition to the boom in the warehousing industry, the city of Riverside's air pollution issues is compounded by rampant wildfires that occur frequently between June and October. Besides causing periods of poor air quality, wildfires have resulted in almost $500 million in damages to Riverside County and have burned almost 200,000 acres between 2008 and 2021.

Ultimately, high levels of air pollution are negatively affecting the health of those living in the region. The people living in the Inland Empire have higher rates of asthma than the national average. Addressing the air quality problem is also essential to minimizing the impacts of future public health crises, especially those where the ailment more greatly affects those with underlying heart or lung conditions, such as COVID-19 and Respiratory Syncytial Virus (RSV). Research suggests that air pollution levels correlate positively with the morbidity and infection rates of these respiratory diseases. Riverside County had a higher COVID-19 death rate at the

peak of the pandemic compared to the rest of the nation and saw a surge of RSV cases this past winter that overwhelmed pediatric hospitals.

There are many other costs associated with poor air quality. High concentrations of air pollution may lead to smog, which hinders visibility and presents a safety concern for vehicle users. Children living in areas with chronic exposure to higher levels of ozone and $PM_{2.5}$ have evidence of more adverse health effects and exacerbated allergies compared with children with lower exposures. Furthermore, indoor air quality is a significant predictor of student performance. High levels of air pollutants worsen student concentration and may decrease student productivity and performance by up to 9 percent. Poor air also costs families immensely in healthcare. In the city of Riverside, a single episode of bronchitis symptom costs $972 to address. Incidence such as these cost Riverside families $4,008 annually, which is 7 percent of the median household income. In total, asthma costs attributable to traffic-related pollutants cost the city of Riverside almost $8.5 million annually.

Introduction

Poor air quality continues to be a major problem in the Inland Empire and poses a major health threat to residents. In California specifically, poor air quality continues to be a persistent problem due to the state's natural topography. Mountain ranges and valleys cause atmospheric inversions, which traps pollutants in a concentrated environment.[1] Furthermore, the increasing industrialization of Southern California is contributing to rising air pollution levels. Evidence indicates that a growing economy is associated with elevated air pollution levels and mobile source pollutants, with every 1 percent increase in trucking-sector employment associated with an increase of 0.12 percent, 0.17 percent, and 0.11 percent in COH, CO, and NO_2 levels, respectively.[2] Poor air quality is also an environmental justice issue as most of the burden of air pollution falls onto disadvantaged communities.[3]

[1] Lave, Lester B., and Eugene P. Seskin. "Air Pollution and Human Health." 2013, https://doi.org/10.4324/9781315064451.
[2] Davis, Mary E. "Recessions and Health: The Impact of Economic Trends on Air Pollution in California." *American Journal of Public Health*, vol. 102, no. 10, 2012, pp. 1951–1956., https://doi.org/10.2105/ajph.2012.300658.
[3]Anderson, Christa M., et al. "Climate Change Mitigation, Air Pollution, and Environmental Justice in California." *Environmental Science & Technology*, vol. 52, no. 18, 2018, pp. 10829–10838., https://doi.org/10.1021/acs.est.8b00908.

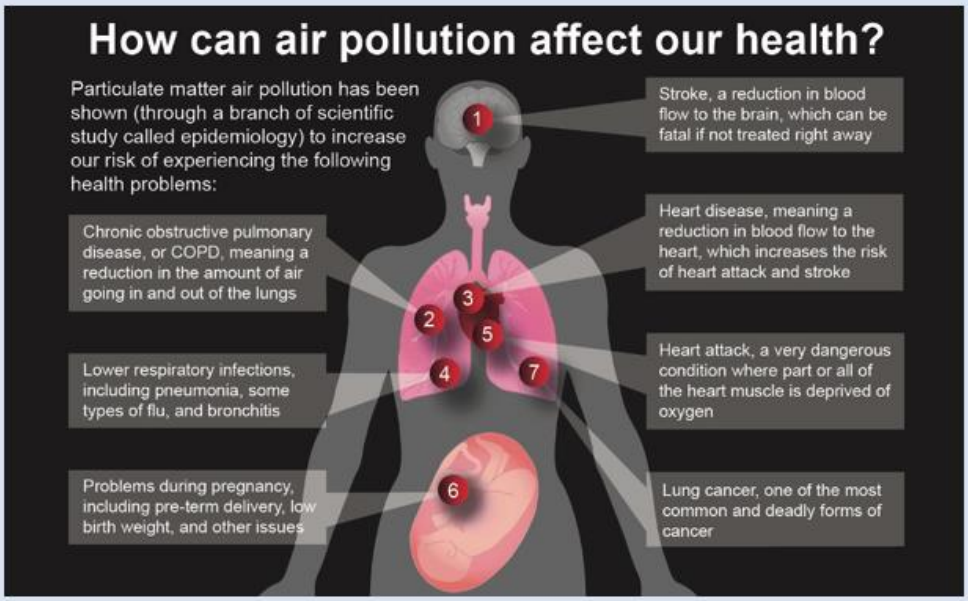

Figure 1: Air pollution affect on human health (Source: NASA)

There is a strong association between air pollution and bronchitis and lung cancer. Evidence also suggests air pollution is correlated with cardiovascular disease and non-respiratory tract cancers.[4] Elderly people, infants, and those with chronic cardiopulmonary disease, influenza, or asthma are most susceptible to mortality and serious morbidity effects from short-term acutely elevated exposures.[5]

[4] Lave et al. (n 1)
[5] Pope, C. Arden. "Epidemiology of Fine Particulate Air Pollution and Human Health: Biologic Mechanisms and Who's at Risk?" *Environmental Health Perspectives*, vol. 108, 2000, p. 713., https://doi.org/10.2307/3454408.

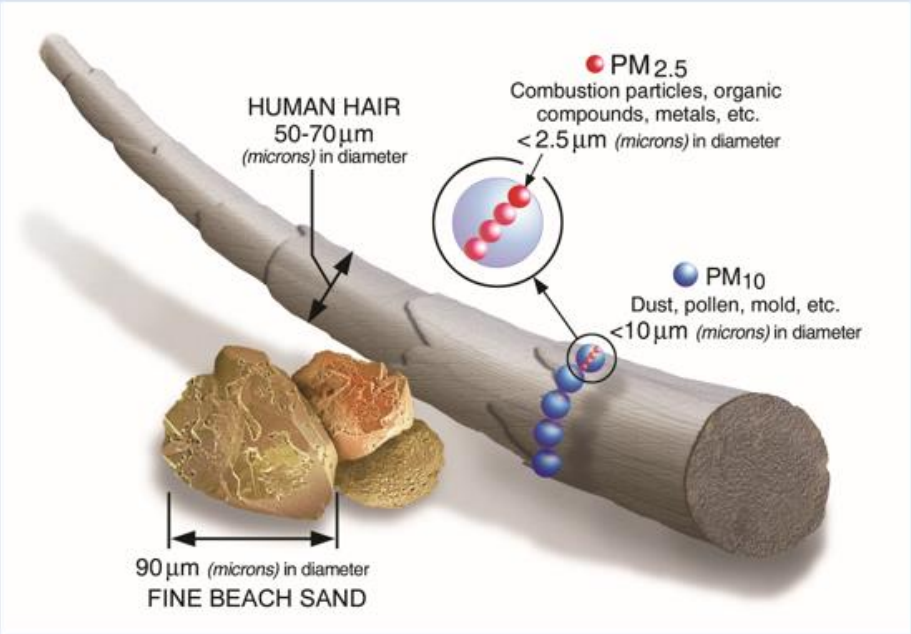

Figure 2: Size Comparison of Air Pollutants (Source: U.S. EPA)

Particle pollution in the atmosphere consists mainly of coarse particles and fine particles. Coarse particles are often naturally occurring and originate primarily from soil and other crustal materials. Fine particles are derived chiefly from combustion processes in transportation, manufacturing, and power generation.[6] These types of particulate matter (PM) tend to be referenced as coarse particulate matter (PM_{10}) and fine particulate matter ($PM_{2.5}$), respectively, with the numbers referencing the diameter of the particles. The finer particles can more easily penetrate lung tissues and indoor environments and transport over longer distances.

The State of Air Quality in the Inland Empire

Counties within the Inland Empire have some of the worst air quality in the United States. The Inland Empire's failure to maintain good air quality can be attributed to two major factors. First, natural wind patterns transport aerosols from Los Angeles to the Inland Empire, and the mountainous topography traps these pollutants in the region. The second major factor is the enormous economic and industrial growth in the region.[7] The Inland Empire's economic hubs are major sources of particulate matter, NO_x, and volatile organic compounds (VOCs), the latter two being major precursors to ozone. The Inland Empire is the only area in the country that still fails to meet the nitrogen oxide (NO_x) National Ambient Air Quality Standard (NAAQS).

[6] *ibid*

[7] Lloyd, Alan C., et al. "Air Quality Management in Los Angeles: Perspectives on Past and Future Emission Control Strategies." *JAPCA*, vol. 39, no. 5, 1989, pp. 696–703., https://doi.org/10.1080/08940630.1989.10466555.

