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Practicum Project: Air Pollution Mapping

Executive Summary

The primary objective of this project is to compile comprehensive localized air pollution data from diverse sources, enabling the identification of sensitive receptor (people or other organisms that may have a significantly increased sensitivity or exposure to contaminants by virtue of their age and health) locations such as parks, hospitals, schools, daycare facilities, elderly housing, and medical facilities. The culmination of this data facilitates the creation of a [base map](#), which, in turn, underpins Rise South City's forthcoming project - an interactive platform designed for community engagement. Moreover, it holds the potential to lay the groundwork for the integration of community input into the planning and execution of future projects, thereby fostering a more inclusive and responsive approach to air quality challenges within the community. This project could provide a significant step towards improving air quality, promoting community involvement, and achieving sustainable progress in the region.

Introduction

Rise South City is a nonprofit organization in South San Francisco that aims to create a new center of gravity in the climate movement. At its core, the organization concentrates on the intersection of climate and social equity issues, striving to foster meaningful dialogues with communities on the frontlines of these challenges. Their overarching goal is to bring together frontline communities, allies, and organizations, fostering resilient, regenerative, and equitable neighborhoods. One of Rise South City's ongoing projects is air quality monitoring, particularly in the development of ambient (outdoor) monitoring networks.

The community Rise South City strikes to serve is South San Francisco. The City of South San Francisco is located on the San Francisco Peninsula in San Mateo County, about 2.5 miles away. It encompasses approximately 5,000 acres and has a population of 73,328 people. The racial makeup of South San Francisco is 37.3% White, 2.6% African American, 0.6% Native American, 36.6% Asian, 1.7% Pacific Islander, 15.1% from other races, 6.1% from two or more races as of 2022. The city is home to Genentech, one of the world's largest biotech companies, as well as a satellite office of Amgen, the



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world's largest biotech firm. However, Eastern part of the city is considered as a disadvantaged community under Senate Bill 535¹.

Through the Environmental Policy and Management Master's program at UC Davis, I was placed as a Graduate Student Researcher to work with Rise South City. Our objective was to create an air quality vulnerability map that provides an initial overview of pollution intensity, spatial distribution, and the current location of sensitive receptors. The map provides layers of sensitive receptor locations and high-risk areas of air pollution, incorporating data from sources such as industry emissions and on-road pollutants for the city of South San Francisco. This map serves to highlight the significance of an ambient monitoring network.

Motivation

Sensitive receptors are people that are more sensitive to contaminants due to their age, health, or health status. For example, children, the elderly, and people with illnesses are considered sensitive receptors. Sensitive receptor locations may include hospitals, schools, and day care centers, and other locations determined by the air district board or California Air Resources Board.

According to EPA, the average American spends 93% of their life indoors². However, gathering locations, despite their social and recreational benefits, can sometimes be pollution hotspots in disadvantaged communities. Factors such as proximity to industrial areas, heavy traffic, and lack of green infrastructure may expose these areas to higher levels of air pollution. In this context, ensuring equitable access to clean and safe outdoor spaces becomes paramount, particularly for vulnerable populations like sensitive receptors. Efforts to address these challenges should involve a holistic approach that integrates urban planning, air monitoring, and community engagement. By understanding the specific needs and concerns of disadvantaged communities, policymakers and stakeholders can implement measures that mitigate pollution, enhance green infrastructure, and ensure that these gathering locations remain vibrant, healthy, and inclusive spaces for all residents.

¹ California Office of Environmental Health Hazard Assessment, "SB 535 Disadvantaged Communities," oehha.ca.gov, 2022, <https://oehha.ca.gov/calenviroscreen/sb535>.

² U.S. Environmental Protection Agency, "Report to Congress on Indoor Air Quality: Volume II - Assessment and Control of Indoor Air Pollution," 1989.



