Geographies of Risk:
Evaluating Environmental Racism in late 20th Century Silicon Valley

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Abstract

Santa Clara county, home to California's Silicon Valley, is also home to over twenty recognized Superfund sites. Research in environmental justice literature has established that Hazardous Waste Sites (HWS) – like these Superfund sites – have historically been found, both on the local and national level, near marginalized communities. This study explored the characteristics and severity of disparity in the siting locations of HWS in the Bay Area counties of Santa Clara and Alameda between the years of 1970 and 1990, during which the area benefited from a semiconductor manufacturing economy. Disparity for each year was determined using a novel application of a Monte Carlos spatial test to compare demographics of HWS-hot communities against an expected distribution. The proportion of Black persons and elderly persons below the poverty line were found to always be significantly positively correlated. The findings indicate that the nature of disparity changed between 1970 and 1990, shedding light on the importance of time-and-place specificity to better understand injustices.

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Introduction

Santa Clara County is the county with the highest number of Superfund sites in the country, which continues to affect residents and ecosystems in the Silicon Valley. Through a statistical analysis of hazardous waste sites in Santa Clara and Alameda Counties in relation to census neighborhood demographics, a specific number of demographic characteristics are consistent predictors of hazardous waste site presence throughout the 1970 to 1990 study period. Black communities, in-county workers, and the elderly poor were found to be disproportionately burdened with hazardous waste facilities throughout this period. These findings are contextualized in this study with historical information about the industrial and residential development of the Silicon Valley.

The Implications of Disparity in Environmental Hazard Exposure

In 1987, the United Church of Christ (UCC) published an unprecedented, nation-level study of the correlation between race and waste in the United States. It came after public outcry over the legal ruling to place 120 million pounds of toxic waste in North Carolina's highest Black proportion county, Warren County, in a structurally unfit location. The UCC study introduced the academic terms environmental racism and environmental justice as well as an empirical method of gathering quantitative data to prove the trend that they argued linked these individual cases together. The UCC study found that, above all else, race had the strongest correlation with where waste sites were located, indicating that people of color were unequally burdened with these environmental hazards.[1]Since the study, as the field of spatial analysis in environmental justice has developed, continually improving methods have provided stronger evidence for the disparity in environmental hazard exposure, while other bodies of literature have offered explanations as to why these disparities exist, and what the implications of it are.

In UCC's study, Hazardous Waste Sites (HWS) as identified by the US Environmental Protection Agency (EPA) were the environmental hazard looked at when considering disparity. These sites were identified based on a review of known environmental contaminants and the contamination of the land in or around the site. The health effects of certain environmental contaminants have been studied in medical settings to significantly negatively impact both an individual's health in addition to their children,[2] whose experienced neonatal and childhood health can have lasting impacts into adulthood.[3]

[1] Lee and Chavis, "Toxic Wastes and Race in the United States."
[2] Vesterinen et al., "Cumulative Effects of Prenatal-Exposure to Exogenous Chemicals and Psychosocial Stress on Fetal Growth."
[3] Banzhaf, Ma, and Timmins, "Environmental Justice," 2019.

These effects are also shown to be compounded when environmental and socioeconomic stressors interact for multiplicative effects.[4]

Recent environmental justice studies have expanded this disparity analysis to various other structures, together called Locally Unwanted Land Use (LULUs)- including HWSs but also industrial zones, highways, municipal/non-toxic landfills, and other land uses not previously identified as toxic- with undesirable effects on the neighborhoods that host them.[5] Besides correlated health issues, LULUs are detrimental to convenience and quality of living. Hedonic housing models, or housing price modeling based on the available educational, environmental, and other amenities available in a neighborhood, reflect this.[6]So, recognizing disparities in exposure and proximity to environmental hazards help us identify related trends in also public health, community formation, and generational wealth accumulation when considering the intergenerational impacts.

Environmental Justice in the Bay Area

In the mid-1900s the county of Santa Clara experienced a boom of both industrial and residential development as it became a national center of electronics production.[7] The perception of the technology industry was different in that it was seen as a clean industry, in contrast to coal plants or landfills, though they would prove to be some of the heaviest environmental contaminators; Santa Clara county has the highest count of Superfund sites in the United States, which are sites heavily contaminated with toxic waste and identified by the EPA as deserving publicly-funded remediation.[8] The majority of these sites were identified between the 70s and 80s during several public investigations into groundwater contamination from electronic manufacturing firms, after which increasing regulations and global competition led to the offshore movement of electronics manufacturing that used to be done in-house.[9] This and the availability of HWS documentation limited the scope of this study to the decades between 1970 and 1990.

The structure of the electronics industry – the dichotomized workforce, the segregation of housing and industry, and the unique industrial development pattern of small firms with high professional inter-firm collaboration - set during Silicon Valley's founding impacted the industry's development during the 1970s to the 1990s in that it contributed to some of the issues that would come to fruition during this period. Silicon Valley would face the first of international competition in the electronics industry and national immigration patterns changed the makeup of its workforce. Other challenges were more home-grown: increasingly inescapable environmental pollution and housing shortages, both of which led to dissatisfaction in workers regardless of occupation.