California's 39th Congressional district complies with the NAAQS for both sulfur dioxide and lead as regulated by the U.S. Environmental Protection Agency (EPA), but still fails to meet federal health standards for both $PM_{2.5}$ and ozone.[8]

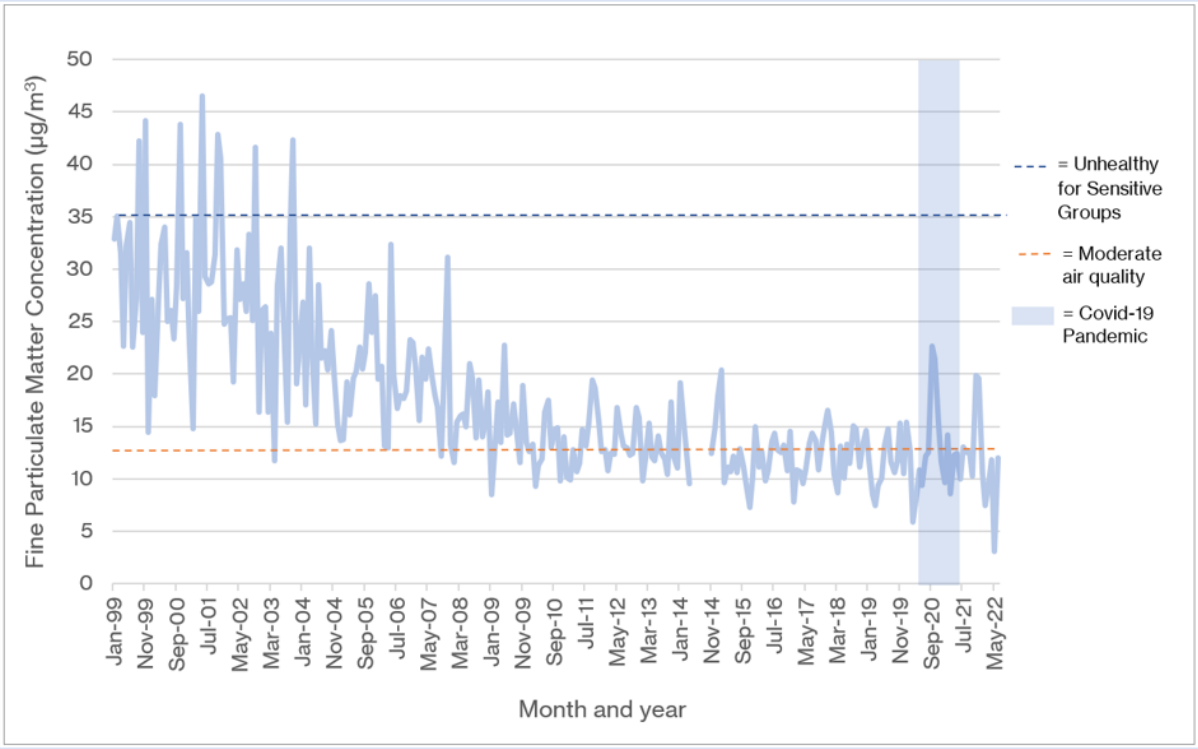

Figure 3: Fine Particulate Matter Concentration in Riverside County 1999-2022 (EPA Sensor: 60658001)

Within the region, $PM_{2.5}$ concentrations have followed national trends and have decreased noticeably since 1999. However, $PM_{2.5}$ concentrations in the region are still substantially higher than they are nationally. Within Riverside, the daily average $PM_{2.5}$ concentration is about 12.91 $\mu g/m^3$ as compared to 7.66 $\mu g/m^3$ nationally as of 2019.[9] Nationwide ozone concentrations have decreased by 16 percent since 2000. However, Riverside has not seen a similar improvement in ozone air quality during that time period.[10]

[8] "Green Book | US EPA." *EPA*, Environmental Protection Agency, 31 Jan. 2023, https://www3.epa.gov/airquality/greenbook/anayo_ca.html.

[9] . Published by Ian Tiseo, and Jun 21. "U.S. PM2.5 Air Pollution Exposure." *Statista*, 21 June 2022, https://www.statista.com/statistics/1137388/united-states-pm25-air-pollution-exposure/.

[10] "Editorial: Port Pollution Is a Crisis. It's Going to Take More than a $20 Container Fee to Fix." *Los Angeles Times*, Los Angeles Times, 26 Oct. 2022, https://www.latimes.com/opinion/story/2022-10-26/port-pollution-surge-pandemic

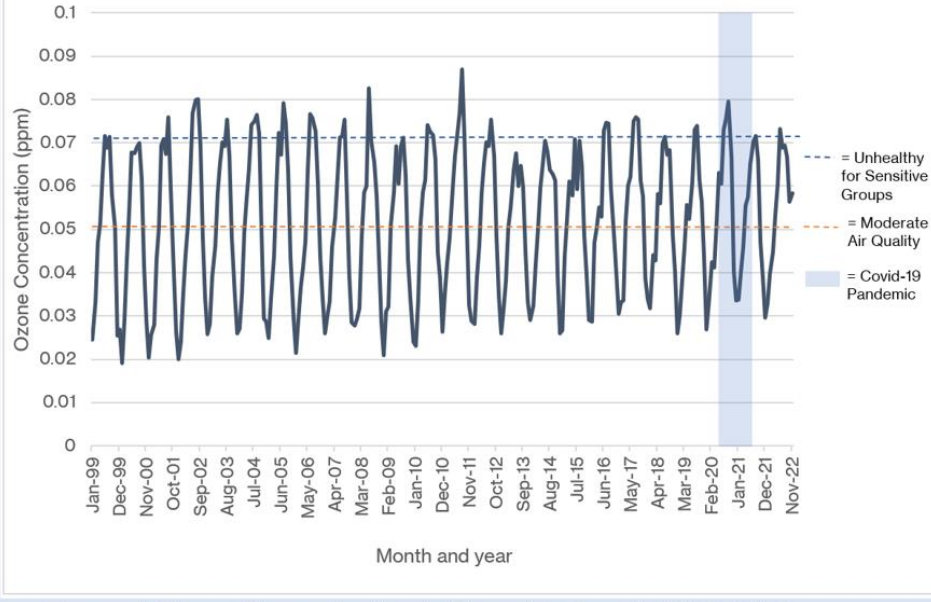

Figure 4: Ozone Concentration in Riverside County 1999-2022 (EPA Sensor: 60658001)

Figures 5 and 6 below model air pollution patterns throughout the year in Riverside. $PM_{2.5}$ concentrations are at a low during the spring months before starting to increase in the summer and early fall. This peak in summer and early fall coincides with California's wildfire season, which are large sources of $PM_{2.5}$. Furthermore, within the district, 30 percent of the total $PM_{2.5}$ mass concentrations are organic carbon and elemental carbon pollutants. These carbon concentrations decrease from September to December due to a decrease in photochemical activity in the region and remain low until the spring season.[11]

[11] Na, Kwangsam, et al. "Primary and Secondary Carbonaceous Species in the Atmosphere of Western Riverside County, California." *Atmospheric Environment*, vol. 38, no. 9, 2004, pp. 1345–1355., https://doi.org/10.1016/j.atmosenv.2003.11.023.

Figure 5: Average Monthly Fine Particulate Matter Concentration by Month in Riverside County 1999-2022 (EPA Sensor: 60658001)

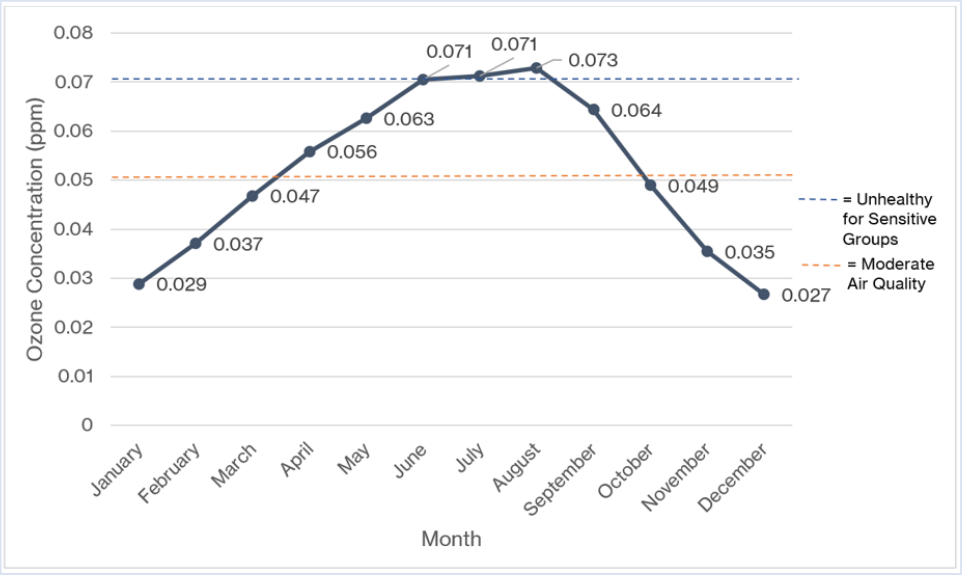

Figure 6: Average Monthly Max Ozone Concentration in Riverside County 1999-2022 (EPA Sensor: 60658001)

Within the district, ozone concentrations tend to peak during the summer months of June, July, and August. As seen in the ozone monitoring data in figure 6, there is a steady increase in ozone concentration from January to June, followed by a steady decrease from August to December. Ozone is formed when heat and sunlight catalyze NO_x and VOCs to undergo chemical reaction. Because of this, ozone more readily forms in hot, dry weather, leading to

higher concentrations during the warmer, summer season. As mentioned above the Inland Empire is the only area in the country that still fails to meet the NO_x NAAQS, further contributing to high levels of ozone in the district.

Overall, within the Inland Empire, outdoor air quality is still a greater issue than indoor air quality. Concentrations of trace elements, such as sulfur, silicon, and iron, and $PM_{2.5}$ tend to be lower indoors relative to outdoors. However, indoor air quality is still of concern since it is abundant within our district's residences and schools, with some trace elements being carcinogenic.[12] Trace elements that derive from combustion-related activities, such as sulfur, nickel, and lead, are more prevalent indoors than elements that arise from crustal elements that resuspend in the air due to erosion and movement activities. Sources of these include indoor cooking appliances, as well as outdoor emissions that can penetrate indoor environments.

