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Confronting Environmental Inequality: Assessing and Mitigating Students' Exposure to Near Roadway Air Pollution in Silicon Valley

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Introduction

Near roadway vehicle emissions, such as particulate matter (PM), nitrous oxides, and other contaminants, are major sources of air pollution, which can cause respiratory and cardiovascular illnesses.[1] Chronic air and noise pollution exposures can also negatively influence cognitive function and student learning. Of greatest concern are concentrations within 500 feet of high traffic street edges, but concentrations can be harmful at distances up to 1320 ft.[2] Vulnerable populations such as children, the elderly, or those with impaired health are likely to suffer the greatest impacts. In 2003, the California legislature passed SB 352, prohibiting building new schools within 500 ft of high traffic roadways. However, SB 352 does not address what action should be taken to reduce the health risks for children at school sites already near high traffic roadways, and the Bill acknowledges that a disproportionate amount of low income students attend such schools. **A recent report found that nationwide more than 8000 public schools or about one in every 11 public schools, serving roughly 4.4 million students is located within 500 ft. of a road with more than 30,000 vehicles per day, or at least 10,000 cars and 500 trucks per day. Many more head start and private schools are also exposed.**[3] An earlier study, found that 13.5% of students attended schools within 820 ft of a major roadway, concluding that minority and underprivileged children were disproportionately affected, although some results varied regionally.[4]

To better understand pollution patterns, environmental justice issues, and the community responses in Santa Clara County (SCC), we started field research in the Greater Washington Neighborhood of San Jose, CA. We started here because of the proximity of schools to high traffic roadways, and the support that Thriving Neighbors Initiative offered through partnerships with Washington Elementary School (WES) and a network of *promotoras* that are improving their community and interested in a community-based research.

Questions

1. What are demographic and spatial patterns in the distribution and exposure to high concentrations of air pollutants around schools in SCC?

2. What are community and stakeholder perceptions about this issue?

3. How can Santa Clara University, K-12 schools and community-based partners work together to:
   - identify locally preferred mitigation strategies that reduce children's exposure to air pollutants? and
   - enhance community health and access to environmental benefits?

4. What are the priority areas, policies, and technologies for mitigating exposure?

Why Santa Clara County

Santa Clara county (SCC) is a diverse and rapidly urbanizing county. It is the 6th most populated county in the state of California with a large Asian and Hispanic populations. Almost one in five (18.6%) residents are non-citizens which is relatively high compared to the state average of 13.5% non-citizens and national average of 7% non-citizens. Out of SCC's 1.92M residents, over 400,000 (22.2%) are students under age 18. 253,016 of these students attend public schools in the county and 16% of these students (40,625) attend high-pollution risk schools (DataUSA 2017).

SCC is a good place to study environmental justice because environmental burdens are not evenly distributed throughout the county. Socially vulnerable populations, particularly Hispanics, are more likely to be exposed to environmental hazards than other populations and white populations have greater access to environmental benefits such as public parks (Stewart, et. al. 2014).

Methods

Our methods included community-based air pollution monitoring, desk-based mapping, and both a focus group and a survey conducted at Washington Elementary School (WES). We integrate these mixed methods through a participatory action research approach.[5] Using Geographic Information Systems, we mapped the location of roads and freeways in relationship to elementary schools. We ultimately determined roads with an Average Daily Traffic (ADT) count of 30,000 cars or more to be labeled a "main road" with high pollution risk while roads with an ADT < 30,000 were considered a "side road" with low pollution risk. We based this justification off of the Bay Area Air Quality Management Districts (BAAQQMD) air dispersion modeling campaign in 2008 which determined that estimated cancer risks and PM2.5 concentrations were found to be minimal for roadways with <30,000 ADT. To identify schools most at risk for air pollution, 500 foot buffers were made for roadways with an average of 30,000 vehicles or more per day. Finally, we used BAAQMD's "Planning Healthy Places" guide to both reduce emissions and exposure as an analytical tool to determine which schools in SCC should implement best practices.

We also conducted 4 sampling campaigns at 5 locations surrounding WES (Fig. 2), and measured ultrafine particles using two handheld condensation particle counters (TSI 3007). Community (*promotoras*) and SCU students conducted the sampling with faculty support. During three 3-week periods, *promotoras* and students collected air quality samples two times per day (in the am and afternoon) on two weekdays per week. We also conducted a survey and focus group in May, 2016 after a *madres* group meeting at WES. Survey questions addressed perceptions of air and noise pollution, and we received 33 completed surveys.

Findings

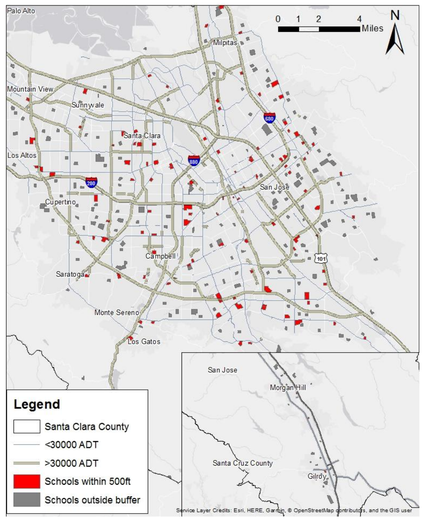


Figure 3: Public schools in Santa Clara County
Source: ESRI, SCU ESS Department, SCC GIS Data Portal, California Department of Transportation.