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One sensitive receptor in particular, children, is more at risk compared to others. Centers for Disease Control and Prevention recommends that children ages 3 through 5 years need to be active throughout the day. Children and adolescents ages 6 through 17 need to be active for 60 minutes every day³. Under the Education Code Section 51222, all students in grades 7-12 must receive a minimum of 400 minutes of physical education every 10 school days⁴. In most cases PE classes and sports take place outside on playground and fields. Additionally, many pediatricians have cited that children are more active outdoors than indoors. Spending outdoor time to increase activity has numerous benefits, such as enhanced motor development, reduced obesity rates, and decreased risk of myopia (nearsightedness). Sun exposure in a safe manner also aids in the production of essential vitamin D required for maintaining overall health and strength⁵.

In addition to supporting recreational activities for children, outdoor spaces often host a myriad of events, ranging from local festivals and concerts to sports tournaments and community fairs. This multifunctional nature enhances their significance in the lives of residents, creating an environment that facilitates both leisure and engagement. As these spaces become hubs of social exchange, they foster a sense of belonging and shared identity among community members.

3 Centers for Disease Control, "How Much Physical Activity Do Children Need?," April 7, 2022, <https://www.cdc.gov/physicalactivity/basics/children/index.htm#:~:text=60%20minutes%20or%20more%20of>.

4 "Courses of Study, Grades 7 to 12," 51222 § (2019), https://leginfo.ca.gov/faces/codes_displaySection.xhtml?sectionNum=51222.&lawCode=EDC.

5 Danette Glassy and Pooja Tandon, "Playing Outside: Why It's Important for Kids," HealthyChildren.org, 2023, <https://www.healthychildren.org/English/family-life/power-of-play/Pages/playing-outside-why-its-important-for-kids.aspx#:~:text=Children%20and%20teens%20who%20spend>.



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Methodology

To develop this vulnerability map, I conducted: a literature review, four informational interviews, and community air quality mapping of South San Francisco.

Literature Review

I examined relevant California legislation, policies, and regulation that pertain to air pollution mitigation and community development including key elements of AB 617⁶, California Air Resources Board's (CARB) Community Air Grant Program⁷ and Blueprint 2.0⁸.

Informational Interview

For a deeper grasp of CARB's community-oriented air quality initiatives and the implications of AB 617, I conducted interviews with Julia Luongo, CARB Air Pollution Specialist; Cheryl Winfield, CARB Air Resources Engineer; and Sierra Maciorowski, an Executive Fellow at CARB. Throughout our interactions, they shared various resources and assisted me in navigating CARB's archived documents pertaining to air quality and environmental justice.

Vulnerability Air Quality Mapping of South San Francisco

I conducted a spatial analysis and mapped the locations of gathering spots and sensitive receptors. I then overlaid this data with CalEnviroScreen 4.0, roadway PM 2.5 intensity, permitted stationary sources, and oil and gas locations. This allowed me to identify high-risk areas within disadvantaged communities. Based on my preliminary analyses, a few locations of sensitive receptor sites, including childcare, nursing homes, schools, and community parks, within areas with high CalEnviroScreen scores and situated in regions with high pollution levels are pointed out by black arrows. Below is a list of data sources used to perform the spatial analysis. An extensive list is provided in Appendix A.

6 Cristina Garcia, "Non Vehicular Air Pollution: Criteria Air Pollutants and Toxic Air Contaminants,," Pub. L. No. 617 (2017), https://leginfo.ca.gov/faces/billNavClient.xhtml?bill_id=201720180AB617.

7 California Air Resources Board, "Community Air Protection Program Communities | California Air Resources Board," WW2.ARB.CA.GOV, accessed August 2, 2023, <https://ww2.arb.ca.gov/capp-communities>.

8 California Air Resources Board's Office of Community Air Protection, "Draft Blueprint 2.0," June 2, 2023, chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://ww2.arb.ca.gov/sites/default/files/2023-07/DRAFT_BP2.0_Intro_Pt1_ENG.pdf.