Causes of Air Pollution Nationally

EPA has released various reports detailing emission contributions by source category from 1990 to 2014 for various pollutants across the United States.[13] Fuel combustion and industrial processes are the largest source of anthropogenic $PM_{2.5}$ emissions in the two most recent time periods with available data (2011 and 2014).

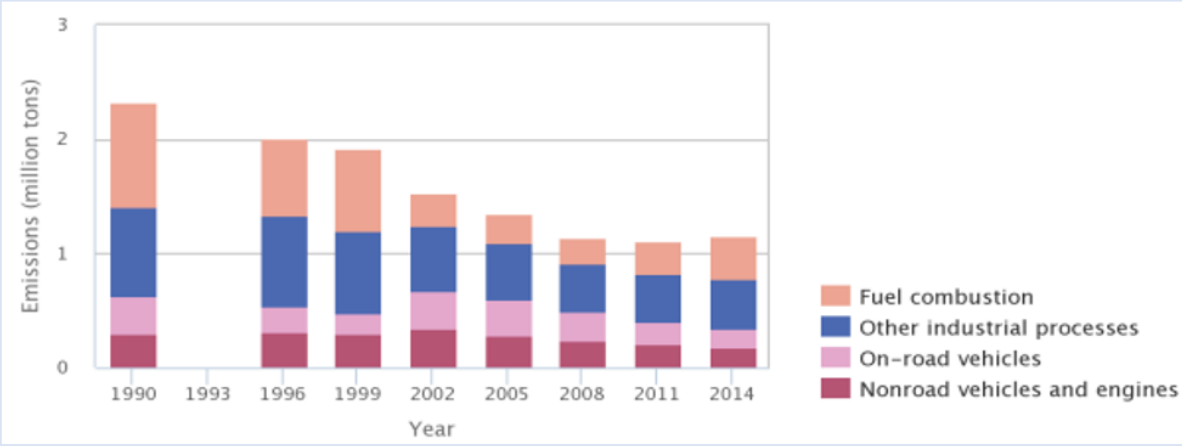

Figure 7: Anthropogenic $PM_{2.5}$ emissions by source category in the U.S. 1990 – 2014 (Source: U.S. EPA)

[12] Na, Kwangsam, et al. "Trace Elements in Fine Particulate Matter within a Community in Western Riverside County, CA: Focus on Residential Sites and a Local High School." *Atmospheric Environment*, vol. 38, no. 18, 2004, pp. 2867–2877., https://doi.org/10.1016/j.atmosenv.2004.02.022.

[13] "Report on the Environment (ROE)." *EPA*, Environmental Protection Agency, 8 Mar. 2018, https://cfpub.epa.gov/roe/indicator.cfm?i=15.

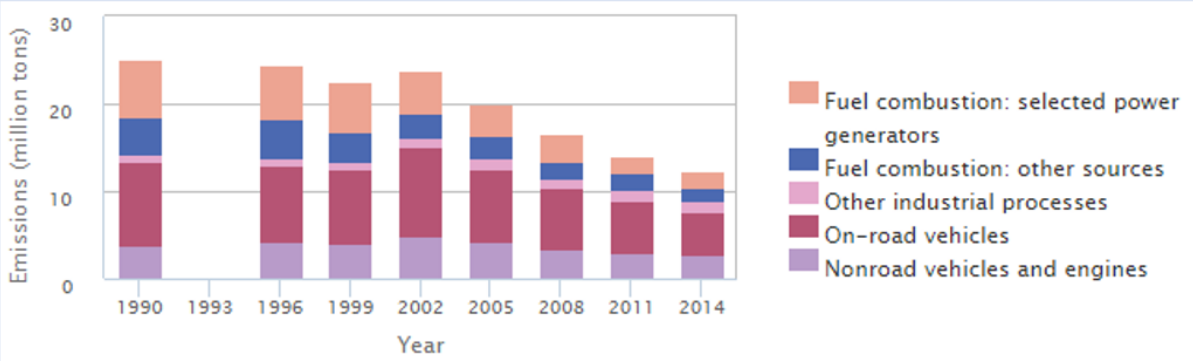

Figure 8: Anthropogenic NO_x emissions by source category in the U.S. 1990 – 2014 (Source: U.S. EPA)

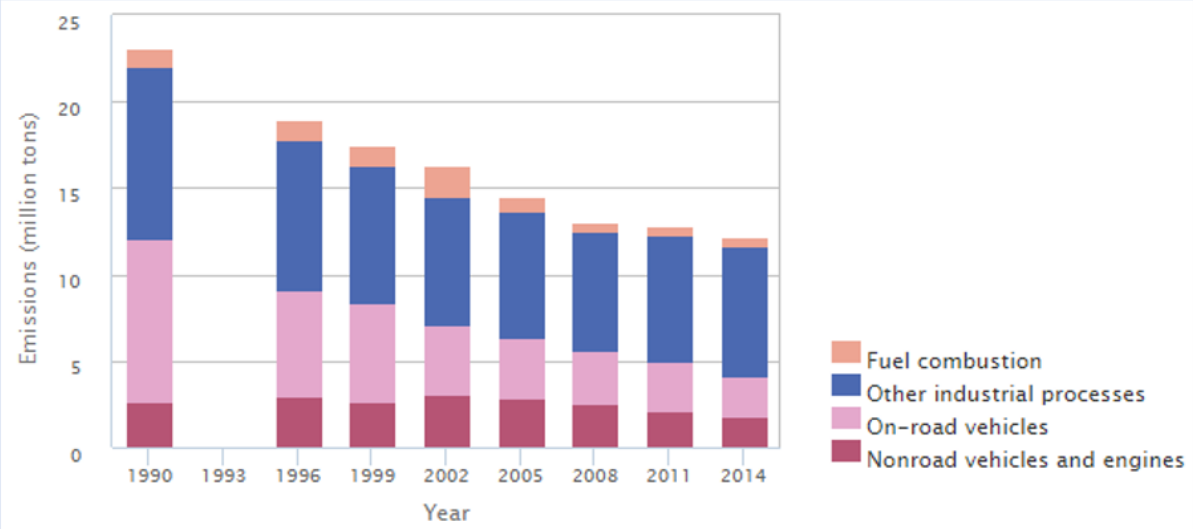

Figure 9: Anthropogenic VOC emissions by source category in the U.S. 1990 – 2014 (Source: U.S. EPA)

Sources of the ozone-precursors NO_xs and VOCs vary slightly in terms of contributions nationally. While NO_x pollution primarily originates from on-road vehicles, VOCs are similar to $PM_{2.5}$ in that a large portion of anthropogenic emissions derive from industrial processes. However, unlike for $PM_{2.5}$, fuel combustion is not a significant emitter of either ozone-precursor. Similar emission sources can be attributed to poor air quality in the district and Inland Empire for these air pollutants.

Cause of Air Pollution in California's 39th Congressional District

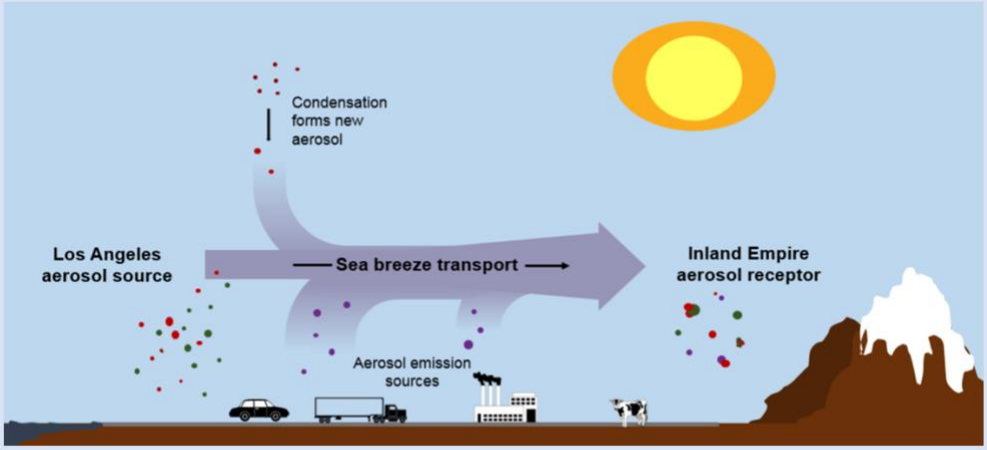

Figure 10: Air Pollution Movement from Los Angeles to the Inland Empire (Source: Taia Sean Wu, UCSF. Wu, 2015)

A large cause of pollution is the westerly sea-breeze that transports aerosols from Los Angeles to the Inland Empire. As the sea breeze transports the pollution, it takes on new particles and the particulate matter evolves. This movement covers about 50 miles and leads to higher pollution concentrations in the Inland Empire compared to the source location.[14] These particles then get trapped and linger in the region due to the natural topography that forms a basin. The port of Los Angeles and the port of Long Beach are major sources of emissions that ultimately travel towards the Inland Empire. The Ports of Los Angeles and Long Beach combined are the busiest port in the nation and the 10th busiest in the world. Activities such as ships travelling in and out of port, loading and unloading, drayage, and trucking activities emit large amounts of particulate matter and NO_x which can end up in the Inland Empire. These emissions also increase substantially during periods of high congestion and shipping activity, most notably during the end-of-year holiday season. As seen in figure 12, $PM_{2.5}$ concentrations at the port on average increases by roughly 20.4 percent from October to December.