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4 Morello-Frosch and Shenassa, "The Environmental 'Riskscape' and Social Inequality."
5 Jr, Sadd, and Morello‑Frosch, "Who's Minding the Kids?"; Szasz and Meuser, "Unintended, Inexorable."
6 Banzhaf, Ma, and Timmins, "Environmental Justice," Winter 2019.
7 Saxenian, "Silicon Chips and Spatial Structure."
8 Schlossberg, "Silicon Valley Is One of the Most Polluted Places in the Country."
9 Pellow and Park, *The Silicon Valley of Dreams*; Sonnenfeld, "The Politics of Production and Production of Nature in Silicon Valley's Electronics Industry."

The clean image was important to uphold in order to appeal to local governments and attract professional workers. Still, information on the industry's pollution was tightly controlled lest it is used to argue for regulation of the industry, or organize labor movements within it.[10]

Literature review

Toxic Wastes and Race in the United States[11] pioneered a research method that provided the burgeoning Environmental Justice Movement (EJM) with data supporting their claims and demands while providing an empirical framework for activists to prove environmental inequity in their own communities. A follow-up paper by Mohai and Saha (2005) showed how the lack of standardization in spatial analysis methods between the papers led to the use of a method that masked the correlation between demographic categories and the locations of various locally unwanted land uses (LULUs) including, but not limited to, HWSs, municipal landfills, and highways. The paper showed that a commonly used method in the papers that refuted the UCC's findings failed to properly identify the true host communities of LULUs, in this way masking disparity. Mohai and Saha propose the alternative distance-based method, which considers the demographics of all tracts falling within a defined radius from a LULU, rather than relying on zip codes or census tracts, when defining the demographics of a LULU hosting community. The standardization of the use of distance-based spatial analysis has made the body of literature proving significant racial and sociopolitical environmental hazard inequity more robust since these publications.[12]

While research methods and EIF frameworks in relation to understanding regional environmental inequity have developed since the release of *Toxic Wastes and Race in the United States,* the literature notes a need for longitudinal spatial studies using distance-based methods in order to increase the robustness of the field.[13] In addition to spatial analysis, using historical methods to add to the literature of case studies of EIF can help us understand how widespread and interconnected identified causal processes are and over what geographies.[14] Finally, while environmental inequality in the Bay Area has already been the subject of extensive historical analysis, a spatial analysis using current best research practices would help to bring the region into the body of literature using mixed methods, improving our understanding of how EIF processes vary across the US.

Research Question and Hypothesis

The question I ask is two-pronged: (1) Is there a disparity in the distribution of HWSs in relation to neighborhood demographics? (2) Can the causal relationships contributing to these disparities be identified through spatial and historical analysis?

(1) I expect to see a significant correlation between HWS locations and demographic variables, such as race and class, in directions that indicate that there is disparity, specifically disparity like what has been found in national-level disparity analyses, meaning a positive correlation with census categories representing people of color, low-wage or blue-collar occupations, poverty, and education up to the

[10] Pellow and Park, *The Silicon Valley of Dreams*; Sonnenfeld, "The Politics of Production and Production of Nature in Silicon Valley's Electronics Industry."
[11] Lee and Chavis, "Toxic Wastes and Race in the United States."
[12] Agyeman et al., "Trends and Directions in Environmental Justice."
[13] Mohai and Saha, "Which Came First, People or Pollution?," December 1, 2015.
[14] Sicotte, "The Importance of Historical Methods for Building Theories of Urban Environmental Inequality."

high-school level.[15] I also expect that the proportion of Asian Americans, foreign-born, and renter occupancy positively correlate with HWS presence, while owner-occupancy and long-term housing unit occupancy are negatively correlated.

Past literature of historical analyses on HWSs have emphasized the importance of a locale's specific industrial developmental history in how environmental disparities manifest to burden populations with differing characteristics across geography.[16] My hypotheses of which demographic factors would be correlated was taken from factors identified by prior literature, while incorporating key features of Silicon Valley's semiconductor industry, and applied across data from 1970, 1980, and 1990. These slices in time showed that as time progressed, analysis results veered away from my hypotheses. Specifically, assumptions about disparate environmental burdens on non-Black communities of color and industry-worker communities did not hold. This suggests that more specific developmental history to Santa Clara and Alameda counties in the 1990s needed to be considered in hypotheses formation, such as the local housing and revitalization policy history mentioned in this study's discussion section,[17] and lesser documented histories of community action in response to HWS sitings. The findings of this longitudinal study of HWSs support that specific developmental history is important not only across geography, but also time. This is an opportunity for further research.

Methods

To focus on the unique case of domestic technology manufacturing in the California Bay Area, the scope of this study will be limited to the counties of Santa Clara and Alameda, California for the period of 1970 to 1990 to investigate whether changes in the development of the electronics industry revealed causal relationships of disparity formation. The disparity in HWS distribution will be determined by using data sets of HWS locations and data sets of demographic information about neighborhoods. Demographic data will be sourced from 1970, 1980, and 1990 census data in census tract units. HWS location data will be sourced from California's Department of Toxic Substances Control's online public database, EnviroStor[18].