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Data Sources:

- Point pollutants sources were collected from Bay Area Air Quality Management District's (BAAQMD) Stationary Source Screening Map⁹
- City facilities data were collected from City of South San Francisco Open Data Portal¹⁰
- Oil and gas wells were collected from California Department of Conservation's California State Geoportal¹¹
- Hospital, nursing homes, childcare centers, early learning and care sites, K-12 public schools, colleges, and university locations were collected from Homeland Infrastructure Foundation-Level Data (HIFLD)¹²

Result

Pollution sources considered in the map are permitted stationary sources, highway/road traffic, and oil/gas well. With the South San Francisco boundary, there is one oil/gas well that does not have a major effect on the overall air quality. However, 243 records of permitted stationary sites are found within the city with majority of them located in high-scored CalEnviroScreen (zip code: 94080) region to the east of the city.

Statistical Analyses

With available information, I conducted statistical analyses of permitted stationary source cancer risk, chronic hazard index and PM 2.5 to further examine the health impact of these (Table 1). Additionally, highway/road traffic also significantly affects air quality east of South San Francisco. The PM 2.5 values in the U.S. Route 101 could fall between 2.582-7.381 and disperse outward. Although the pollution level may not exceed the state regulation thresholds, it is still relatively high compared to communities west to the U.S. Route 101. A brief description of cancer risk, chronic hazard index, and PM 2.5 is provided below.

9 Bay Area Air Quality Management District, Header Controller Stationary Source Screening Map, 2023, <https://baaqmd.maps.arcgis.com/apps/webappviewer/index.html?id=845658c19eae4594b9f4b805fb9d89a3>.

10 City of South San Francisco, City Facilities, 2019, Data-South City.open data.arcgis.com, 2019, <https://data-southcity.opendata.arcgis.com/datasets/southcity::city-facilities/explore?location=37.656780%2C-122.431670%2C14.89>.

11 California Department of Conservation, WellSTAR: Oil and Gas Wells, 2022, 2022, <https://gis.data.ca.gov/datasets/cadoc::wellstar-oil-and-gas-wells/explore?location=37.085174%2C-119.581050%2C7.13>.

12 SGC Transformative Climate Communities Program, "Round 5 Final Program Guidelines," February 28, 2023, https://sgc.ca.gov/programs/tcc/docs/20230308-TCC_R5_Guidelines.pdf.



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Table 1: Cancer Risk, Chronic Hazard Index and PM 2.5 Statistics

	Cancer Risk	Chronic Hazard Index	PM 2.5
Number of records	243	243	243
Minimum	0	0	0
Maximum	593.61	1.59	51.56
Average	19.1	0.04	0.57
Standard deviation	59.61	0.16	4.21

Definition:

- Cancer Risk: Cancer risk (in millions) is estimated using conservative assumptions aggregated from all permitted sources related to the facility.
- Chronic Hazard Index: Chronic hazard (unitless) estimated using conservative assumptions if the facility emits toxic air contaminants (TACs) with assigned chronic reference doses. A Chronic hazard value less than or equal to 1 indicates that adverse effects are not likely to occur, and considered to have negligible hazard.
- PM2.5: Conservatively estimated annual PM2.5 concentrations assigned to the facility in units of micrograms per cubic meter ($\mu\text{g}/\text{m}^3$). Most studies indicate PM2.5 at or below $12 \mu\text{g}/\text{m}^3$ is considered healthy with little to no risk from exposure.



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Vulnerable Sensitive Receptor Location