As seen in Figure 11, Monthly $PM_{2.5}$ emissions at the ports have decreased since 2003, but still hover around "moderate" air quality. Ozone concentrations also have not changed substantially since 2010, as seen in Figure 13. However, these pollutants are further concentrated when the sea breeze blows it to the district. As such, even though these ports are not in the district, addressing emissions from their activity remains a major avenue for cutting emissions in the Inland region.

[14] Wu, Taia Sean, "Comparing Bulk Aerosol Profiles in the Mixed Layer in Coastal Los Angeles and the Inland Empire" (2015). Scripps Senior Theses. Paper 547. http://scholarship.claremont.edu/scripps_theses/547Lloyd, Alan C., et al.

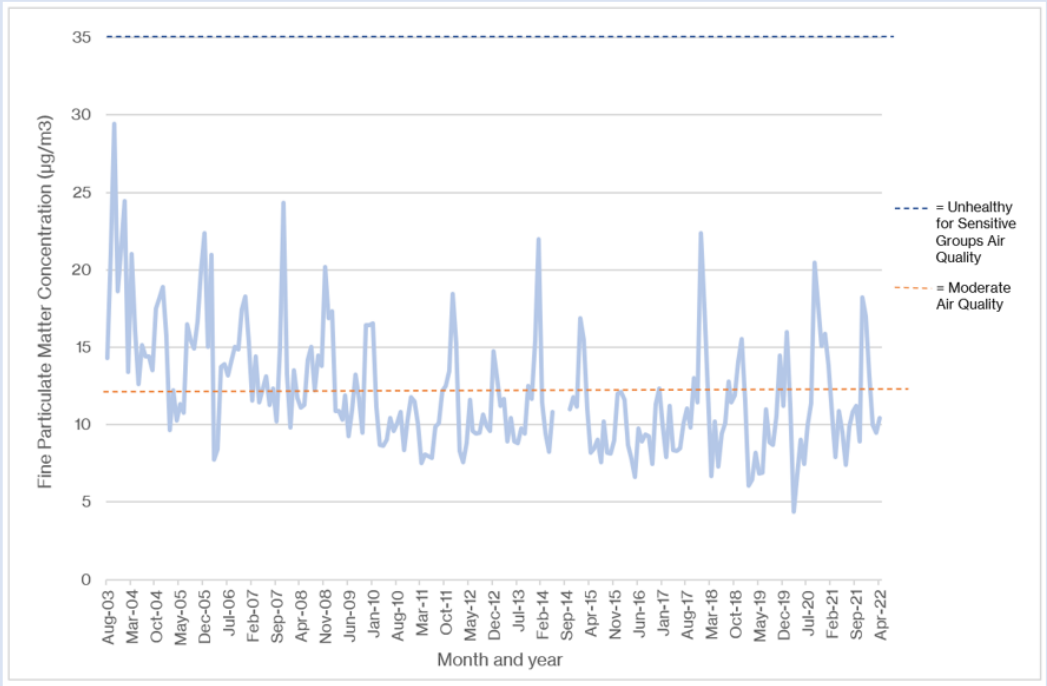

Figure 11: Fine Particulate Matter Concentration at Los Angeles and Long Beach Port 2003-2022 (EPA Sensor: 60374004)

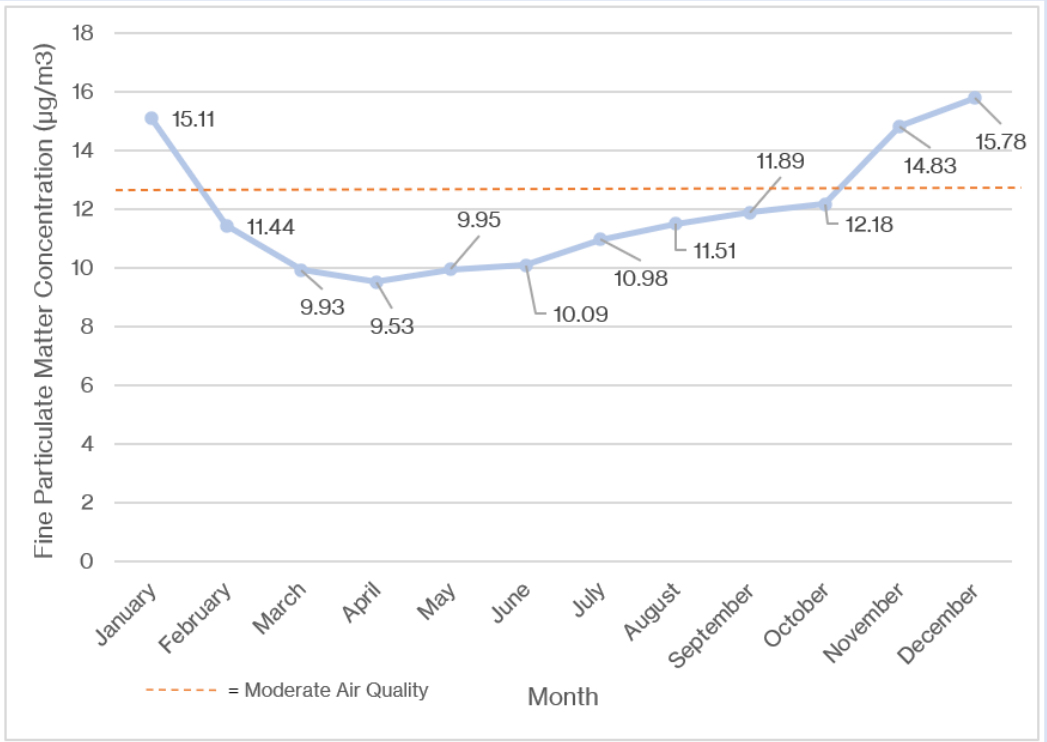

Figure 12: Average Monthly Fine Particulate Matter Concentration at Los Angeles and Long Beach Port 2003-2022 (EPA Sensor: 60374004)

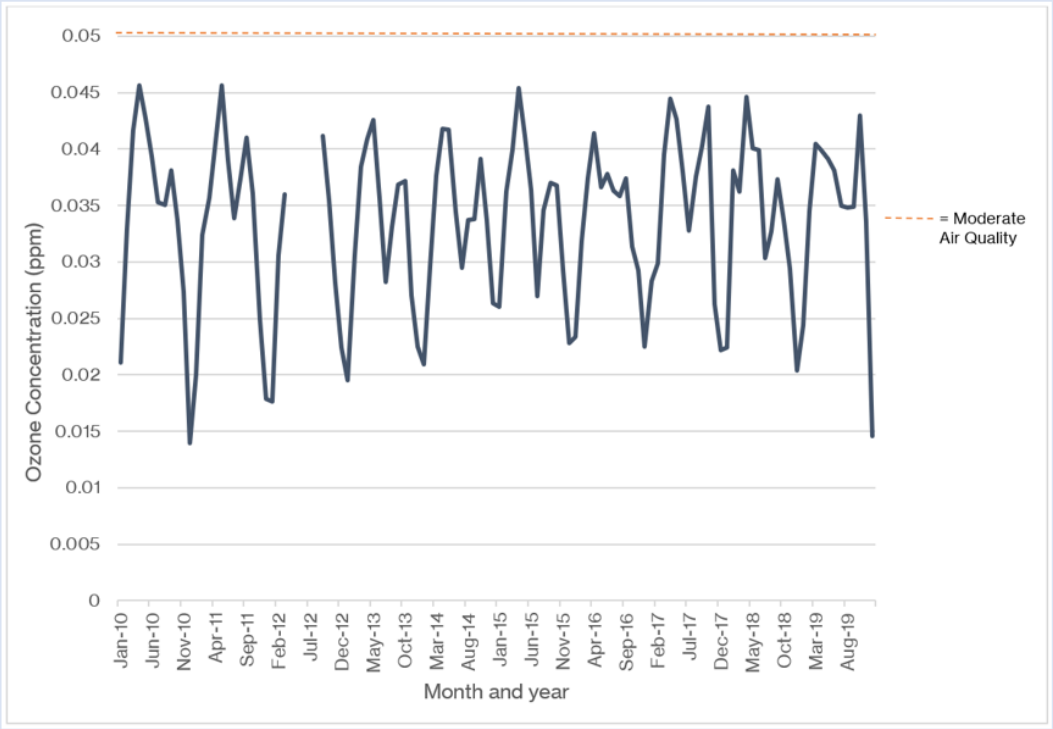

Figure 13: Ozone Concentration at Los Angeles and Long Beach Port 2010-2019 (EPA Sensor: 60374006)

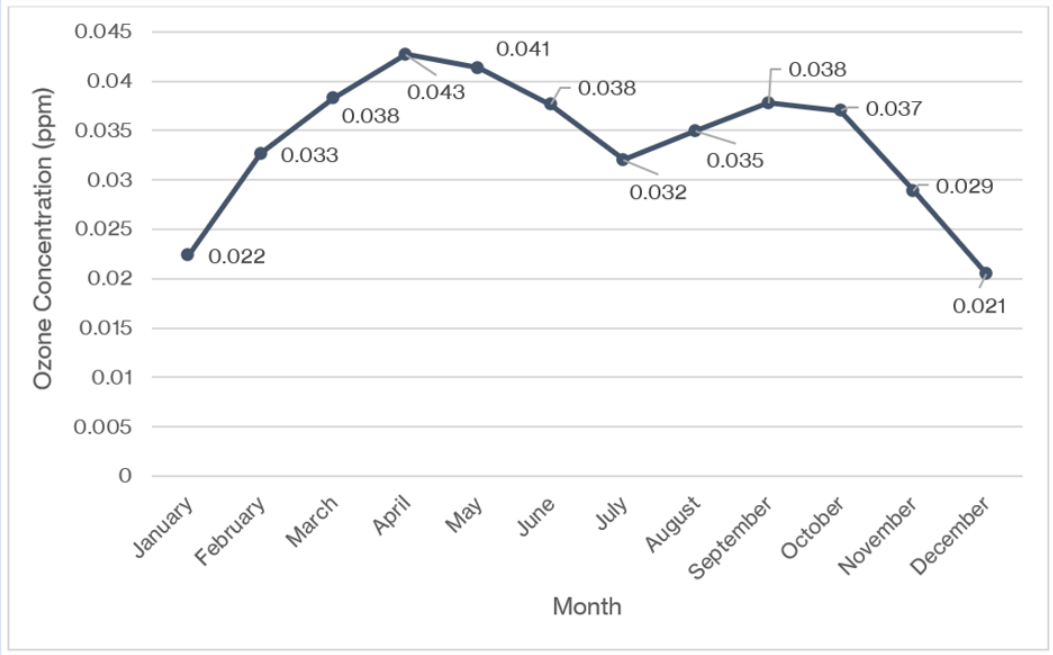

Figure 14: Average Monthly Max Ozone Concentration at Los Angeles and Long Beach Port 2010-2019 (EPA Sensor: 60374006)

