Expanding CalEnviroScreen as a Tool for Environmental and Public Health Resilience

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EXECUTIVE SUMMARY

The COVID-19 pandemic has disproportionately affected certain groups in California and throughout the United States— often including overlapping communities of color, lower-income communities, and medically vulnerable populations. These disproportionate impacts highlight stark disparities in health burdens and benefits and raise questions about how we should distribute resources in a large-scale health crisis. CalEnviroScreen (CES) is a mapping and database tool created by the California Office of Environmental Health Hazard Assessment that is currently used by various state agencies to identify communities that are disproportionately affected by multiple sources of pollution and may be especially vulnerable to environmental hazards. This paper aims to examine how CES can be used—and be more useful—in the context of public health crises, based on lessons learned from the ongoing pandemic.

We (a team of UC Berkeley undergraduate students) compared CES with another key environmental health and justice mapping tool and identified potential avenues for improving and using CES to inform more effective and equitable public health crisis response. In a comparison with EJScreen (EJS), an environmental health and justice mapping tool developed by the U.S. Environmental Protection Agency, we identified 7 indicators that are not currently included in CES but are both correlated with health outcomes and could be easily incorporated due to EJS' data transparency. In addition, we conducted a literature review to identify 10 additional indicators (primarily socioeconomic/demographic) that may be especially relevant to public health but are not currently included in either tool.

We argue here that CES could be expanded to more specifically address public health needs. In addition, we discuss how CES is currently used, drawing on several case studies, and offer a proposal for expanding its use for identifying "health-disadvantaged" communities to inform both environmental and public health interventions, recognizing that public health and environmental health are tied hand in hand.

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BACKGROUND

a. What is CES and what is it used for?

CES is a mapping tool which utilizes environmental, socioeconomic, and health indicators to determine which communities in California are most burdened by multiple sources of pollution and may be especially vulnerable to the effects of pollution. It organizes environmental, socioeconomic, and health indicators (visualized in Figure 1) to produce pollution burden, population characteristics, and overall scores for each census tract to enable relative comparisons of communities ("About CalEnviroScreen"). A higher score indicates a higher pollution burden, greater vulnerability based on population characteristics, or both. Individual indicators are measured using data from state and federal government sources including the California Air Resources Board (CARB), the California Department of Public Health (CDPH), and the U.S Census.[2]

CES is used by California governmental agencies to "aid in administering environmental justice grants, promote compliance with environmental laws, prioritize site-cleanup activities and identify opportunities for sustainable economic development," as well as by local nonprofit organizations ("CalEnviroScreen FAQs"). It has also been used to inform policies, programs, and expenditures meant to address environmental justice issues in California communities across the state. For example, Senate Bill 535 (2012) requires that 25% of revenue from the cap-and-trade program's Greenhouse Gas Reduction Fund be invested in disadvantaged communities (DACs), which CalEPA has defined for the purposes of SB 535 as the top 25% scoring areas in CES, as well as other areas with high pollution and low populations ("SB 535 Disadvantaged Communities"). As of December 2015, 51% of $912 million allocated to California Climate Investments have funded projects that benefit DACs identified by CalEPA (CalEPA 2017). This money goes towards projects such as enforcement, education, and increased monitoring initiatives, the specifics of which will be expanded on later in this report. The Environmental Justice Task Force uses the same definition of DACs in order to strengthen environmental justice initiatives in CES-identified communities and improve enforcement of environmental regulations in those areas ("Environmental Justice Task Force"). CES is also used by the Department of Toxic Substances Control (DTSC), CalRecycle, the Sustainable Communities Planning Grants and Incentives Program, and the Affordable Housing and Sustainable Communities Program, among others, to better target program resources ("Using CalEnviroScreen"). We describe case studies of CES use at the local level—for projects in Boyle Heights, Pacoima, and West Fresno—later in this paper.

CES is a work in progress and OEHHA has identified that there is more which can be done to improve the tool's utility. For example, cardiovascular health was added as an indicator for Version 3.0 after public comments for Version 2.0 expressed that it had not included enough

[2] Full list of sources: U.S Environmental Protection Agency (EPA), The California State Water Resources Control Board, the U.S Geological Survey, the California Department of Pesticide Regulation (DPR), the Mexico Registry of Emissions and Pollutant Transfer (RETC), the US Department of Transportation, US Customs and Border Protection, the San Diego Association of Governments (SANDAG), the California Department of Toxic Substances Control (DTSC), the California Department of Resources Recycling and Recovery (CalRecycle), the US Census Bureau

health indicators. OEHHA has recently released Version 4.0, which includes one new indicator (lead exposure in housing) and updates and refines all indicators.

The ongoing COVID-19 pandemic is highlighting severe public health inequities, so it is particularly important to identify and monitor important determinants of public health to reduce vulnerability and increase resilience in at-risk communities. Our proposal is twofold, focusing on: 1) why CES should include additional indicators related to environmental health and 2) how state agencies and regional governments can use CES to guide more effective public health response, related to the current COVID-19 pandemic and beyond.

b. What indicators does CES include, and what might it be missing?