HWS location points will be used to define a sample population set within a 1 km radius of the point. The demographics of this HWS-host sample population will be determined using the areal appointment method of aggregating weighted by the proportion of the census tract falling within the radius.[19] The demographics of the HWS-host sample population will be ranked against a null distribution in a Monte Carlos test.[20]Hypothesis testing will be applied to this value to determine whether the ranking of the HWS-hosting population did or did not significantly deviate away from the null distribution, indicating covariance with HWS presence and disparity. The null distribution that the HWS-hosting population will be compared against is a sampling of census tracts based on a zonal inhomogeneous

[15] Lee and Chavis, "Toxic Wastes and Race in the United States"; Pastor, Sadd, and Hipp, "Which Came First?"; Saha and Mohai, "Historical Context and Hazardous Waste Facility Siting."
[16] Krieg, "A Socio-Historical Interpretation of Toxic Waste Sites"; Saha and Mohai, "Historical Context and Hazardous Waste Facility Siting."
[17] Saxenian, "Silicon Chips and Spatial Structure."
[18] "EnviroStor."
[19] Mohai and Saha, "Which Came First, People or Pollution?," November 1, 2015.
[20] Besag and Diggle, "Simple Monte Carlo Tests for Spatial Pattern."

Poisson distribution of points to account for spatial autocorrelation.[21]This will be done for every census year, with each year having only the subset of HWSs that were determined to be in existence by that census to capture only the demographics of the population as contemporary with the existence of the HWSs. The results of each demographic variable of each census year will be interpreted in contrast with one another.

Identifying Hazardous Waste Sites in Santa Clara and Alameda County

The California Department of Toxic Substances Control's (DTSC) Envirostor database was the primary reference source for HWSs considered for this project given the documentation, resolution, and proliferation of data publicly available in comparison to other considered sources (the EPA's National Priorities List, Resource Conservation and Recovery Act Database, both EPA and California level Toxic Release Inventory trackers). From this database, the data set used in this research were sites that were either 1) A federally-recognized Superfund site or 2) a site included on the CA EPA's "Cortese List". The Cortese list is a list of hazardous material contamination sites, that the DTSC is required to update annually in compliance with a government code passed in 1985.[22]

The start date of hazardous waste accumulation on the site was manually recorded and determined off-site descriptions, use history, and legal documents were uploaded to each site profile in the EnviroStor database. Whether or not the site was federally operated, or commercial, was also manually recorded. For each site, the following data was pulled: 1) site name, 2) city and county, 3) whether the response was state or federal action, 4) the size of the site in acres, 5) land use history, 6) start year of hazardous waste accumulation, 7) whether the site was federal or commercial, 8) its current land use status, and 9) the site's ID in the EnviroStor database.

Sourcing Community Demographics - Census Data

To determine if there was a disparity in the location of sites related to community demographics, demographics were sourced and aggregated from long-format census answers. Census data was obtained through a UCSB Library license of GeoLytics' Neighborhood Change Database, 2010, which provides census data for all decades back until 1970, transformed and normalized to 2010 tract boundaries, which are the geographical unit of aggregation of collected, individual-level survey responses to the census.[23] The tracts selected for this research were all the ones that fell within Santa Clara and Alameda County boundaries. Two tracts were removed from consideration – one in Santa Clara County and one in Alameda County, out of concern for skewing modeling methods due to a majority of the area being not developable and thus not realistic for sampling.

A total of 34 demographic variables were chosen to be analyzed across the three census years. These demographic characteristics were chosen either for having been identified in previous Environmental Justice research as being significantly correlated with the existence of a hazardous waste site, either positively or negatively, or they were chosen because they were believed to be likely correlated. Of the variables chosen, 3 were not recorded during the 1970 census survey, and the definition of the demographic characteristic was measured by several census variables changed between the census years.

[21] Chakraborty, Maantay, and Brender, "Disproportionate Proximity to Environmental Health Hazards."
[22] Cortese, Government Code Section 65962.5.
[23] GeoLytics, Urban Institute, and US Census Bureau, "Neighborhood Change Database (NCDB) 2010."

Monte Carlos Testing as a Novel Environmental Injustice Test

Monte Carlos testing is the sampling of a test statistic from the simulation of a null distribution, against which the value of a given test statistic is ranked.[24]In this case, the test statistic being measured is the aggregate percentage of one of the 34 chosen variables, and the set of percentages it is compared against to determine significance is sampled from the simulation of a null distribution in which HWS locations are independent of the chosen demographic variables. A p-value test can then be used to determine if the ranking of the test statistic within the null distribution range is significant- whether the test statistic is in line with, or if it is contrary, to the assertion that HWS locations are randomly distributed.

Findings

For this research, 23 variables were found to be significant in 1970, 19 variables were significant in 1980, and 18 in 1990. Out of those variables found to be significant, 18 times they disagreed in direction, meaning that they were positively correlated when it was hypothesized that they would be negatively, or vice versa. The breakdown of that is 3 variables in 1970 differed in direction, 4 in `1980, and 9 in 1990. Hypotheses were supported by the measurement of 20 variables in 1970, 15 variables in 1980, and 9 variables in 1990. Over time, the decreasing agreement with our hypotheses indicates that the nature of disparity in HWS location is moving away from the relationships identified in past literature, but not necessarily if the disparity is increasing or decreasing overall.

For 1970, 23 out of 31 chosen variables were significantly correlated and 20 were correlated in the direction hypothesized, making it the year that most matched with expectations based on past literature. Out of these, 10 variables were positively correlated and 10 were negative. The significant variables that were correlated in the direction opposite of hypothesized were % Foreign Born, % Persons living in the same state as 5 years ago, and % Persons employed as service workers. These results agreed with past literature that found HWS locations to be 1) correlated with populations of color and 2) correlated with in-county workers, and blue-collar occupations indicating that workers at HWSs also lived in host communities, but it was unexpected that no other race or ethnicity category were significantly correlated.