In addition to the ports, the enormous economic and industrial growth in the region has led to a decrease in air quality. Human activities, such as gasoline-powered vehicles, diesel-powered vehicles, wood burning, food cooking operations, and soil-related emission sources, such as paved road dust, tire dust, and vehicular brake lining wear constitute about 26 percent of total carbon-based $PM_{2.5}$ emissions by mass.[15] The increasing concentration of warehouses within the city of Riverside has also led to a massive increase in transportation traffic, and thus vehicle emissions. More details on warehouses will be discussed in the next section. Similarly, emissions from power plants required to accommodate the growth in electricity demand in the area contribute to NO_x emissions.

Warehouses

Over the past two decades, more and more open land and farmland in the Inland Empire has been developed into industrial uses, mostly warehouses. In addition to worsening traffic, air pollution, and quality of life in the region, the warehouse industry has created a working environment with health and safety issues, poor workers' right, and little job security as more tasks are outsourced to automated robots. Within the 39th Congressional District, most warehouses are being constructed around the March Air Reserve Base along Interstate 215 between Moreno Valley and Perris and were constructed after 2003.

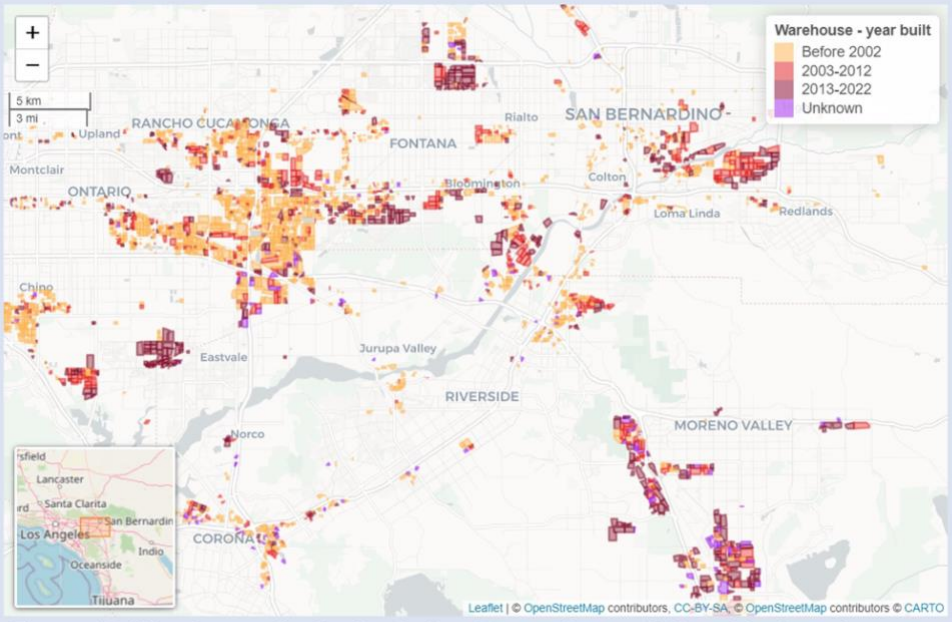

Figure 15: Warehouse distribution in San Bernardino and Riverside Counties. (Sources: Susan A. Phillips, Redford Conservancy at Pitzer College. Michael McCarthy, Radical Research)

[15] Na et al. (n 11)

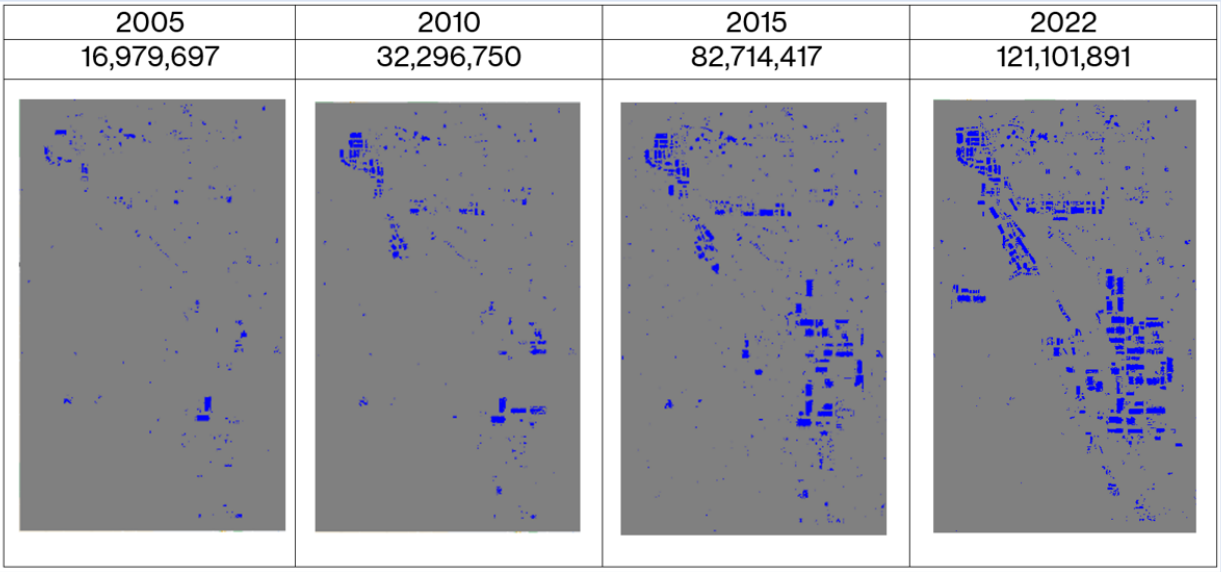

Figure 16: Warehouse Area in the District along Interstate 215 (ft^2)

Using satellite imagery, we can visualize warehouse distribution from 2005 to 2022 and calculate the area that warehouses occupy in the district. In Figure 16, the locations in blue are areas occupied by warehouses and the area in grey are areas that are not. From 2005 to 2022, more than 100,000,000 square feet of warehouse space was constructed along Interstate 215 around the March Air Reserve Base. This growth in warehouse space coincides with the emergence of the region as a distribution center for e-commerce. Today, more than 40 percent of the United States' consumer goods travel through the Inland Empire and sit in local warehouses before they are transported elsewhere. Emissions from these warehouses disproportionately affect communities of color and have led to significant public health challenges for these populations, including an increased risk from COVID-19. The cost of free shipping is being paid for by the families of those in the Inland empire who have developed health problems from the poor air caused by these warehouses.

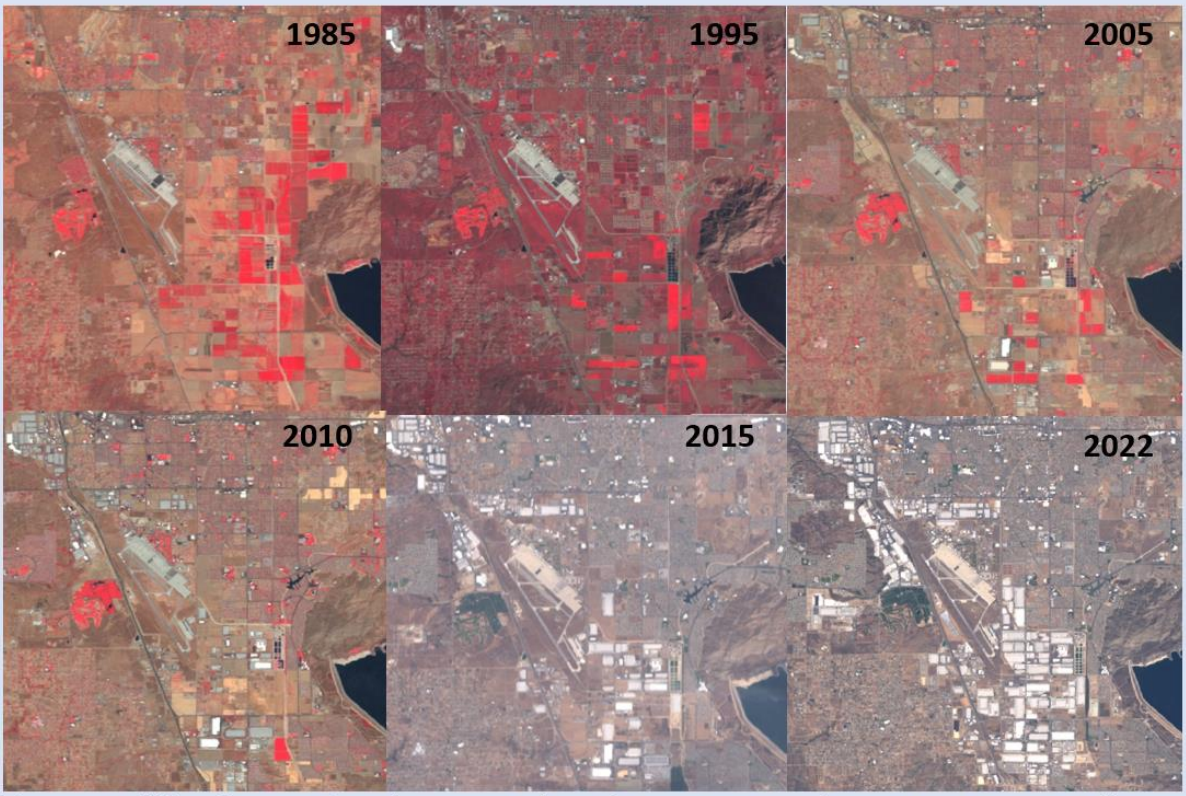

Figure 17: Warehouse Development along Interstate 215 from 1985 to 2022 (Image Source: U.S. Geological Services. Satellites: Landsat 5, Landsat 8).