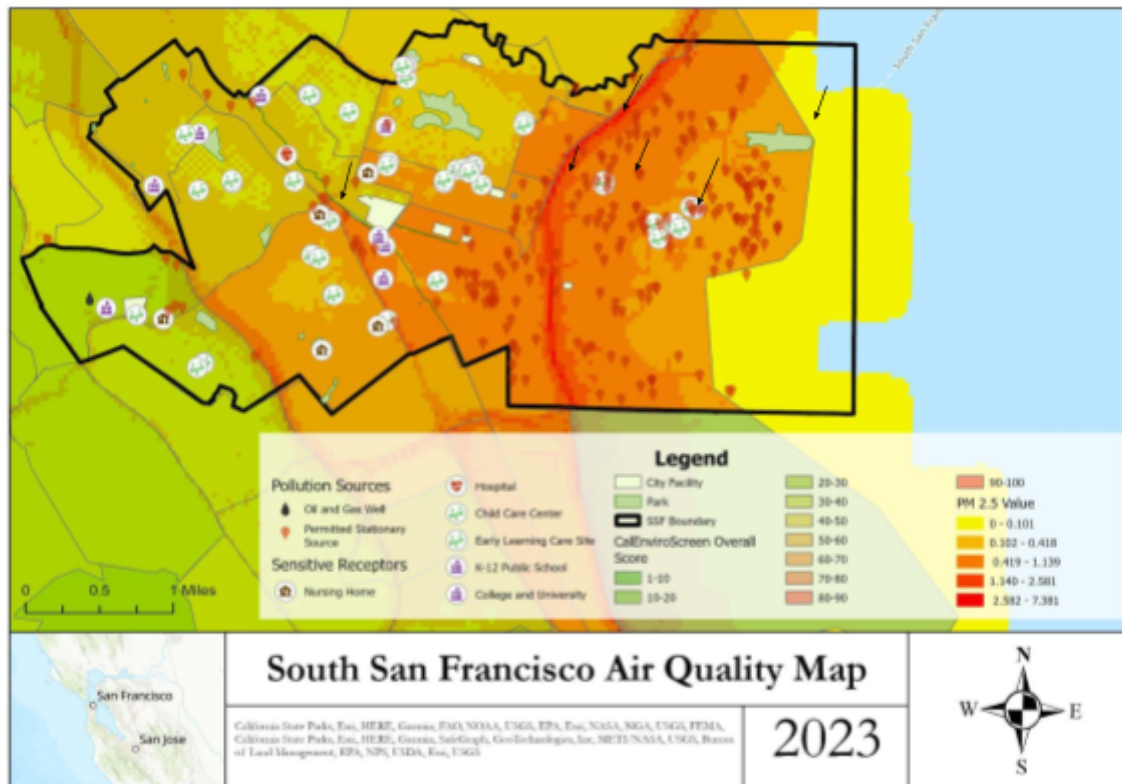


Image 1: A vulnerability map containing sensitive receptor locations and high-risk areas of air pollution, incorporating data from sources such as industry emissions, and on-road pollutants for the city of South San Francisco

Based on my preliminary analyses (Image 1), a few locations of sensitive receptor sites (pointed out by black arrows), including childcare, nursing homes, schools, and community parks, are within areas with high CalEnviroScreen scores and situated in regions with high pollution levels which prevent the neighbor residents from accessing nearby outdoor public spaces and healthy outdoor activities. Their locations are listed below:

Child care center and early learning center:

- Genentech's 2nd Generation
- Cabot Second Generation
- Early Years Preschool
- Bright Horizons



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- Gateway Child Care Center
- Building Kidz

Nursing Home:

- Westborough Royale

Park:

- Gardiner Park
- Cypress and Pine Park
- Oyster Point Marina
- San Bruno Point Park

Discussion

The motivation for this project is rooted in the need to protect and improve the health of sensitive receptors, such as children, the elderly, and those with underlying health conditions. Outdoor spaces, which play a pivotal role in the well-being and engagement of the community, are often impacted by air pollution in disadvantaged areas due to factors like proximity to industrial sites and heavy traffic. The statistics derived from the data analysis revealed potential health impacts, such as cancer risk, chronic hazard index, and PM2.5 concentrations, which are crucial for understanding the health implications associated with air quality in this area. This project has highlighted specific sensitive receptor locations that are at risk due to their proximity to areas with high pollution levels and supports the ongoing efforts of Rise South City.