For 1980, 19 out of 34 chosen variables were significantly correlated and 15 were correlated in the direction hypothesized. Out of these, 10 variables were positively correlated and 5 were negative. The significant variables that were correlated in the direction opposite of hypothesized were % Mexican, % Puerto Rican, % Persons living in the same state as 5 years ago, and % Persons employed as service workers. For 1990, 18 out of 34 chosen variables were significantly correlated and 9 were correlated in the direction hypothesized. Out of these, 5 variables were positively correlated and 4 were negative. The significant variables that were correlated in the direction opposite of hypothesized were % Asian American and Pacific Islander, % Persons listing Hispanic as an ethnicity, % Mexican, % Puerto Rican, % Foreign Born, % Persons living in the same county as 5 years ago, % Persons living in the same state as 5 years ago, and % Persons employed as precision production, craft, and repair workers. Unexpectedly, all race and ethnicity categories except % White and % Black were negatively correlated with HWS presence

[24] Besag and Diggle, "Simple Monte Carlo Tests for Spatial Pattern."

and almost all occupation categories became insignificant. But this was the first year where both % Renter and % Owner occupancy were significantly correlated as hypothesized.

Only two out of the 34 variables that were tested were found to not be significant for any census year, % Native American and % Cuban, both of which were not recorded during the 1970 census. Otherwise, all variables were found to be significant for at least one census year. Seven variables were found to always be significantly correlated with HWS location throughout the three census years. Three of those were positively correlated for all years: % Black, % Persons Working in the Same County they live in, and % Elderly persons (65+ years old) below the poverty level the previous year. Three were negatively correlated for all years: % Housing units occupied, Persons 25+ years old who have a bachelor's or graduate/professional degree, and % Persons living in the same state as 5 years ago. Finally, % Persons Working in the same Metro Region they live in was negatively correlated in 1970 and 1980, then became correlated in 1990.

Discussion

Representatives of Chosen Hazardous Waste Sites

The HWSs within Santa Clara and Alameda counties that were analyzed in this study were taken from the Cortese List and the EPA National Priorities List, both of which identify hazardous material contaminations that endanger public health according to state and federal regulations, respectively. This data set does not contain all HWSs and is not entirely representative of the HWSs that exist. While its useful to examine such sites to understand the demographics of class, race, and environmental disparities of a region, other HWSs should be considered. Our sample included a range of types of HWSs- Commercial hazardous waste generators with unexpected leakage, illegally run TSDFs, old DDT spray regions, illegal waste dumping, and federal testing sites and military contractors. While the results of this research are helpful in that it reveals trends reflecting the experiences of those who are cornered into living near the worst cases of hazardous pollution in Silicon Valley, it may not be equally extrapolated to all communities hosting HWSs, particularly Large Quantity Generators, in the Bay Area.

Discrepancies in Spatial Representation

Within the set of HWSs analyzed in this research, there are several aspects of the data that attributed the error to our results. One issue is the use of points to represent sites, which range drastically in size. Within our dataset, the smallest sites were fractions of an acre, and the largest sites went over 3000 acres. For some of the largest sites, the consideration of site size is comparable to the buffer used to sample community demographics, the site perimeter being pulled from GIS data provided by California's DTSC. Another related issue is the choice of location for a representative point within the site itself. This disagreement can come from choosing between multiple locations owned by the polluting firm, and more importantly, it arises in trying to locate what has ultimately dispersed pollution.

Representativeness of Census Data

For the 1970 Census survey, persons of Native American or Asian American, or Pacific Islander heritage were not asked to identify, nor were Cuban Americans. These are the only three of the variables chosen that only had two census years of data, but changing definitions of race, ethnicity, as well as occupations also impacted and added uncertainty to the findings. For example, although "% Hispanic" is an available demographic variable for 1970, 1980, and 1990, Szaz and Meuser[25] identify perceptible changes in the operationalization of this category. For one, becoming a self-reported category rather than being determined by a census employee, and two, change in definition, from in relation to Spanish origin and Spanish speakers to later being defined in relation to Latino ethnicity, of which the intended population of capture between these two definitions is not completely overlapping as well as fluid from an individual's own changing perception of identity over time and different social environments.

Similarly, our results were affected by the quality of data collection for Asian Americans in the census. The industrial history of Silicon Valley shows that a wide range of migration pathways into the region are represented by the different diasporas grouped under pan-Asian, suggesting an equally varied class and socioeconomic experience.[26] Disaggregation of Asian-American into ethnic groups would hypothetically produce results that better agree with the hypotheses of this study.

Although perceived as less changeable than ethnic and race categories, given the rapid demographic, industrial, and spatial reorganizational change that took place between the 70s and 90s, several other variables considered may have had similar operational changes throughout the 30 years. Categorizing jobs within the available occupational tiers provided by the census may have changed, which could impact the interpretation of observed changes in associated income/benefit/class structure and expectations of these categories over time that would be indiscernible when looking at changes in occupational significance to HWSs correlation. Another variable that we would have expected to change definition over time is "% Persons Working in the same Metro Region they live in" given the development of most parts of the Bay Area over the studied period into a well-connected metropolitan region. Note also that the above- mentioned work-variables consist of some of the most volatile of our indicators in changing significance over time- "% Persons Working in the same Metro Region they live in" was the only variable significant for all three years that changed in directional significance.