Impact of Wildfires

In addition to the boom in the warehousing industry, the city of Riverside's air pollution issues are compounded by rampant wildfires that occur between June and October. A 2003 study found that heavy smoke from these wildfires increases PM_{10} and $PM_{2.5}$ concentrations by 160 and 100 micrograms per cubic meter on average, respectively.[16] Levels of pollution directly attributable to wildfires will only increase as the climate continues to change. In 2020, wildfires accounted for up to 25 percent of $PM_{2.5}$ across the US.[17] Specific to the Western United States, from 2004-2009 wildfires were estimated to have contributed 12 percent of the total $PM_{2.5}$[18], but

[16] Wu, Jun, et al. "Exposure Assessment of Particulate Matter Air Pollution Before, during, and after the 2003 Southern California Wildfires." *Atmospheric Environment*, vol. 40, no. 18, 2006, pp. 3333–3348., https://doi.org/10.1016/j.atmosenv.2006.01.056.

[17] Burke, Marshall, et al. "The Changing Risk and Burden of Wildfire in the United States." *Proceedings of the National Academy of Sciences*, vol. 118, no. 2, 2021, https://doi.org/10.1073/pnas.2011048118.

[18] Liu, Jia Coco, et al. "Particulate Air Pollution from Wildfires in the Western US under Climate Change." *Climatic Change*, vol. 138, no. 3-4, 2016, pp. 655–666., https://doi.org/10.1007/s10584-016-1762-6.

in recent years has accounted for up to half of the overall $PM_{2.5}$ exposure in the region.[19] Wildfire contributions are expected to increase by about 160 percent from the 2004-2009 levels by 2051. Furthermore, smoke waves, which are events after wildfires where $PM_{2.5}$ is at least 20 micrograms per cubic meter for two or more consecutive days, are expected to increase in intensity by 31 percent and increase in length by an average of 15 days by 2050 according to current climate change models.[20] This has further ramifications on other public health issues. For example, the 2020 fire season exacerbated COVID-related health problems, as evidence suggests worsened air pollution during peak wildfire season increased COVID-19 cases and deaths in various counties across California.[21] Recent toxicological studies have also suggested that wildfire particulate matter may be up to ten times more toxic than equal doses of ambient $PM_{2.5}$ to the respiratory system and $PM_{2.5}$ from wildfire smoke has led to up to a 10 percent increase in hospital admissions in southern California.[22]

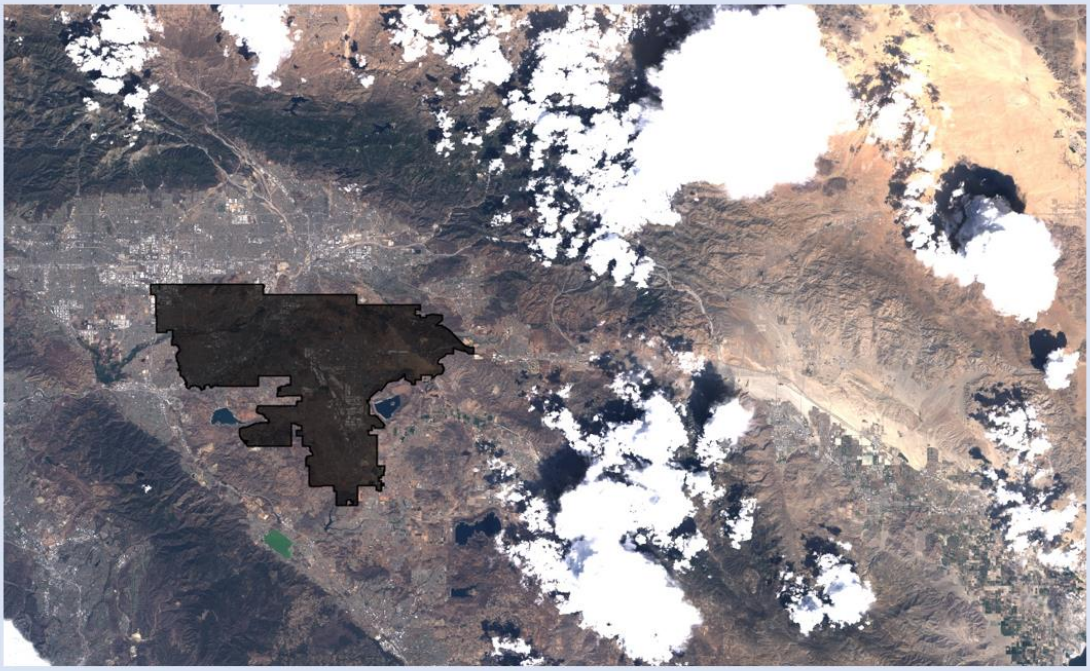

Figure 18: Fairview Fire (9/5/2022 – 10/5/2022). Wildfire smoke surrounds California's 39th Congressional District (outlined in black). Image collected by NASA Satellite Landsat 9 on 9/28/2022 at 11:22 AM.

[19] Liu et al. (n 17)
[20] Liu et al. (n 18)
[21] Naqvi, Hasan Raja, et al. "Wildfire-Induced Pollution and Its Short-Term Impact on Covid-19 Cases and Mortality in California." *Gondwana Research*, 2022, https://doi.org/10.1016/j.gr.2022.04.016.
[22] Aguilera, Rosana, et al. "Wildfire Smoke Impacts Respiratory Health More than Fine Particles from Other Sources: Observational Evidence from Southern California." *Nature Communications*, vol. 12, no. 1, 2021, https://doi.org/10.1038/s41467-021-21708-0.

Year	Total # of fires	Acres burned	Dollar Damage
2008	152	31,025	$97,695,477
2009	158	2,542	$565,250
2010	183	4,548	$53,475
2011	208	2,318	$335,600
2012	172	6,256	$1,494,451
2013	224	49,460	$7,978,346
2014	106	372	$275,802
2015	120	1,256	$35,148
2016	133	2,088	$3,660
2017	211	14,899	$315,015
2018	173	2111	$115,605
2019	190	5,061	$498,090
2020	230	54,556	$380,024,372
2021	198	788	$2,598,441
Total	2,458	177,280	$491,988,732

Figure 19: Fire incidents in Riverside County 2008-2021 (Source: CalFire)

Within the District, the total number of wildfires fluctuate anually. In addition to causing periods of poor air quality, wildfires have caused almost $500 million in damages to Riverside County and have burned almost 200,000 acres between 2008 and 2021. The fire seasons in 2008, 2013, and 2020 were especially damaging years for the county, with each year having more than 30,000 acres of burned land.

Health Repercussions in the Inland Empire

Higher levels of air pollution are linked to the development of various pulmonary and cardiovascular conditions and exacerbate a number of diseases. Most notably, increasing evidence indicates that air pollution contributes to the development of asthma and worsens associated symptoms.[23] The Inland Empire sees a higher rate of asthma compared to the national average. Within Riverside County, 10.6 percent of children and 8.5 percent of adults had asthma

[23] Tiotiu, Angelica I., et al. "Impact of Air Pollution on Asthma Outcomes." *MDPI*, Multidisciplinary Digital Publishing Institute, 27 Aug. 2020, https://doi.org/10.3390%2Fijerph17176212.

in 2018.[24] These rates are greater than the national average in 2018, with 7.5 percent of children and 7.7% of adults nationally having asthma.[25]

Despite higher rates of asthma in the Inland Empire, rates of hospitalization due to asthma are lower in the region than they are nationally. Asthma hospitalization rates in Riverside County in 2018 were 3.2 events per 10,000 people[26], compared to the national average of 5.5 events per 10,000 people.[27] Though there is no clear explanation for this, it can be speculated that residents with symptoms choose not to seek help due to the high financial and time costs associated with treatment.

Evidence also indicates that areas with higher levels of air pollution were more dramatically affected by the COVID-19 pandemic. Public health studies have shown that there is an association between long-term exposure to air pollution and higher COVID-19 mortality rates. One study from the Harvard School of Public Health found that an increase of 1 $\mu g/m^3$ in the long-term average $PM_{2.5}$ is associated with a 11 percent increase in COVID-19 mortality.[28] Such trends can be seen in the Inland Empire. Rates of death due to COVID-19 in Riverside County and San Bernardino County have consistently been equal to or greater than the national average. During the largest volume of cases and hospitalizations between December 2020 and January 2021[29], weekly deaths per 100,000 population peaked at 14.9 and 16.0 for Riverside and San Bernardino County, respectively. This is more than double the national peak of 7.0 weekly deaths per 100,000 population during this same period.[30] Addressing the air quality problem is essential to minimize the impacts of future public health crises; especially those, like COVID-19, where the ailment puts those with underlying heart or lung conditions at greater risk. In November, The Inland Empire saw one of its worst surges of respiratory syncytial virus (RSV),

[24]"California Breathing County Asthma Data Tool." *California Breathing County Asthma Data Tool*, https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/EHIB/CPE/Pages/CaliforniaBreathingCountyAsthmaProfiles.aspx.