Moving forward, Rise South City has recently submitted a grant application to CARB and will continue to develop a strong ambient monitoring network within South San Francisco, building resilience in the frontline communities. Currently, a JPEG image and an interactive digital version of the map are available on Rise South City's website for engagement and educational purposes.

Recommendation

Taking into account the findings from CalEnviroScreen and the designation of SB 535 Disadvantaged Communities, as well as the spatial analysis conducted in this project, and an evaluation of the existing air quality monitors installed throughout the city by previous initiatives (Image 2), it becomes evident that there is a significant gap in monitoring the most vulnerable areas of South San Francisco. For example, Rise South City has commendable distributed monitoring locations evenly, yet the data reveals that the



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most at-risk portion of the city, specifically the Eastern City area, remains under-monitored with only two devices installed.

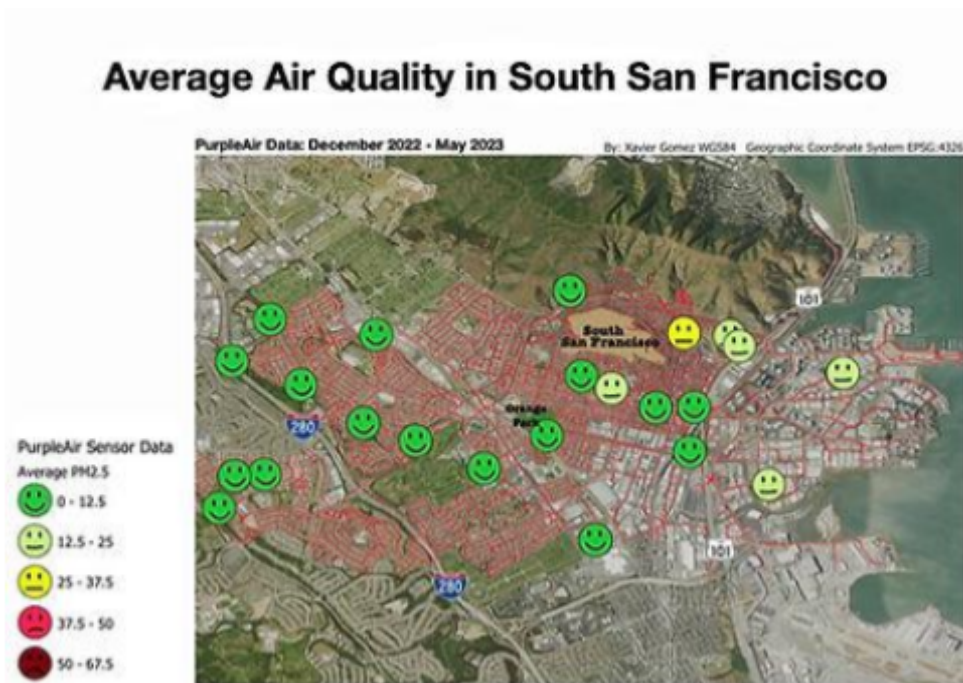


Image 2: This map displays the average air quality between December 2022 and May 2023 developed by Xavier Gomez as Rise South City's effort to install Purple Air Sensor monitor in South San Francisco.

The Eastern City is densely populated, situated downwind of a busy freeway, and is recognized as a disadvantaged area, which exacerbates the need for thorough air quality monitoring. In light of these factors, I recommend that Rise South City prioritize the installation of additional monitors, especially near sensitive receptor sites such as childcare centers, as part of their ongoing efforts to enhance air quality. This targeted approach would ensure a more comprehensive understanding and management of air quality in the areas that need it most.