In order to identify vulnerable communities, CES utilizes 21 statewide environmental, socioeconomic, and health indicators, categorized into "Pollution Burden" and "Population Characteristics." Thirteen environmental exposure and effects indicators are categorized under Pollution Burden and address concentrations of primary air pollutants, drinking water contaminants and impaired water bodies, indicators relating to toxic releases and hazardous waste, pesticides, and the impacts of traffic (see full list of indicators in Figure 1). Population Characteristics indicators include five socioeconomic indicators relate to poverty, housing-burdened low-income households, educational attainment, linguistic isolation, and unemployment and three indicators that directly address health outcomes: emergency department visits for asthma, emergency department visits for heart attacks (cardiovascular disease), and low birth weight infants. For each census tract, CES assigns a value for the intensity of each indicator as a percentile relative to the rest of the state. These percentile values in each census tract are then averaged, indexed, and assigned a score from 0 to 100, with higher values indicating greater vulnerability, which is displayed on the map tool output (Faust, et al. 2021).

The indicators and outputs utilized by CES reflect the program's original focus on environmental health and pollution impacts in California, and have resulted in the allocation of resources and the initiation of projects. However, as our analysis revealed, CES does not fully address the relationship between environmental health, socioeconomic inequality, and public health outcomes, especially in the context of a global health crisis like COVID-19. In order to assess what additional indicators could better guide actions to reduce or address public health vulnerabilities during—and in advance of—public health crises, our team first compared the indicators included in CES and EJS, a similar mapping tool used to identify vulnerable communities at the federal level. We identified indicators that are included in EJS but not in CES. We then conducted a literature review to determine whether additional indicators, not currently included in either tool, are correlated to adverse health outcomes and would thus be useful if incorporated into a tool like CES.

c. What is EJS and why is it a relevant tool for comparison with CES?

EJS is a tool developed by the U.S. Environmental Protection Agency that uses transparent, accessible environmental and demographic indicators to "screen for areas that may be candidates for additional consideration, analysis or outreach as EPA develops programs,

policies and activities that may affect communities" ("How does the EPA use EJScreen?"). Its 11 environmental indicators are primarily collected and/or calculated from EPA databases, and its 6 demographic indicators are primarily derived from U.S. census data. EJS also includes additional data from the 2014-2018 American Community Survey to input data involving more specific socioeconomic factors such as employment type, language, and local housing prices. As EJS is a large-scale, detailed, and comparative tool with a similar mission to CES, and the data underlying its indicators are publicly accessible, we posit that CES could be straightforwardly modified to include relevant EJS indicators it currently lacks as both are composed of information available for census tracts.

OUR FINDINGS

a. What did our comparison and literature review reveal?

Our team first distinguished the indicators included in EJS but not yet included in CES. For each indicator, we assessed evidence supporting its addition to a future iteration of CES. Finally, we conducted a literature review to identify additional indicators—not currently included in either tool—that are strongly correlated with public health and that could help CES better identify health-vulnerable communities in need of actions to address vulnerabilities in the context of public health crises like the COVID-19 pandemic. Figure 1 (see next page) summarizes these findings:

Figure 1. Table of Indicators Included in CES, EJS, Both and Neither
Indicators included in CES AND EJS, Indicators included in CES, Relevant indicators not included in CES that are included in EJS, Relevant indicators found in literature to be associated with COVID-19 vulnerability that are not included in CES [Source: CES 3.0, CES 4.0 draft tool]

Environmental	Socioeconomic	Health
PM 2.5	Educational Attainment	Asthma Rate
Ozone	Unemployment	Cardiovascular Disease
Diesel PM	Linguistic Isolation	Low Birth Weight Infants
Hazardous Waste	Poverty	Obesity
Traffic	Housing Burden	Pulmonary Diseases
Lead from Housing [4.0]	Renter Occupied Housing, Owner Occupied Housing, Public Housing	Cancer
Superfund Proximity	Park Access	
Drinking Water [4.0]	Prisons	
Impaired Waste [3.0] Impaired Water [4.0]	Tribal Areas	

Solid Waste	Health Insurance	
Pesticides	Food Access/Deserts	
Cleanups	Internet Access	
Groundwater	Digital Literacy	
Toxic release	Frontline/Essential Workers	
NATA Respiratory Hazard Index	Electricity Access	
NATA Cancer Risk from Air Toxin Inhalation		
Extreme Heat		
Wildfires (effect on PM 2.5)		

b. Environmental indicators that could be added to CES

We found that three environmental indicators are included in EJS but not in CES: National-Scale Air Toxics Assessment (NATA) Respiratory Hazard Index, NATA Cancer Risk from Air Toxin Inhalation, and Extreme Heat. Our team concluded that Risk Management Plan (RMP) Site Proximity, a fourth indicator found only in EJS, was substantially similar to CES' information on superfund and hazardous waste sites. Based on our research, the air pollution and extreme heat indicators appeared most important.