[25] "Most Recent National Asthma Data." *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 13 Dec. 2022, https://www.cdc.gov/asthma/most_recent_national_asthma_data.htm.

[26]"California Breathing County Asthma Data Tool." *California Breathing County Asthma Data Tool*, https://www.cdph.ca.gov/Programs/CCDPHP/DEODC/EHIB/CPE/Pages/CaliforniaBreathingCountyAsthmaProfiles.aspx.

[27] "2019 Archived National Asthma Data." *Centers for Disease Control and Prevention*, Centers for Disease Control and Prevention, 6 June 2022, https://www.cdc.gov/asthma/archivedata/2019/2019_archived_national_data.html.

[28]Wu, X., et al. "Air Pollution and Covid-19 Mortality in the United States: Strengths and Limitations of an Ecological Regression Analysis." *Science Advances*, vol. 6, no. 45, 2020, https://doi.org/10.1126/sciadv.abd4049.

[29]Couture, Alexia, et al. "Estimating Covid-19 Hospitalizations in the United States with Surveillance Data Using a Bayesian Hierarchical Model: Modeling Study." *JMIR Public Health and Surveillance*, U.S. National Library of Medicine, 2 June 2022, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC9169704/#:~:text=The%20largest%20peak%20in%20hospitalizations,surveillance%20data%20has%20several%20benefits.

[30] "U.S. Covid Risk & Vaccine Tracker." *Covid Act Now*, https://covidactnow.org/us/california-ca/county/riverside_county/?s=45203271.

overwhelming emergency departments and children's hospitals in the region.[31] RSV infection rates positively correlate with increasing levels of air pollution, further underscoring how poor air quality can exacerbate public health predicaments.[32]

Smog

Air pollution in the district tends to get stuck in the valley due to the natural topography causing temperature inversions, which leads to significant smog issues in the region.[33] The brown haze that is omnipresent in the district during the summer has given the region the nickname "Smog Belt." Since smog is primarily composed of ozone, it is also derived from both sources in Los Angeles and Orange County and industrial emissions from the region's growing warehousing and trucking industry. Daily sea breezes bring smog to Riverside from Los Angeles and Orange County.[34] Smog can lead to varying degrees of crop damage that impacts the agriculture industry in the Inland Empire, such as leaf injury during periods of aggravated air pollution, with gaseous air pollution being the most common cause of plant damage.[35] Smog also directly impacts county growth by decreasing the quality of life and making areas less desirable places to live.[36]

Children Allergies and Effects on Education

Children living in areas with chronic exposure to higher levels of ozone and $PM_{2.5}$ have evidence of more adverse health effects compared with children with lower exposures. Pollutants exacerbate the effects of allergens among those with existing susceptibility[37], but don't initiate allergies.[38] $PM_{2.5}$, NO_2, and soot levels are associated with significant increases in incidences of

[31] Writer, Contributing. "RSV Surge Sending Children to Emergency Rooms in Inland Empire." *Press Enterprise*, Press Enterprise, 6 Nov. 2022, https://www.pressenterprise.com/2022/11/06/rsv-surge-sending-children-to-emergency-rooms-in-inland-empire/.

[32] Nenna, Raffaella, et al. "Respiratory Syncytial Virus Bronchiolitis, Weather Conditions and Air Pollution in and Italian Urban Area: An Observational Study." *Environmental Research*, vol. 158, 2017, pp. 188–193., https://doi.org/10.1016/j.envres.2017.06.014.

[33] Blumenthal, D.L., et al. "Anatomy of a Los Angeles Smog Episode: Pollutant Transport in the Daytime Sea Breeze Regime." *Atmospheric Environment (1967)*, vol. 12, no. 4, 1978, pp. 893–907., https://doi.org/10.1016/0004-6981(78)90028-8.

[34] Bland, Warren R. "Smog monitoring and control in the Los Angeles area: some facts and some implications." (1975).

[35] Middleton, J., J. Kendrick, and H. Schwalm. "Smog in the south coastal area: injury to herbaceous plants in the affected area found to be result of air pollution by gases and aerosols." *California Agriculture* 4.11 (1950): 7-10.

[36] Kahn, Matthew E. "Smog Reduction's Impact on California County Growth." *Journal of Regional Science*, vol. 40, no. 3, 2000, pp. 565–582., https://doi.org/10.1111/0022-4146.00188.

[37] Parker, Jennifer D., et al. "Air Pollution and Childhood Respiratory Allergies in the United States." *Environmental Health Perspectives*, vol. 117, no. 1, 2009, pp. 140–147., https://doi.org/10.1289/ehp.11497.

[38] "Traffic-Related Air Pollution in the Development of Asthma and Allergies during the First Eight Years of Life." *Journal of Asthma*, vol. 47, no. 8, 2010, pp. 949–949., https://doi.org/10.3109/02770903.2010.502377.

asthma.[39] Climate change will only further affect the abundance and properties of bioaerosols as carriers of aeroallergens.[40] Overall, studies have shown an association between long-term exposure to urban air pollution and asthma and allergies, especially for children residing in the same address for 3 or more years.[41]

A 2004 study specifically found that some of these pollutants exist within high schools in Riverside County.[42] Though air pollutants, such as $PM_{2.5}$ and ozone, originate mainly from outdoor emission sources, they are easily able to infiltrate indoor environments, especially if these buildings are near large emission sources. Specifically, combustion-related elements can infiltrate indoor environments more easily than crustal elements. Within the schools in our district, the dominant trace elements all originate from combustion of fossil fuels, such as sulfur, iron, and silicon. Since sources for these emissions do not exist inside most of our schools, these trace elements must have penetrated from the outdoor environments.[43] Concentrations of air pollution are higher inside schools on weekdays than weekends, most likely due to the increase in activity and human traffic on weekdays.[44] Potential health effects of poor indoor air quality on students include headaches, eye and skin irritations, nausea, and fatigue.

It is important that we address this issue not only to protect the health of our children, but also to ensure our students get a quality education. Indoor air quality is a significant predictor of student performance.[45] Increased levels of nitrogen oxides and ozone in schools are linked with a decrease in attendance.[46] Similarly, high levels of air pollutants in indoor environments worsens student concentration[47], and may decrease student productivity and performance by up to 9 percent.[48]

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[39] *ibid*

[40] "Air Pollution and Climate Change Effects on Allergies in the Anthropocene: Abundance, Interaction, and Modification of Allergens and Adjuvants." https://doi.org/10.1021/acs.est.6b04908.s001.

[41] Penard-Morand, C., et al. "Long-Term Exposure to Close-Proximity Air Pollution and Asthma and Allergies in Urban Children." *European Respiratory Journal*, vol. 36, no. 1, 2010, pp. 33–40., https://doi.org/10.1183/09031936.00116109.

[42] Na et al (n 11)

[43] *ibid*

[44] *ibid*

[45]Mohai, Paul, et al. "Air Pollution around Schools Is Linked to Poorer Student Health and Academic Performance." *Health Affairs*, vol. 30, no. 5, 2011, pp. 852–862., https://doi.org/10.1377/hlthaff.2011.0077.

[46]Mendell, M. J., and G. A. Heath. "Do Indoor Pollutants and Thermal Conditions in Schools Influence Student Performance? A Critical Review of the Literature." *Indoor Air*, vol. 15, no. 1, 2005, pp. 27–52., https://doi.org/10.1111/j.1600-0668.2004.00320.x.

[47] U.S. Environmental Protection Agency. 2003. Indoor air quality and student performance. EPA/402/K-03/006. Washington, DC.

[48]Wyon, D. P. "The Effects of Indoor Air Quality on Performance and Productivity." *Indoor Air*, vol. 14, 2004, pp. 92–101., https://doi.org/10.1111/j.1600-0668.2004.00278.x.

Costs of Poor Air Quality

Poor air quality directly affects various economic sectors. Air pollution costs the U.S. roughly 5 percent of its yearly gross domestic product in damages, with most of the costs coming from pre-mature deaths. These damages mainly affect manufacturing, agriculture, utilities, and transportation.[49]

In terms of health, welfare costs from premature deaths due to air pollution in the United States is projected to go from $440 billion in 2015 to $1.1 trillion in 2060.[50] Outside of premature deaths, the symptoms that arise from polluted air have large cost consequences for local communities since they also cause non-fatal cardiovascular and respiratory conditions.[51] In the city of Riverside, a single episode of bronchitis symptom costs $972 to address. Incidence such as these cost Riverside families $4,008 annually, which is 7 percent of the median household income. In total, asthma costs attributable to traffic-related pollutants cost the city of Riverside $8.5 million annually .[52] From 2005-2007, 329 hospital admissions and Emergency Room visits were due to air pollution in excess of federal standards at the Riverside Community Hospital.[53] Overall, in California during this same time period, 29,808 hospital and emergency room visits were caused by air pollution not meeting federal clean air standards, costing healthcare payers $193,100,184.[54] Urban aerosol is linked to cardiovascular and respiratory illnesses, with the toxicity of such pollution generally increasing with decreasing aerosol pollution diameters.[55] In 2008, it was estimated that exposure to ozone and fine particulate matter ($PM_{2.5}$) could be linked to 432 and 721 deaths in San Bernardino and Riverside, respectively. Furthermore, it was estimated that the total cost of $PM_{2.5}$ health-related impacts across the South California Air Basin was $13.06 billion in 2008.[56]

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[49] "How Much Does Air Pollution Cost the U.S.?" *Stanford Earth*, https://earth.stanford.edu/news/how-much-does-air-pollution-cost-us.