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Appendix A

Community Air Protection Program Consistently Nominated Communities

Table 1: Bay Area AQMD

Community	County	Consistently Nominated By		
		District	CBO	Community
East Contra Costa County (includes Pittsburg Bay Point)	Contra Costa	X		
East Palo Alto	San Mateo	X		
Fairfield	Solano	X		
Gilroy	Santa Clara	X		
Greater Oakland	Alameda	X		
Hayward (parts)	Alameda	X		
Morgan Hill	Santa Clara	X		
North Central San Mateo	San Mateo	X		
Redwood City	San Mateo	X		
Rodeo to parts of Crockett	Contra Costa	X		X
San Francisco	San Francisco	X		
San Jose	Santa Clara	X		
San Leandro	Alameda	X		
San Rafael	Marin	X		
Santa Rosa	Sonoma	X		
South San Francisco	San Mateo	X		
Treasure Island	San Francisco	X		
Tri-Valley	Alameda, Contra Costa	X		
Vallejo	Solano	X		
West Berkeley	Alameda	X		

Table 2: Imperial APCD

Community	County	Consistently Nominated By		
		District	CBO	Community
Northern Imperial County Corridor-unincorporated communities of Niland, Desert Shores, Salton Sea Beach, Salton Sea, Bombay Beach, Seeley	Imperial	X	X	
Salton City	Imperial	X	X	X

Table 3: Sacramento Metropolitan AQMD

Community	County	Consistently Nominated By		
		District	CBO	Community
Florin (Community C)	Sacramento			X
Meadowview (Community G)	Sacramento	X	X	X
North Sacramento	Sacramento	X	X	X
Del Paso Heights, Norwood/Old North Sacramento (Community B in District analysis)	Sacramento			X
Oak Park, Fruitridge	Sacramento	X	X	X
South Natomas (Community A in District Analysis)	Sacramento	X		

Table 4: San Joaquin Valley APCD

Community	County	Consistently Nominated By		
		District	CBO	Community
"The West Side" (Huron, Avenal, and Coalinga)	Fresno		X	X
Delano	Kern		X	X
Fairmead	Madera County		X	X
Kettleman City	Kings County		X	X
La Viña	Madera County	X	X	
Lanare	Fresno		X	X
Le Grand	Merced		X	X
Lindsay	Tulare		X	X
Lost Hills	Kern		X	X
North Bakersfield	Kern	X	X	X
South Madera- La Vina, Parkwood, Parksdale, Borden, Italian Swiss Colony, Iragose, and Ripperday	Madera County		X	X
South Merced	Merced		X	X
South Modesto (Modesto, Modesto Airport neighborhood)	Stanislaus		X	X
South Tulare & Matheny Tract	Tulare		X	X
Southwest Modesto	Stanislaus		X	X
Wasco	Kern		X	X
West Stanislaus County	Stanislaus		X	X

Table 5: South Coast AQMD

Community	County	Consistently Nominated By		
		District	CBO	Community
Bloomington, Fontana, Rialto	San Bernardino	X		X
Buena Park, Anaheim, Fullerton, Orange	Orange	X		X
Central and East Riverside, Rubidoux	Riverside	X		
Chiriaco Summit	Riverside	X		X
Colton, Grand Terrace, San Bernardino (southwest)	San Bernardino	X		X
Compton, Rancho Dominguez, Willowbrook, Lynwood	Los Angeles	X		X
Corona, Temescal Valley	Riverside	X		X
El Monte, South El Monte, Avocado Heights, Hacienda Heights, La Puente (west), Bassett	Los Angeles	X		X
Gardena, Alondra Park, Lawndale	Los Angeles	X		X
Inglewood, Hawthorne, Westmont, Vermont*	Los Angeles	X	X	
Maywood, Commerce (east), Vernon, Bell	Los Angeles	X	X	
Mira Loma, Jurupa Valley, Eastvale, Pedley	Riverside	X	X	
Pacoima, North Hollywood, Sun Valley, San Fernando, Sylmar	Los Angeles	X	X	
Paramount, North Long Beach	Los Angeles	X	X	
Rancho Cucamonga, Ontario (east)	Riverside	X	X	
Santa Ana	Orange	X	X	
Torrance	Los Angeles	X	X	
Van Nuys	Los Angeles	X	X	
Westlake, Korea Town, Mid-city, Mid-Wilshire	Los Angeles	X	X	



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