Finally, there is well-documented concern about the representativeness of the census in its claim of capturing the entire population living in the U.S, considering that undocumented populations and more largely communities of color who are not reached out to have had low rates of response, though census data is often adjusted to account and estimate missing data.[27] But a concerning gap in information for the study of the Silicon Valley region would be oversight of homeless populations, considering the region's well-documented and long-standing housing shortage issue.[28]

Assumptions in Calculations and Modeling

This study utilized a data source of census data that was normalized and transformed to match 2010 census tract boundaries.[29] This enables cross-comparison of demographics between years, as the census tracts are altered every census to capture approximately 2000 people per tract. These proportional transformations are done on an assumption that these counts are spread out throughout the tract in a

[25] Szasz and Meuser, "Unintended, Inexorable."
[26] Saxenian, "Silicon Chips and Spatial Structure."
[27] Szasz and Meuser, "Unintended, Inexorable."
[28] Saxenian, "Institutions and the Growth of Silicon Valley."
[29] GeoLytics, Urban Institute, and US Census Bureau, "Neighborhood Change Database (NCDB) 2010."

uniform manner, which is most likely not true, but is necessary in order to do mathematical operations with spatial units.

The areal appointment was used to aggregate the demographic makeup of census tracts that fell within sample boundaries. The method combines demographic counts from included tracts based on the proportion of the total area of the tract that falls within the sampling buffer, which similarly assumes a uniform distribution that is most likely not true. This is an issue that was the original cause for concern in earlier research that used methods like the unit-hazard approach which only takes into consideration the unit that the HWS fell within, often large areal units like zip codes.[30]This is an issue when HWSs border perimeters but do not account for neighboring units and makes results susceptible to ecological fallacy as mentioned in Chapter 1. By using areal units that are smaller, or more importantly, closer to the spatial organization that processes of EIF/ HWS placement take place on, the issues caused by these assumptions are reduced, as shown in the literature preference and acceptance of the areal appointment method.[31]

Determining Null Distribution

Our null distribution that was used to determine if the demographic variables of HWS-hosting communities were significantly correlated was notably not a normal random distribution, but instead a Zonal Inhomogeneous Poisson. Our rationale was that if concerns of environmental racism, classism, or other disparaging structures in placement or housing stratification were unsupported, at the very least HWSs could be expected to cluster around urban centers as defined by population density because of industrial demand for labor, or connection to commerce and distribution networks, rather than a purely randomly based spatial distribution throughout the counties. It is also understood that, spatially, events or occurrences, which are called point processes, are better modeled as clustering rather than uniform or normally distributed.[32]Because of our null distribution model choice, it was necessary to keep in mind that what HWS-hosting communities were being compared to were samples of urban centers.

Trends Identified - Losing Significance

Many variables that became insignificant between 1970 and 1990 were work related- in 1990, all occupation variables except “% Persons employed as precision production, craft, and repair workers” were no longer correlated with HWS placement, and “% Persons employed as precision production, craft, and repair workers” became negatively correlated when it was hypothesized to be positively correlated. The drop in significance of occupation after having been so suggested that the composition of HWS-hosting communities is no longer representative of the labor force HWSs need. It could be that HWS workers are commuting from further away regions, especially considering the region’s housing shortage.[33] It could also be representative of land use change and urban revitalization, as the intent of placing sites on the Cortese List is to begin remediation for new users, which has been connected to re-gentrification trends.[34]

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[30] Saha and Mohai, “Historical Context and Hazardous Waste Facility Siting.”
[31] Kearney and Kiros, “A Spatial Evaluation of Socio Demographics Surrounding National Priorities List Sites in Florida Using a Distance-Based Approach”; Mohai and Saha, “Which Came First, People or Pollution?,” December 1, 2015.
[32] Chakraborty, Maantay, and Brender, “Disproportionate Proximity to Environmental Health Hazards.”
[33] Saxenian, “Institutions and the Growth of Silicon Valley.”
[34] Banzhaf, Ma, and Timmins, “Environmental Justice,” 2019.

Despite being highly positively correlated with HWS presence in 1970, in 1980 and 1990 unemployment, overall poverty rate, as well as poverty rate for non-elderly persons were no longer significantly correlated with HWS presence, though elderly poverty was always significantly positively correlated with HWS presence. The lack of unemployment and poverty correlation could similarly be indicative of post-industrial revitalization and changes in land use of sites, or decreased proportion of hosting communities being tied to HWSs work. It could also be that sites established post-1970 had different site selection regimes that selected less on racial, social, and class factors, or that employed and located near a labor force that differed in demographics from the traditional HWS found in scholarly literature. This would be the case for most Palo Alto sites, and the attraction of a professional class during Silicon Valley's founding.[35] The reason that the correlation for elderly poverty has resisted the trend seen in overall unemployment and poverty might be the existence of a stationary elderly population, through senior living facilities or other housing subsidies, considering that HWS-hosting communities are the renter majority.