CES includes distinct indicators tracking PM 2.5, ozone, and diesel pollution. However, while National Ambient Air Quality Standards only address six major ("criteria") air pollutants, pollution sources emit many other chemicals that can cause disease and contribute to negative health outcomes (Bagley 2020). These include, for example, the numerous chemicals that may be released in petrochemical operations or from incinerators and ultra-fine particles, black carbon, and other byproducts of diesel exhaust (Bagley 2020). This correlation between environmental health and human health underscores the importance of monitoring air pollution in part to identify at-risk communities, especially communities vulnerable to respiratory illnesses like COVID-19. This aligns with CES' mission to address inequalities in environmental health across communities. Thus, while there currently exists no fully comprehensive indicator to capture the true extent of the impact of air pollutants on health, indicators like the **NATA Respiratory Hazard Index** and **Cancer Risk from Air Toxin Inhalation** directly correlate exposure to toxic pollutants with health risks and would thus be useful additions to a tool like CES.

Extreme heat is another indicator not included by CES which has drastic consequences for human health. According to the CDC, extreme heat events can trigger heat stroke, respiratory illnesses (as heat is correlated to increased concentration of air pollutants), and increased mortality ("Extreme Heat"). A recent study conducted in Los Angeles County revealed that during summer heat events, a one percent increase in residents working outdoors resulted in an "8.1 percent increase in heat-related [emergency department (ED)] visits and a 7.9

percent increase in heat-related hospitalizations, while each percentage increase in residents working in agriculture and related sectors resulted in a 10.9 percent increase in heat-related ED visits." (Riley et al. 2013) Heat vulnerability, especially in California, is currently increasing and "oppressive weather patterns" are predicted to further increase over the coming century (Sheridan et al. 2012), which will continue to exacerbate health issues in vulnerable communities, especially those with large agriculture, construction, or other outdoor industries. During the COVID-19 pandemic, extreme heat in urban communities has posed an issue as the congregation at cooling centers (sites where air conditioning is accessible to provide relief and protection during extreme heat) increases transmission risk, as it involves gathering indoors where it is often difficult to maintain physical distancing ("COVID-19 and Cooling Centers"). Thus, this indicator will be an increasingly relevant one to incorporate in a tool focused on identifying and addressing public health needs.

Finally, based on our literature review, one environmental indicator that is currently not addressed by CES but may be especially important in California is **wildfire** frequency and severity. Wildfire seasons are increasing in length and intensity with global climate change, and wildfire events, which have led to the losses of homes, valuables, and lives, can cause devastating impairments of lung function due to unsafe PM 2.5 levels (Henderson 2020). A recent study in Reno, Nevada demonstrated that the time period most affected by wildfire smoke (August 16 to October 10) corresponded to an estimated 17.7% increase in the number of local COVID-19 cases (Kiser et al. 2021). Within communities affected by wildfire events, acute health conditions associated with smoke disproportionately affect populations with pre-existing conditions due to other air pollution exposure (Garthwaite 2021). In addition, extreme wildfire conditions in California have led to deliberate electricity shut-offs by Pacific Gas and Electric, which additionally impacts on COVID-19 risk as discussed later in this report (Graff 2020). Thus, it is highly important to monitor wildfire frequency and risk not only for local stakeholders to implement preventative wildfire mitigation measures, but also at a state level to be able to better identify communities at higher risk of developing or exacerbating health issues during and after events of wildfire. While EJS does not currently have an indicator easily transferable to CES, there exist relevant data sources such as the California Public Utilities Commission's FireMap, which provides accessible information regarding current regions of Tier 2 and 3 Fire Threat levels ("CPUC High Fire Threat District"), as well as Cal Adapt's map tool with associated available data, which predicts area burned in hectares by year until the year 2090 ("Wildfire").

c. Socioeconomic indicators from EJS that could be added to CES

CES and EJS both include important socioeconomic indicators that are associated with health outcomes. Two extremely relevant indicators which are included as map layers on EJS but are not included in CES are race/ethnicity and age (% over 65 and % under 5). Often, low-income communities and communities of color are overlooked, actively neglected, or ignored when in need of public or environmental health assistance resulting in a lack of resources to combat challenges (Jackson 2019). Although CES has not included race/ethnicity or age in any of its editions due to the fact that some government entities are restricted from using it as a factor in decision making, it is a vital factor in designing environmentally and racially just policy

used in responding to public health crises (CalEPA 2013). While race/ethnicity and age do not necessarily have to be a part of the overall Population Characteristics indicator which is used to determine DACs, they could at least be included as map layers available to inform responses to health and environmental issues within DACs because different racial communities and age groups have varying public health risks and needs.

Several other social map layers included in EJS that would be relevant to include in CES as indicators to identify health-disadvantaged communities include: Renter Occupied Housing, Owner Occupied Housing, Public Housing, Parks, Prisons, and Tribal Areas.

Housing type (owned versus rented as well as public housing) and availability have been shown to determine health outcomes (Smith et al. 2003). California has long faced a critical housing shortage, and in the past year the state has faced a devastating eviction crisis due to unprecedented job loss and economic hardship, especially in low income populations and communities of color. Eviction has been shown to likely increase COVID-19 infection rates as it results in "overcrowded living environments, doubling up, transiency, limited access to healthcare, and a decreased ability to comply with pandemic mitigation strategies" (Benfer et al. 2021). Overall, having a better understanding of renter populations and public housing could be beneficial to identifying communities at risk of eviction and the associated devastating impacts on health.