[50] Lanzi, E. "The economic consequences of outdoor air pollution. Organization for Economic Cooperation and Development." (2016).

[51] "Health Effects and Costs of California Smog." *Energy Blog*, https://sites.uci.edu/energyobserver/2018/01/29/health-effects-and-costs-of-california-smog/.

[52] Brandt, Sylvia J., et al. "Costs of Childhood Asthma Due to Traffic-Related Pollution in Two California Communities." *European Respiratory Journal*, vol. 40, no. 2, 2012, pp. 363–370., https://doi.org/10.1183/09031936.00157811.

[53] Romley JA, Hackbarth A, and Goldman, DP, The Impact of Air Quality on Hospital Spending, Santa Monica, Calif.: RAND Corporation, TR-777-WFHF, 2010 (http://www.rand.org/pubs/technical_reports/TR777/).

[54] Murphy, J.J., et al. "The Cost of Crop Damage Caused by Ozone Air Pollution from Motor Vehicles." *Journal of Environmental Management*, vol. 55, no. 4, 1999, pp. 273–289., https://doi.org/10.1006/jema.1999.0256.

[55] Wu (n 14)

[56] Stewart, Devoun R, et al. "Linking Air Quality and Human Health Effects Models: An Application to the Los Angeles Air Basin." *Environmental Health Insights*, vol. 11, 2017, p. 117863021773755., https://doi.org/10.1177/1178630217737551.

High levels of ground-level ozone not only affect human health but also damages crops, forests, and structural materials.[57] In terms of agriculture, high levels of pollutants reduce crop yields and affect agricultural productivity by decreasing the efficiency of photosynthesis. Ozone alone is responsible for 90 percent of U.S. crop losses attributable to air pollution. In 1990, anthropogenic ozone caused between $2.8 and $5.8 billion in damages to major grains in the United States, with ozone from motor-vehicle emissions responsible for $2.0 to $3.3 billion of the damages.[58]

Outside of agriculture and health, there is an effect on education and work productivity. From 2005-2007, there were 1.26 million school absences costing $106 million in the South Coast Basin, which includes Riverside and San Bernardino County. There were also 2 million days of respiratory symptoms in children. For adults, there were 3.5 million days of reduced activity and 470,000 lost days of work.[59]

Congressional Action to Improve Air Quality

The federal government has passed various policies to improve the air quality of the United States. The Air Pollution Control Act of 1955, Clean Air Act of 1963, and Air Quality Act of 1967 provided funding for research into air pollution and established federal programs to monitor and control poor air quality. Congress then established the Clean Air Act of 1970 to overhaul the federal government's role in air pollution control. This legislation authorized the development of comprehensive federal and state regulations to limit emissions from industrial and mobile sources. The National Environmental Policy Act then created the EPA to implement the various programs and requirements included in the Clean Air Act. Two major amendments to the Clean Air Act were also adopted in 1977 and 1990. The 1977 amendments established major permit review requirements to ensure attainment and maintenance of the NAAQS. The 1990 Amendments then substantially increased the authority and responsibility of the federal government by establishing new regulatory programs to control acid rain and further expanding provisions pertaining to attainment and maintenance of NAAQS.

The EPA still provides grants and funding for research that studies air pollution and their sources to best inform policy. Notably, the EPA has awarded grants to the University of California Riverside to study the contributions of sources of pollutions to air quality challenges, such as a $780,000 one in 2020. The Inflation Reduction Act that passed in 2022 also has funding for air monitoring programs.

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[57] *ibid*
[58] Murphy, J.J., et al. "The Cost of Crop Damage Caused by Ozone Air Pollution from Motor Vehicles." *Journal of Environmental Management*, vol. 55, no. 4, 1999, pp. 273–289., https://doi.org/10.1006/jema.1999.0256.
[59] "Health Effects and Costs of California Smog." *Energy Blog*, https://sites.uci.edu/energyobserver/2018/01/29/health-effects-and-costs-of-california-smog/.

Congress has also passed various renewable and clean energy policies that reduce the danger posed by air pollution in the district by decreasing the prevalence and usage of fossil fuels. The 1992 Energy Policy Act created a renewable energy production tax credit that rapidly expanded wind energy industry. Similarly, the 2020 omnibus package included funding for the development and deployment for clean energy technologies and clean energy tax incentives. The Inflation Reduction Act also invests $369 billion to helping build a clean energy economy.

Conclusions and Potential Solutions

Overall, while air quality has improved dramatically since the 1990s in the Inland Empire, more work still needs to be done to improve environmental conditions. As of 2022, the district still contains some of the highest average levels of $PM_{2.5}$ and ozone in the nation. This high level of air pollution has significant economic and health costs in the region. Poor air quality impedes further county development and population growth, damages agricultural outputs, and increases hospital admissions. The increase in warehouses and economic productivity in the region has halted progress in decreasing air pollution. The challenge is further exacerbated by the increase in wildfire frequency in Southern California.

There are various policy avenues that could be taken to improve the air quality. Measures to increase the sequestration of organic carbon formed during photochemical activities could lead to a perceptible drop in $PM_{2.5}$ concentrations.[60] Climate change mitigation policies can also have significant co-benefits for air quality, mostly from reduced reliance on fossil fuels in the energy and transportation sector.[61] Decelerating the development of warehouses in the Inland Empire would also reduce the addition of emission sources and allow more time for air quality-improving policies to be implemented.

Moreover, the EPA can adjust their approach regarding the prevalence of wildfires when designating areas for attainment with the NAAQS under the Clean Air Act. Currently, days with heavy air pollution can be excluded when evaluating whether an area attains the NAAQS if local governments demonstrate this pollution was caused by wildfires. However, this approach appears at odds with the transboundary nature and growing contribution of wildfire smoke to air quality challenges.[62]

Furthermore, given that part of the air quality issue in the Inland Empire is a result of sea breeze transporting emissions from Los Angeles, a broader regional approach is needed. The present approach is fragmented into county-operated air pollution control districts.[63] Improving

[60] Na. et al. (n 11)
[61] Anderson, et al (n 3)
[62] Burke, et al (n 17)
[63] Bland and Warren, (n 34)

coordination and communication between these districts would allow policymakers to better address transboundary air pollution. Aggressive policies to reduce emissions from the Ports of Los Angeles and Long Beach would also lead to noticeable improvements in air quality in the Inland Empire. More funding towards these ports environmental goals could help ensure they meet their zero-emission operation goals. These funds could be directed from the bipartisan infrastructure law or Inflation Reduction Act. Currently, the ports have pledged to have zero-emission cargo-handling equipment by 2030[64] and zero-emission trucking by 2035[65], but it is unlikely these goals will be met given the present slow rate of transition.

Efforts to reduce emissions from the ships themselves can also be pursued. These could be stricter regulations on the types of fuels shipping companies can use or further investment into the research and development of cleaner, fuel substitutes. Notably, hydrogen energy is seen as a potential zero-emission substitute for large transportation ships when the technology improves and costs go down. Lastly, setting federal standards for how far out ships must anchor while waiting to unload their cargo at the port could significantly reduce the emissions that are blown into the district. This would be especially impactful during periods of high congestion and increased shipping activity.

[64] Munguia, Hayley. "Ports Work toward 2030 Goal for Full Fleet of Zero-Emission Cargo Equipment." *Long Beach Business Journal*, 19 Sept. 2022, https://lbbusinessjournal.com/news/ports-work-toward-2030-goal-for-full-fleet-of-zero-emission-cargo-equipment/.

[65] "Decarbonizing Ports: Zero Emission Trucks as-a-Service Models." *ENGIE Impact*, https://www.engieimpact.com/insights/accelerate-port-decarbonization#:~:text=Ports%3A%20Air%20Quality%20and%20Sustainability%20in%20Focus,-The%20Port%20of&text=However%2C%20to%20fully%20address%20their,instrumental%20to%20achieving%20their%20ambitions.

Glossary

Clean Air Act: A comprehensive federal law passed in 1970 that regulates air emissions.

Climate Change: The long-term shifts in temperatures and weather patterns.

Inland Empire: An urban and metropolitan area in Southern California centered around the cities of San Bernardino and Riverside, and bordering Los Angeles County to the west.

National Ambient Air Quality Standard (NAAQS): Limits on ambient concentrations of six pollutants that cause smog, acid rain, and other health hazards. These were established by the U.S. Environmental Protection Agency under authority of the Clean Air Act.

Nitrogen Oxide (NO_x): A group of poisonous and highly reactive gases that are primarily emitted from vehicle exhaust.

Ozone: A pale blue gas that is harmful to breathe since it is highly reactive and damaging to living cells. Ozone is an important component of smog.

Particulate matter (PM): a general term used to describe microscopic solids or liquids that can be inhaled and cause health problems.

Smoke waves: Events after wildfires where $PM_{2.5}$ concentrations are at least 20 micrograms per cubic meter for two or more consecutive days.

South Coast Basin: One of several regional air basin areas designed by the state of California for the purpose of air quality management. This district includes Orange, Los Angeles, Riverside, and San Bernardino Counties.

The District: Referring to California Congressional District represented my Congressman Mark Takano. The district is in western Riverside County and includes the cities of Moreno Valley, Perris, and Riverside.

Trace Elements: a chemical element that is present only in small amounts.

U.S. Environmental Protection Agency (EPA): Executive government agency that protects people and the environment from significant health risks and enforces environmental regulations.

Volatile organic compounds (VOC): A group of organic chemicals that include any compound of carbon. Notably, VOCs undergo photochemical reactions that contribute to ozone formation.

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