Trends Identified – Gaining Significance

While overall fewer variables were found to be more significant in 1990 than in previous census years, two groups of variables became significant when they had not been in 1980 or 1970. For one, racial indicators, specifically "% Asian American and Pacific Islander", "% Persons listing Hispanic as ethnicity", "% Mexican", and "% Puerto Rican" all became significantly negatively correlated, meaning there were smaller percentages in HWS-hosting communities compared to our null population and is opposite of what was hypothesized. It was originally hypothesized that these variables would be positively correlated based on past research and the dependence of the electronics manufacturing industry on Asian immigrant labor. The correlation might be reflecting the county-level structures of "industry" cities and "bedroom" cities, or the segregation of residential and industrial land use into as far as different cities rather than both in the same city.[36] Given the self-sorting of people of color into communities of their co-ethnics,[37] and that what was available during sorting was planned urban-suburban areas, it may explain why variables of people of color were significantly correlated instead of the expected proportion of white. These variables also went from non-significant to being significant, which may also indicate stronger influences of segregation based on race, whether as a reflection of a less diverse workforce or more racial stratification economically.

The second group of variables that became increasingly significant to HWS presence was indicators of owner-to-renter ratio ("% renter-occupied housing units", "% owner-occupied housing units"). Unlike the racial variables, these variables significantly supported our hypothesis, which was that the proportion of renter occupancy would be positively correlated and owner occupancy negatively correlated. The change of housing in HWS-hosting communities from being mixed owner and renter occupancy to being majority renter could indicate the socioeconomic mobility of homeowners who now rent out their previous home.

Unexpected Correlated Demographic Variables

[35] Saxenian, "Institutions and the Growth of Silicon Valley."
[36] Saxenian.
[37] Epple, "Modeling Population Statification Across Locations."

Several variables indicative of migration patterns did not agree with what was originally hypothesized. For example, its significance in other research and the use of immigrant labor in manufacturing led us to hypothesize that "% foreign born" would be positively related with HWS presence, but it was found to be negatively correlated and not correlated for one of the years. It could be indicative that in Silicon Valley, foreign-born is a status that is not tied to a particular ethnic, racial, or socioeconomic category making it too large of a variable to be interpretable, unlike found in other regions.[38]

In a similar vein, "% Persons living in the same house", "% Persons living in the same county", and "% Persons living in the same state all as 5 years ago" were found to be negatively correlated or not significantly correlated. We hypothesized that % of Persons living in the same county and % of Persons living in the same state would be positively correlated with HWS presence. While we hypothesized that % Living in the same house would be negatively correlated because concerns already existed about housing shortages, making it an owner's market, we reasoned that industrial jobs and job availability would restrain people into industrial areas for extended time periods, making % Living in the same county and % Living in the same state positively correlated. The negative correlation of these two variables might be interpreted as that those who live in HWS-hosting communities are more transitory than other Silicon Valley communities, on both a time scale as well as distance, with % Living in the same state has been significantly negatively correlated with HWS presence all three censuses. This may be because Silicon Valley may differ from the literature of nearby housing not being occupied by HWS workers, or it may be giving insight into the transitory, high-turnover nature of such jobs.

Correlations that Stood Steadfast

The variation and disagreement between our results to our hypotheses have given insight into the disparity present in Silicon Valley, how it agrees with patterns of disparity elsewhere in the United States, and how the local processes of EIF have changed over time. Despite the changing environment, several variables supported our original hypotheses in all three census years. For example, a college degree and higher were negatively correlated- so was the proportion of occupied housing in the community. The proportion of Black, the percentage of persons working within the county they live, and percent elderly poor were all significantly positively correlated for all three census years. All three of these variables are significant in the direction hypothesized, supporting national-level findings of disparity in association with Black communities, communities formed out of HWS labor sources, and high-school level education.[39]

Conclusion

Environmental equity studies since the 1980s have repeatedly found HWSs to be contemporarily located in marginalized communities, such as communities of color and socioeconomic class stature, in both national and regional spatial analyses.[40] This study set out to apply such research methods to determine HWS disparity in the counties of Santa Clara and Alameda county, two regions that have yet to

[38] Pastor, Sadd, and Hipp, "Which Came First?"

[39] Been and Gupta, "Coming to the Nuisance or Going to the Barrios?"; Bullard and Wright, "Environmentalism and the Politics of Equity."

[40] Been and Gupta, "Coming to the Nuisance or Going to the Barrios?"; Bullard and Wright, "Environmentalism and the Politics of Equity"; Lee and Chavis, "Toxic Wastes and Race in the United States"; Pastor, Sadd, and Hipp, "Which Came First?"

be explored using these methods in the literature. Regional analyses of HWS locations have often emphasized the relation of found disparity to the dominant industries of the region,[41]which in this study's region of interest, since the mid-20th century, has been the electronic industry (Saxenian, 1981).[42]

This analysis established that, in Silicon Valley, disparity exists in which demographic populations are more liable to living near HWSs. Despite changes in correlation seen in other demographic variables throughout the period studied, a higher proportion of Black communities, in-county workers, and the elderly poor were disproportionately burdened with HWSs. The implications of this disparity are multifold- communities hosting HWSs are at risk of environmental contaminants, intentional or unintentional, with detrimental health effects that can be both immediate and accumulating, both within an individual's lifetime and generationally passed on.[43]Many of these HWSs are also undesirable public amenities, which impact a neighborhood's quality of life for the residents and are detrimental to their ability to accumulate capital over time or through home ownership.[44] The reasons for this disparity are not sufficiently explained by either this spatial analysis or a history of the industrial development of the region's electronic history, meaning further research is warranted to understand why these populations are liable to HWS presence.