Parks and overall proximity to green space have also been correlated to lower rates of cardiovascular disease, obesity, and diabetes, especially in teenagers. However, there are significant disparities in access to these spaces in communities throughout California, exacerbating inequities in public health as well as quality of life (as parks are a space where residents can often enjoy recreational activities while maintaining a safe distance from others) during the COVID-19 pandemic. Therefore, adding a park accessibility map layer to CES could be useful in identifying unique communities vulnerable to health issues, and could be useful in guiding interventions focused on increasing opportunities for active behavior and beneficial health outcomes (Maroko et al. 2009).

Prisons are currently identified by EJS and also can serve as an identifier of health-disadvantaged communities. In the context of the COVID-19 pandemic, carceral conditions have resulted in case and mortality rates higher in jails and prisons than in the general community, and "more incarcerated people have died from COVID-19 in U.S. correctional facilities in the past year than died by capital punishment in the past 70 years" (Chin et al. 2021). Not only is it vital to protect incarcerated people and staff during such public health crises, but emphasizing prison locations and demographics can be critical for curbing the spread of infectious diseases such as COVID-19 into the surrounding communities, "especially Black and Latinx communities that are disproportionately affected by jail- and prison-linked coronavirus spread" (Barsky et al. 2021). Including an indicator monitoring prison locations on CES would clearly increase its utility in identifying novel health-disadvantaged communities and directing resources in the context of public health crises.

Lastly, **Tribal land** is an especially relevant indicator as the COVID-19 pandemic revealed a significant disparity in health outcomes and access to treatment by race, especially in Native communities on Tribal lands (Yellow Horse et al. 2021). Structural inequalities, such as lack of plumbing, poor access to transportation, and inaccessible health communication, are factors which were found to exacerbate negative health outcomes in these communities. Tribal lands

should thus be monitored in order to assure that they are not ignored and that Indigenous communities receive equitable access to healthcare-related benefits from available public health-oriented programs.

d. Socioeconomic indicators from literature review that could be added to CES

In order to identify which communities are most likely to be affected by public health crises, CES should also take into account additional relevant socioeconomic factors correlated to health outcomes. Our literature review identified these key indicators to be: health insurance, food access, internet access and digital literacy, percentage of "essential workers," and reliable electricity access.

One primary indicator identified by our literature review is rates of **health insurance**. In 2019, over 26 million Americans were uninsured, with higher rates of uninsurance in Latinx and Black populations and low-income communities (Keisler-Starkey 2020). Not only do these uninsured populations experience a high burden of pre-existing conditions and comorbidities that exacerbate their risk of complications from infections like COVID-19, they are "more likely to delay access to care and to use emergency departments, rather than seek care through an established primary care provider" which in turn "raises the potential of uninsured patients increasing the risk of infection among already stretched emergency department staff" (Khatana et al. 2020). Job losses during the COVID-19 pandemic have only increased rates of uninsurance, as over half of non-elderly adults in the US rely on their employer for sponsored health insurance (Khatana et al. 2020). Apart from the US census, which collects data on health insurance type and rates through three national surveys ("Health Insurance"), the California Healthy Places Index (HPI) is an accessible tool with a variety of indicators aiming to "highlight the community conditions shaping health outcomes in neighborhoods across California" ("Frequently Asked Questions"). In addition to percent of adults insured, it also collects and displays data on supermarket access, education, and transportation access and commuters, all of which will be described in the coming paragraphs as relevant indicators as well which can either be incorporated into or used in conjunction with future editions of CES. Overall, it is vital to include and monitor rates of health insurance with a tool like CES as it is a direct means of identifying communities which would be at even greater risk of severe negative health outcomes due to environmental and/or public health crises.

Food access was found to be another relevant determinant of health. People who cannot access good quality, healthy food are more likely to develop conditions such as hypertension and diabetes which only increase susceptibility to developing severe or fatal COVID-19 (Lewis 2020). In 2015, the USDA determined that 12.8% of the US population lived in food deserts, areas where residents live more than a mile from the nearest supermarket or grocery store in urban areas, or ten miles away in rural areas. The requirements to shelter in place, in combination with economic devastation caused by the current COVID-19 pandemic, has unfortunately only exacerbated disparities in food access (Lewis 2020). In order to map an indicator like food access, CES could incorporate data from the HPI as mentioned previously, as well as the Food Access Research Atlas and a Food Environment Atlas created by the Economic Research Service through the US Department of Agriculture. These atlases present food access indicators (including supermarket availability, fast food versus restaurant availability, and more)

broken down by census tract across the country ("Food Access Research Atlas"). In addition, Feeding America, which conducts an annual "Map the Meal Gap" study to identify food insecure communities and eligibility for assistance programs, has created a similar map tool broken down by county ("Food Insecurity in California"). This organization has also created a separate map tool to visualize the predicted impact of the COVID-19 pandemic on food insecurity rates in 2021 ("State by State Resource"). As data from these resources is both collected at a reasonable spatial resolution and is fairly accessible, including a food access indicator on CES would not only be useful but also doable.