Preliminary Analysis - Schools and High Traffic Roadways

- Using 2016 schools and 2005 - 2015 traffic data we calculated that 102 out of 351 (29%) K-12 schools are within 500 feet of high-traffic roadways, and 56 out of 234 public elementary schools (24%).
- 15% of SCC schools are within 500 ft of a major roadway, compared to the national average of about 9%.[3] In addition, 16% of students in the county attend at-risk schools.
- Analysis of participation in Free or Reduced Price Meals (FRPM) program at schools within 500 ft of high traffic roadways finds 43% vs. 36% for schools > 500 ft away.

Figure 1: Air Quality Sampling Sites

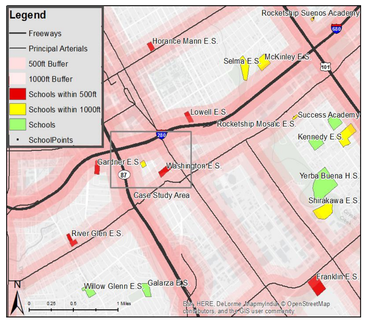


Figure 2: Close-up of greater case study area

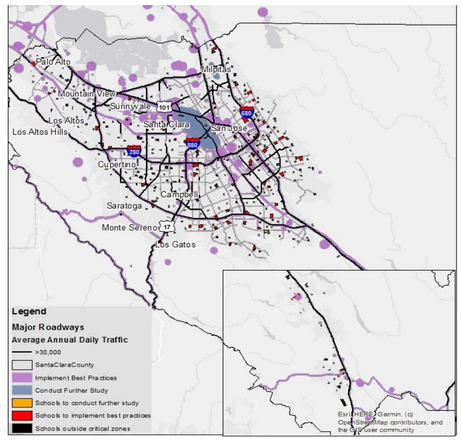


Figure 4: Planning Healthy Places and SCC Public Schools
Source: Bay Area Air Quality Management District, ESRI, SCU ESS Department, SCC GIS Data Portal, California Department of Transportation.

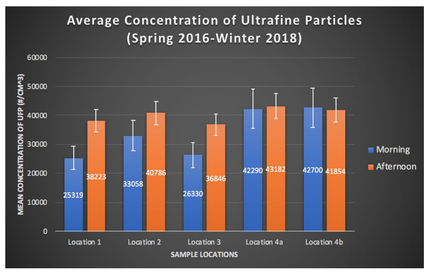
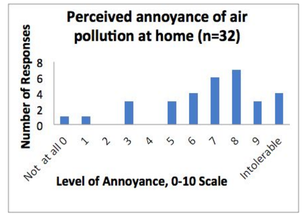
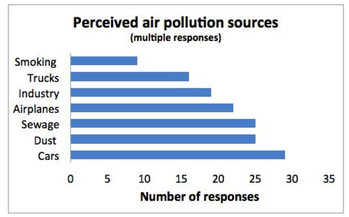


Figure 5: Concentrations of UFP by site
Source: Community-based monitoring.

Findings Continued – Survey and Focus Group Responses





F: Selected findings - focus groups with residents

Air pollution, one of several environmental hazards

Focus group responses: "My concern is that all our kids and all of the mothers who have children in this area are affected by air quality in one way or another."

"I live near 280. The air quality there is definitely worse because of how close it is to the freeway, and by two major streets... But it doesn't seem like that big of a concern for many people, because the consumption of marijuana is incredibly prevalent, and the rise of this problem was not incremental, it was dramatic."

"What can we do? Well, I think the best thing would be to find alternative routes for cars to commute. Putting signs up encouraging use of public transportation might be helpful along with no smoking."

Discussion & Mitigation

Preliminary analysis finds that an unexpectedly high percent (29%) of SCC public schools are within 500 ft of a high traffic roadway. Some evidence of environmental inequality based on free and reduced school meal participation.

The analysis of spring 2016 to winter 2018 data shows higher average concentrations of UFP in the afternoon that correlate with traffic data not shown here (Fig 5). More continuous air pollution monitoring is also needed.

The survey and focus group show that parents are concerned about multiple neighborhood issues, including annoyance due to air pollution and air traffic noise.

What can be done to mitigate children's air pollution exposures at schools?
Schools near highly trafficked roadways should plan for strenuous activity outdoors such as physical education classes to be held outside of peak traffic times. Additionally, windows and doors in the school building should be closed during peak traffic hours and indoor sources of air pollution should be minimized. If possible, ground floor use should be limited as much as possible. It is recommended to designate ground floors and land closest to the pollution source as storage, maintenance, parking, and office space while classrooms and play/sport areas as far away from pollution sources as possible (EPA 2015). Additionally, faculty and staff should be briefed on best air quality practices routinely in order to increase awareness and understanding of the issue. While it is not possible for existing schools near major roadways to relocate, these strategies may help these at-risk schools reduce exposure to the best of their ability.

Specific suggested mitigation tools include:
1. Traffic management such as roundabouts and speed limit reductions
2. Street design to encourage air flow
3. Filtration systems of minimum efficiency reporting value (MERV) of at least 13 to reduce UFMs from indoor and outdoor sources.
4. Installation of solid and / or vegetative barriers to increase pollution dispersion reduce concentrations of particles and gases.[6]
5. Improved ventilation design away from pollution sources and upgrades to ventilation, central heating, and air-conditioning (HVAC) systems

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