The findings of national-level spatial analyses of HWS locations were supported by this regional study of Silicon Valley, adding it to the growing literature supporting that time and time again Black communities and other socioeconomically disadvantaged populations are disproportionately subjected to living near HWSs, as contextualized by regional developmental history and economy.[45]This research showed that this disparity does exist for the region, and more importantly begins to point to the communities affected, to better direct resources and implement preventative planning practices for the future industrial development of the region. This research also found that, for Silicon Valley, those disparities have changed, warranting a re-examination of contemporary disparity and why it exists. Comparison of demographics across the three census years suggests that disparity is no longer clearly along racial lines, but coincides with wealth and capital access, as represented by increasing significance in home ownership correlation, and the intersections of class and race that lead to those opportunities. Finally, this study also provides an example of the usefulness of Monte Carlos tests in environmental inequity analysis, in contrast to commonly used regression techniques.[46]

While this research established the existence, and some of the characteristics of, disparity for the given period in Silicon Valley, further research can better characterize said disparity. This includes extending analysis to the present day, evaluating 2000 and 2010 census data, or reselection of variables as informed by the results of this research, such as looking further into homeownership by race. Data sources outside of census data should also be considered, such as survey data or data that disaggregates

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[41] Krieg, "A Socio-Historical Interpretation of Toxic Waste Sites"; Pastor, Sadd, and Hipp, "Which Came First?"; Saha and Mohai, "Historical Context and Hazardous Waste Facility Siting."
[42] Saxenian, "Silicon Chips and Spatial Structure."
[43] Banzhaf, Ma, and Timmins, "Environmental Justice," 2019; Morello-Frosch and Shenassa, "The Environmental 'Riskscape' and Social Inequality."
[44] Banzhaf, Ma, and Timmins, "Environmental Justice," Winter 2019.
[45] Bullard and Wright, "Environmentalism and the Politics of Equity"; Lee and Chavis, "Toxic Wastes and Race in the United States"; Mohai and Saha, "Which Came First, People or Pollution?," December 1, 2015.
[46] Chakraborty, Maantay, and Brender, "Disproportionate Proximity to Environmental Health Hazards."

Asian-American categories. Prior research has also shown that demographic correlations have varied as a function of distance from a HWS, a technique that could be applied here .[47] The research done in this study also provides the basis for a longitudinal regression study of HWS founding in the region, which can bring insight into the concern of whether if HWSs are placed in disadvantaged communities or if communities are formed around HWSs.

[47] Chakraborty, Maantay, and Brender.

Works Cited

Agyeman, Julian, David Schlosberg, Luke Craven, and Caitlin Matthews. "Trends and Directions in Environmental Justice: From Inequity to Everyday Life, Community, and Just Sustainabilities." *Annual Review of Environment and Resources* 41, no. 1 (November 2016): 321–40. https://doi.org/10.1146/annurev-environ-110615-090052.

Banzhaf, Spencer, Lala Ma, and Christopher Timmins. "Environmental Justice: Establishing Causal Relationships." *Annual Review of Resource Economics* 11, no. 1 (2019a): 377–98. https://doi.org/10.1146/annurev-resource-100518-094131.

———. "Environmental Justice: The Economics of Race, Place, and Pollution." *Journal of Economic Perspectives* 33, no. 1 (Winter 2019b): 185–208. https://doi.org/10.1257/jep.33.1.185.

Been, Vicki, and Francis Gupta. "Coming to the Nuisance or Going to the Barrios? A Longitudinal Analysis of Environmental Justice Claims." *Ecology Law Quarterly* 24, no. 1 (1997): 1–56.

Besag, Julian, and Peter J. Diggle. "Simple Monte Carlo Tests for Spatial Pattern." *Journal of the Royal Statistical Society. Series C (Applied Statistics)* 26, no. 3 (1977): 327–33. https://doi.org/10.2307/2346974.

Bullard, Robert, and Beverly Hendrix Wright. "Environmentalism and the Politics of Equity: Emergent Trends in the Black Community." *Mid-American Review of Sociology* XII, no. 2 (1987): 21–38. https://doi.org/10.17161/STR.1808.5017.

Dept. of Toxic Substances Control. "EnviroStor." California Environmental Protection Agency, 2000. https://www.envirostor.dtsc.ca.gov/public/.

Chakraborty, Jayajit, Juliana A. Maantay, and Jean D. Brender. "Disproportionate Proximity to Environmental Health Hazards: Methods, Models, and Measurement." *American Journal of Public Health* 101, no. S1 (December 2, 2011): S27–36. https://doi.org/10.2105/AJPH.2010.300109.

Cortese, Dominic. Government Code Section 65962.5, Pub. L. No. 65962.5 (1977). https://leginfo.legislature.ca.gov/faces/codes_displaySection.xhtml?lawCode=GOV&sectionNum=65962.5.

Envirostor. "EnviroStor Data Management System: DTSC Enhances the Public's Access to Inspection and Enforcement Data," April 2014. https://www.envirostor.dtsc.ca.gov/public/EnviroStor%20Fact%20Sheet.pdf.