In our current age of technological change and advancement, **internet access** and **digital literacy** are necessities which also impact health risks and outcomes. Lack of access to emergency risk communication and unbiased information spread—which impacts already health-disadvantaged communities of color, low income, housing insecure, and elderly communities—was found to correlate to risk of infection and severity of disease (Clark-Ginsberg et al. 2020). The American healthcare system has seen massive shifts in the past year alone, and thus future healthcare initiatives and systems must take into account inequities not only in health communication to the public but in telemedicine and online healthcare access (Nouri et al. 2020, Early et al. 2021). While it is difficult to measure digital literacy with a quantitative indicator, internet access can be captured and visualized using data from sources like the California Interactive Broadband Map, which displays broadband deployment, adoption, communities with public projects aimed to increasing internet equity, and speed of internet by provider ("California Interactive Broadband Map").

While CES includes an unemployment indicator, other indicators related to **employment** may be very important for understanding health outcomes during public health crises. For example, the COVID-19 pandemic has emphasized that the nature of the work people do can drastically change their likelihood of exposure to communicable disease. "Essential workers," a broad category of employees who "conduct a range of operations and services in industries that are essential to ensure the continuity of critical functions", have been at a significantly higher risk of infection during the COVID-19 pandemic, as these employees could not work from home regardless of community case rates and spread. Among essential workers, racial disparities in COVID-19 mortality became increasingly clear: one study revealed that vulnerability to coronavirus exposure was highest in Black communities, who disproportionately work in nine vital occupations that increase their exposure to COVID-19 (Rogers et al. 2020, Lagasse 2020). In California, Latinx communities have been affected the most overall in terms of cases and mortality rates, and Native Hawaiian/Pacific Islander communities have been disproportionately affected relative to population size ("Tracking Covid-19 in California"), which emphasizes the need for race/ethnicity to be a factor guiding environmental and public health interventions. While there currently exist no direct data sources which capture the percentage of essential workers by county or census tract, CES could incorporate data from the census—which collect data on the number of employees working from home—as well as the Healthy Places Index—which collects data on the percentage of workers who commute to their jobs via walking, biking, or transit. However, racial/ethnic differences in COVID-19 cases, hospitalizations, and deaths (and other health impacts more generally) within essential worker populations further add reason to emphasize race/ethnicity information on CES in addition to broader socioeconomic indicators like essential employment.

Lastly, based on our literature review, reliable **electricity access** could be a relevant determinant of health in all households, especially regarding electronic medical devices and online learning, work, and access to health communication. The current pandemic has only worsened energy insecurity, with higher rates of utility disconnection reported in Black and Hispanic households (Memmott et al. 2021). While there is currently no resource which comprehensively collects data on utility disconnection that include non-environmental reasons, as mentioned previously Pacific Gas & Electric has published an outages map which tracks outage sites across the state and the number of customers affected ("Outages"). Power disruptions related to environmental risks (primarily due to wildfire) are noted as "Public Safety Power Shutoffs" and disconnection for other reasons are marked alongside the number of customers the shutoff affected. Overall, as this indicator relates directly to environmental indicators such as wildfire and extreme heat but shines a light on uniquely vulnerable communities, this indicator would be yet another useful addition to a public health-focused CES.

e. Human Health indicators that could be added to CES

CES should directly capture and analyze three key health indicators—specifically, **cancer**, **obesity**, and **pulmonary diseases** (including COPD, pulmonary fibrosis, etc)—in addition to environmental and socioeconomic data, to identify more specific if not novel health-disadvantaged communities. The CDC has compiled a list of diseases which increase risk and severity of COVID-19 infection, and these three are supported by rigorous and numerous studies ("Science Brief"). While these indicators are relevant to understanding COVID-19 risk, they are also common comorbidities which increase risk and severity of many other diseases (Khatana et al. 2020). To capture these indicators on a tool like CES, the tool could input data from the California Healthy Maps, which outputs health statistics beyond the county level and displays cancer and obesity statistics by ethnicity, as well as rates of uninsurance and food insecurity ("California Health Maps").

f. Recommendations and moving forward

While the current indicators included in CES have been useful in identifying communities burdened by pollution and environmental hazards, the COVID-19 pandemic has shined a light on uniquely health-vulnerable communities which are currently not being monitored. Thus, in order to be able to identify health-disadvantaged communities and expand the utility of CES as a comprehensive environmental and public health tool, we propose the incorporation of the additional indicators described above. Of the indicators described, the most relevant are ones that have both a strong correlation with public health outcomes and EJ as well as ones whose data are readily accessible for use and incorporation.

These include:

- **Map layers included in EJS:** NATA Respiratory Index, NATA Cancer Index, Extreme heat, Housing type, Park access, Prisons, and Tribal lands
- **Indicators monitored by external sources:** Extreme heat, Health insurance, Food access, Internet access, Cancer, and Obesity

Ultimately, by integrating some or all of the indicators mentioned above, CES would be better equipped to identify communities with public health vulnerabilities and support actions to improve environmental and public health and increase community resilience to public health crises across the state. The ongoing pandemic has only solidified our understanding that disease outbreaks contain environmental and socioeconomic threats playing out in a public health landscape where racial, socioeconomic, and other demographic inequities are intertwined with burdens of environmental pollution, fueling increasing health vulnerabilities.

CURRENT AND POTENTIAL USES OF CES

a. CES has been used to target environmental enforcement initiatives for overburdened and vulnerable communities

CES has already been used to identify vulnerable communities for which to allocate funds and design interventions. Using the cumulative indicators maps, underlying data, and socio-economic data, **Fresno, Boyle Heights, and Pacoima** were identified by the Environmental Justice Compliance and Enforcement Working Group as communities vulnerable to pollution and socioeconomic disadvantages relative to other parts of the state ("Los Angeles Initiative Report" 2017). The initiatives conducted in these communities to increase monitoring, enforcement, and education to improve environmental justice and health will be discussed later in this report. See Box 1 below for brief descriptions of these cases. Reviewing these programs helped us understand some of the ways by which CES has aimed to improve public and environmental health. The outcomes of previous projects will assist us in examining how CES could be used with a greater focus on health and public health crises. Using these projects as examples, successes and shortcomings of CES can be analyzed through a public health lens.

In addition to the larger-scale projects described in Box 1, CES has been used to target smaller-scale, supplemental environmental projects in DACs which have suffered from violation of environmental regulations, led by a variety of state and local agencies ("Fresno Initiative Report" 2015).[3] According to one study, the California Climate Investment projects with funding directed by CES provided benefits such as: 4,100 affordable housing units, 14,000 trees in urban areas, 2,904 single family home solar power systems, energy efficiency upgrades for 8,961 single family homes, and energy efficiency and/or solar power system for 4,549

[3] These include the State Water Resources Control Board, the Department of Toxic Substance Control, the California Public Utilities Commission, the California Energy Commission, the San Diego Climate Action Plan, the Los Angeles County Mobility Plan, the Chevron Richmond Refinery Modernization Project Environmental Impact Report, Senate Bill 1000, and Assembly Bill 693.

households in multifamily housing ("CalEnviroScreen: A Critical Tool" 2018). While these interventions have had positive consequences, it is important to note that they have been purely "environmental" initiatives which lack a strong public health focus, despite the end goal being to improve local public and environmental health outcomes. Reporting on these general outcomes also includes no mention of improvement of health as a result, which we argue should be a focus of CES as it would increase its utility as an environmental justice tool. As the state uses CES moving forward to identify communities in need of aid to foster environmental health, a focus specifically on human health factors could help address some of the deeply connected systemic inequities that the COVID-19 pandemic has revealed.

Overall, while these initiatives have provided preventative solutions that have short term impacts on health outcomes, residents continue to suffer from the permanent health consequences of previous pollution even if preventative measures are taken for the future. It is the responsibility of environmental organizations to have a public health outlook and impact because interdisciplinary work is the only way public and environmental health can be equitable across the state.

Box 1. Case Studies of CES Partnerships

West Fresno

In 2013, West Fresno was ranked the unhealthiest place to live in California ("Congress must aid" 2013). Known for its poor air quality, Fresno receives air pollution from heavy highway traffic, truck traffic, factories, agriculture, pesticides, and wildfires ("Fresno Air Quality Index"). As a result, emergency room visits due to asthma are extremely high relative to the rest of the state, staggeringly in the 98th percentile. The rates of asthma in west Fresno are the highest in Fresno County where over 20% of children under 17 have been diagnosed. Fresno's overall asthma rates are disproportionately high in African American and Native American children in the region (Rondero et al. 2004).

The Environmental Justice Compliance and Enforcement Working Group (Working Group) began the first project using CES to identify target communities in West Fresno in 2013 ("Fresno Initiative Report" 2015). The project area chosen by the Working Group partnership encompassed parts of west Fresno and some surrounding areas included in Fresno County. One of the most serious sources of pollution comes from traffic, causing the study area to be in a particularly vulnerable area in terms of respiratory health ("Fresno Initiative Report" 2015).