Epple, Dennis. "Modeling Population Statification Across Locations: An Overview." *International Regional Science Review* 26, no. 2 (April 1, 2003): 189–96. https://doi.org/10.1177/0160017602250975.

GeoLytics, Inc, Urban Institute, and US Census Bureau. "Neighborhood Change Database (NCDB) 2010: Tract Data for 1970-80-90-00-10." Branchburg, New Jersey: GeoLytics, 2013.

Jr, Manuel Pastor, James L. Sadd, and Rachel Morello‐Frosch. "Who's Minding the Kids? Pollucion, Public Schools, and Environmental Justice in Los Angeles." *Social Science Quarterly* 83, no. 1 (2002): 263–80. https://doi.org/10.1111/1540-6237.00082.

Kearney, Greg, and Gebre-Egziabher Kiros. "A Spatial Evaluation of Socio Demographics Surrounding National Priorities List Sites in Florida Using a Distance-Based Approach." *International Journal of Health Geographics* 8, no. 1 (June 17, 2009): 33. https://doi.org/10.1186/1476-072X-8-33.

Krieg, Eric J. "A Socio-Historical Interpretation of Toxic Waste Sites: The Case of Greater Boston." *American Journal of Economics & Sociology* 54, no. 1 (January 1995): 1–14. https://doi.org/10.1111/j.1536-7150.1995.tb02622.x.

Lee, Charles, and Benjamin Chavis. "Toxic Wastes and Race in the United States." *United Church of Christ Commission for Racial Justice*, 1987. http://d3n8a8pro7vhmx.cloudfront.net/unitedchurchofchrist/legacy_url/13567/toxwrace87.pdf?1418439935.

Mohai, Paul, and Robin Saha. "Reassessing Racial and Socioeconomic Disparities in Environmental Justice Research." *Demography* 43, no. 2 (2006): 383–99.

———. "Which Came First, People or Pollution? A Review of Theory and Evidence from Longitudinal Environmental Justice Studies." *Environmental Research Letters* 10, no. 12 (December 1, 2015b): 125011. https://doi.org/10.1088/1748-9326/10/12/125011.

———. "Which Came First, People or Pollution? Assessing the Disparate Siting and Post-Siting Demographic Change Hypotheses of Environmental Injustice." *Environmental Research Letters* 10, no. 11 (November 1, 2015a): 115008. https://doi.org/10.1088/1748-9326/10/11/115008.

Pastor, Manuel, Jim Sadd, and John Hipp. "Which Came First? Toxic Facilities, Minority Move-In, and Environmental Justice." *Journal of Urban Affairs* 23, no. 1 (2001): 1–21. https://doi.org/10.1111/0735-2166.00072.

Pellow, David N. "Environmental Inequality Formation: Toward a Theory of Environmental Injustice." *American Behavioral Scientist* 43, no. 4 (January 1, 2000): 581–601. https://doi.org/10.1177/0002764200043004004.

Pellow, David N., and Lisa Sun-Hee Park. *The Silicon Valley of Dreams: Environmental Injustice, Immigrant Workers, and the High-Tech Global Economy*. Critical America. New York: University Press, 2002.

Saha, Robin, and Paul Mohai. "Historical Context and Hazardous Waste Facility Siting: Understanding Temporal Patterns in Michigan." *Social Problems* 52, no. 4 (November 2005): 618–48. https://doi.org/10.1525/sp.2005.52.4.618.

Saxenian, AnnaLee. "Institutions and the Growth of Silicon Valley." *Berkeley Planning Journal* 6, no. 1 (1991). https://doi.org/10.5070/BP36113117.

———. "Silicon Chips and Spatial Structure: The Industrial Basis of Urbanization In Santa Clara County, California," March 1, 1981. https://escholarship.org/uc/item/56q8x15x.

Schlossberg, Tatiana. "Silicon Valley Is One of the Most Polluted Places in the Country." The Atlantic, September 22, 2019. https://www.theatlantic.com/technology/archive/2019/09/silicon-valley-full-superfund-sites/598531/.

Sicotte, Diane M. "The Importance of Historical Methods for Building Theories of Urban Environmental Inequality." *Environmental Sociology* 2, no. 3 (2016): 254–64. https://doi.org/10.1080/23251042.2016.1221170.

Sonnenfeld, David. "The Politics of Production and Production of Nature in Silicon Valley's Electronics Industry." *International Journal of Business and Society* 3 (January 1, 2002): 1–24.

Szasz, Andrew, and Michael Meuser. "Unintended, Inexorable: The Production of Environmental Inequalities in Santa Clara County, California." *American Behavioral Scientist* 43, no. 4 (January 1, 2000): 602–32. https://doi.org/10.1177/00027642000043004005.

US EPA, OLEM. "National Priorities List (NPL) Sites - by State." Data and Tools. US EPA, August 14, 2015. https://www.epa.gov/superfund/national-priorities-list-npl-sites-state.

Vesterinen, Hanna M., Rachel Morello-Frosch, Saunak Sen, Lauren Zeise, and Tracey J. Woodruff. "Cumulative Effects of Prenatal-Exposure to Exogenous Chemicals and Psychosocial Stress on Fetal Growth: Systematic-Review of the Human and Animal Evidence." *PLoS ONE* 12, no. 7 (2017): e0176331. https://doi.org/10.1371/journal.pone.0176331.