The enforcement initiative was implemented with the goal of reducing pollution as well as reducing its impact on the community. This goal consisted of three components: community consultation to determine community concerns, compliance assistance for regulated industries and businesses, and coordinated, multi-agency compliance inspections and enforcement activities designed to concurrently address environmental issues within the community. Regulations were implemented to reduce air pollution, hazardous waste mismanagement, solid waste mismanagement, pesticide contamination, and water contamination. CES was instrumental in these projects as it was used by the Working Group to

find target communities for EPA funded projects. CES, alongside community consultation, also informed necessary actions such as compliance enforcement and education as well as regulations ("Fresno Initiative Report" 2015, "Los Angeles Initiative Report" 2017). After two years, the CalEPA reported on the progress of the project. It was found that the project had been mostly successful with an overall compliance rate among facilities and industries was 87%. Furthermore, between 2015 and 2017, Fresno experienced a record low of PM pollution for 27 days ("Fresno Air Quality Index"). In reducing air pollution and other contamination through regulation and community education, the Fresno initiative assisted in improving public health as pollution is correlated with increased health disparities, such as asthma and other pulmonary diseases. Ultimately, CES was useful in identifying a health-disadvantaged area to locate the initiative in and CES data indicated what environmental regulations were needed to improve environmental health. However, there were no initiatives targeted to address needs of overburdened groups such as African American and Native American children in the region. Overall, the enforcement initiative did not mention racial groups suffering disproportionately from health burdens nor did it directly monitor health outcomes as an endpoint of its intervention. To truly be a tool that aids in improving public health, the Working Group could have also used additional indicators of race/ethnicity and health indicators such as annual asthma-related emergency room visits to compare health outcomes before and after completing the project. Although reduced contamination due to environmental enforcement would have improved public health as a whole, organizations that partner with CES for projects should monitor marginalized communities within environmentally burdened regions and provide direct resources to promote health equity.

Boyle Heights and Pacoima

Two other prominent projects initiated by the Working Group using data from CES to identify target communities are located in Los Angeles County. The Boyle Heights and Pacoima projects began in 2015, using the Fresno project as a guiding model ("Los Angeles Initiative Report" 2017). Based on CES data, both of these communities were in the top 5% of DACs regarding pollution burden and relative to the rest of California. The Los Angeles metropolitan area ranks as one of the most ozone-polluted areas in the country and, in Boyle Heights, children are twice as likely relative to the state average to have an asthma related hospital visit ("Los Angeles Neighborhoods" 2012). Adults in Boyle Heights also are more likely to suffer from strokes, cancer, and cardiovascular disease while children are at higher risk of asthma and chronic lung disease (Guidi 2019). In the north-east part of the San Fernando Valley, where Pacoima is located, 1 in 16 children and 1 in 7 adults have asthma (Moran-Perez 2019). Both Boyle Heights and Pacoima are predominantly Hispanic/Latinx, are situated near major highways which create a high air pollution burden of PM 2.5 and diesel PM, have reported contaminated produce, and have a lower median income than Los Angeles as a whole. Furthermore, over 30% of people in both communities lack health insurance. However, CES used environmental vulnerability as a sole reason to choose Pacoima and Boyle Heights as initiative sites, and measures (non-specific to vulnerable groups within these communities) to reduce sources of pollution were proposed.

To better assist the communities, the Working Group did directly partner with local nonprofits in each area to address specific community needs. Direct cooperation with local nonprofits was a difference between the Los Angeles and Fresno projects as in Fresno, general community consultation was mainly utilized rather than specific nonprofit partners ("Fresno Initiative Report" 2015, "Los Angeles Initiative Report" 2017). Through community consultation, concerns about environmental regulations disproportionately affecting small businesses were addressed. Citizens also were able to relay their specific worries to the working group. Issues of interest included air pollution, toxic chemicals, industrial odors, noise pollution, illegal dumping, dust, lack of waste disposal sites, and illegal toxic backyard business activity. The environmental regulation enforcement initiatives focused on waste management, recycling practices, truck emissions regulation, contaminants in produce reduction, water quality management, and solid waste disposal compliance. When reviewing the success of these projects in 2017, it was found that the majority of cites were in compliance with new regulations. However, this initiative, similar to Fresno, only focused on controlling and mitigating pollution sources as opposed to the outcomes and impacts of pollution. To improve public health issues correlated with the targeted environmental issues, health response and treatment need to be implemented in these communities to treat already affected people.

Ultimately, CES' current indicators were able to identify Boyle Heights and Pacoima as communities with a great need for intervention. However, by adding socioeconomic and health-focused indicators, CES could have not only identified other communities with similar issues but more importantly could have also informed the response. In this case, highlighting issues specific to the community, such as underinsurance and other disease prevalence could have improved both program design and health outcomes.

b. How could CES be used to guide response to public health crises?

As demonstrated through the efforts in West Fresno, Boyle Heights, and Pacoima, CES can be used to help target environmental health interventions in communities that have been over burdened by and are vulnerable to pollution. We argue that, based on the relationship between public and environmental health, the inclusion of additional health-relevant indicators (described in section 2) in CES could be used to help create more resilient communities in the face of public health crises by responding directly to existing health issues. Health disparities can often be caused or exacerbated by environmental and societal stressors, thus communities suffering from disproportionate levels of pollution and socioeconomic burdens should be prioritized in pandemic response plans.

Communities identified by CES as disproportionately burdened by and vulnerable to pollution are also those that have been most significantly impacted by the COVID-19 pandemic. As of August, 2021, in Fresno County, 1 in 9 people have tested positive for COVID-19 resulting in 1 death per 573 people. In Los Angeles County (home to Pacoima and Boyle Heights), 1 in 8 people have tested positive resulting in 1 death per 406 people ("California Coronavirus Map and Case Count" 2021). This rate is high compared to Sierra County, the county with the lowest rate, where 1 in every 35 people have tested positive and there have been 0 deaths. In May

2021, 41.1% of Fresno County was fully vaccinated, compared to 52.5% for California as a whole. Within the county, minority communities have had lower vaccination rates. As of late May 2021, about 62% of the Hispanic/Latinx community and 71% of the Black community had not received their first dose (Sheehan 2021). At that time, less than 25% of the Hispanic/Latinx community who were eligible for the vaccine and 19% of the Black community had been fully vaccinated. In comparison, about 37% of White and Asian populations had been fully vaccinated. Furthermore, as of August 2021, both Boyle Heights and Pacoima have a vaccination rate of about 63% which lags behind Los Angeles County as a whole with a rate of about 72% ("COVID-19 Vaccine" 2021). In LA, the vaccination rates differ between races, as about 67% of White residents are vaccinated while just 57% of Hispanic/Latinx and 47% of Black residents are vaccinated. The impact of COVID-19 in California falls disproportionately onto lower income people of color who not only live in communities heavily burdened by other socioeconomic factors (such as underinsurance, lack of park access, lack of electricity and internet access, burden of essential employment, and more—as discussed previously in this report) but also more frequently subject to health risks. Pandemic response, specifically vaccination rollouts, were not effectively targeted to these communities, shown by the current relative rates of vaccination in these communities compared to nearby counties.

This as a whole demonstrates that health tools are not currently identifying all of the factors that determine health outcomes and that should be used to cater an effective and equitable public health response based on individual community needs. It is important to note in addition that if these communities had been allocated health resources based on their unique situations and disadvantages, they may have been more resilient in the face of the pandemic. Two communities may both be identified as DACs by tools like CES, but may have vastly differing burdens which require differing public health interventions respectively. CES indicators, and the proposed indicators above, could have better guided preparation for a health crisis by, for example, sending communities with high incidences of asthma more respirators for their hospitals or advertising health resources and COVID-19 guidelines through flyers rather than on the internet for communities with low internet access.

Historical marginalization despite community outcry has left certain communities—especially uninsured, housing and/or electricity-insecure, high-risk, and other marginalized communities which are often disproportionately lower-income communities of color—systematically burdened by environmental burdens and thus health disparities. Although community members have fought to improve the environmental health and social opportunities in their communities, they have often been denied the resources to make large changes. These communities must be empowered during the COVID-19 pandemic and beyond to reduce the effects of existing health disparities. CES can be instrumental in achieving this. Moving forward, we recommend that agencies associated with environmental projects use CES to include and inform public health interventions as a part of their environmental initiatives. In addition, organizations involved with public health should use CES in conjunction with health-specific tools to inform their interventions, which should be designed incorporating the environmental and socioeconomic factors burdening the community. Apart from governmental projects backed by CES beginning only in the CalEPA, public health-oriented agencies should also use this tool more frequently to inform public health responses in a way that takes into account environmental conditions in specific communities.

In the context of the COVID-19 pandemic, the CA Department of Public Health released a "blueprint for a safer economy" that requires counties to ensure that COVID-19 rates do not disproportionately affect marginalized communities determined based on the Healthy Places Index (mentioned previously in this report), and further requires that they target investments based on the HPI index as well. The HPI includes a variety of indicators (spanning environmental, socioeconomic, and health). The inclusion of CES' many environmental indicators in conjunction with the HPI would improve the identification of health-disadvantaged communities and the appropriate public health response. Examples include using wildfire indicators by the CA Dept of Public Health to inform N95 mask-wearing protocol (for example, in smoky areas, even if a county is designated COVID-19 yellow tier, they should still be advised to wear masks outside as wildfire smoke increases severity of COVID-19). Communities with low park access need means for children and teens to be outside and urban communities facing extreme heat need effective solutions to enable residents to be able to maintain social distance. During instances of extreme heat or wildfire events, in the context of the ongoing pandemic or any period of high prevalence of a respiratory virus, HEPA filter allocation can be directed to locations where people need to stay indoors but cannot socially distance.

In general, all projects that use CES to identify DACs in which to enact projects should also inform their initiatives based on the demographics and characteristics of individual communities. For instance, communities with linguistic isolation should have multilingual resources that are widely available, and low internet access communities should host public health events to raise awareness, or hang up fliers rather than send out emails.

CONCLUSION

CES has been used to target actions to improve public health in communities that are disproportionately burdened by and vulnerable to environmental pollution. Because environmental stressors and socioeconomic inequities reinforce one another to intensify negative public health outcomes, a tool like CES which is already equipped to identify vulnerable communities based on environmental exposures and certain demographic information can be vital to addressing public health crises. A stronger focus on public health and its connection to environmental exposures would ultimately allow the state to identify "health-disadvantaged" communities and to allocate resources to these communities to combat such crises effectively. By implementing the indicators and expanding usage as described in this paper, CES would be able to serve as a model for other states and potentially the country as a whole, aiming to address and serve environmental justice by bringing health needs to the forefront in communities that need the most aid during health crises.

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