NYenviroScreen: An Open Source Data Driven Method for Identifying Potential Environmental Justice Communities in New York State

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Abstract

In 2003, the New York State Department of Environmental Conservation began designating Potential Environmental Justice Areas (PEJA) for the purpose of providing additional public participation opportunities to disadvantaged populations during permitting deliberations. We developed NYenviroScreen to help stakeholders understand, review, and provide input for how future PEJA designation might be updated and improved, including for identifying disadvantaged communities under the newly enacted Climate Leadership and Community Protection Act (CLCPA). We present and compare three potential update methods and provide an interactive web application for investigating model components and composition. The three methods are: (i) three factor clustering using the Jenks natural breaks algorithm, (ii) a cumulative impact model adapted from CalEPA's CalEnviroScreen, and (iii) a hybrid approach that utilizes both methods and incorporates Native American land areas. NYenviroScreen brings together federal and state data sources related to population health, sociodemographics, environmental risk factors, and potential pollution exposures for 15,463 census block groups. We find that a hybrid approach provides the most robust coverage for both rural and urban areas of New York State. By innovating new approaches to such designations and making them publicly accessible, we contribute to the pursuit of environmental justice in New York by generating actionable science.

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The authors declare that they have no competing financial interests.

Abstract

In 2003, the New York State Department of Environmental Conservation began designating Potential Environmental Justice Areas (PEJA) for the purpose of providing additional public participation opportunities to disadvantaged populations during permitting deliberations. We developed NYenviroScreen to help stakeholders understand, review, and provide input for how future PEJA designation might be updated and improved, including for identifying disadvantaged communities under the newly enacted Climate Leadership and Community Protection Act (CLCPA). We present and compare three potential update methods and provide an interactive web application for investigating model components and composition. The three methods are: (i) three factor clustering using the Jenks natural breaks algorithm, (ii) a cumulative impact model adapted from CalEPA's CalEnviroScreen, and (iii) a hybrid approach that utilizes both methods and incorporates Native American land areas. NYenviroScreen brings together federal and state data sources related to population health, sociodemographics, environmental risk factors, and potential pollution exposures for 15,463 census block groups. We find that a hybrid approach provides the most robust coverage for both rural and urban areas of New York State. By innovating new approaches to such designations and making them publicly accessible, we contribute to the pursuit of environmental justice in New York by generating actionable science.

Keywords

Actionable science; combined effect modelling; environmental justice; environmental policy; interactive data visualization

1. Introduction

In the mid-1970s, Lois Marie Gibbs began to notice a disturbing pattern of deaths and illnesses among her neighbors in the working class neighborhood of Niagara Falls, New York, and organized some of her fellow housewives to investigate (Epstein, 1997). They eventually discovered that the entire neighborhood had been built in close proximity to a covered landfill where the Hooker Chemical Company (now Occidental Chemical Company) dumped 21,000 tons of toxic chemicals between 1942 and 1953. Following years of dogged organizing, Gibbs and other residents of the neighborhood succeeded in forcing the federal government to relocate their homes and to pay for many of the costs associated with the health issues residents suffered as a result of their unwitting exposure to industrial toxins. Moreover, the residents' public accountability campaign galvanized efforts that resulted in the passage of the 1980 Comprehensive Environmental Response, Compensation, and Liability Act, better known as the Superfund program, which enabled the cleanup of hundreds of the worst toxic waste sites around the country (Steinzor, 2006).

Along with the early 1980s battle against toxic waste dumping in Warren County, North Carolina, Love Canal was among the first major campaigns to elevate issues of environmental justice into the national consciousness (Bullard, 1994). While issues of justice and equity in the distribution of environmental "bads" across the nation long predate the emergence of the Love Canal tragedy, this campaign can be considered the origin of a recognizable movement for environmental justice in the state of New York. Community leaders emphasized the lower socioeconomic status of residents, arguing that their health was intentionally sacrificed by town leaders' decision to site their neighborhood on top of a former toxic dump - and to withhold information about the potential hazards from the newcomers (Blum, 2008). Moreover, as Blum and others have pointed out, although white women comprised the public face of the movement, black residents were also disproportionately impacted by Love Canal, and black women played key leadership roles in agitating for change.

In the decades since Love Canal first emerged as a household name for the health impacts of toxic waste, movements for environmental justice have broadened and the salient discourses and terminology have continued to evolve. However, the core issue highlighted by Love Canal - inequitable spatial distribution of environmental harm, in the form of exposure to various forms of pollution - has remained a fundamental theme animating environmental justice campaigns nationwide. And yet, while these campaigns have significantly increased public awareness of environmental inequity and environmental racism, underlying disagreements remain. In both the academic and public policy realms, the definition of environmental justice and identification of the most effective and appropriate ways to measure environmental inequality and the disparate impacts of environmental harm have not been resolved. These disagreements are not merely semantic; rather, the selection and application of specific quantitative models and metrics carry consequences for vulnerable individuals and communities.

Academic scholarship and policymaking on environmental justice, informed by and responsive to community organizing and activism, has also continued to center on the socioeconomically and racially disparate distribution of negative environmental externalities (Beck, 1986). Scholars have shown that this unevenness, both among exposed populations and among producers of pollution (Collins, Munoz & JaJa, 2015) often places disproportionate burdens of environmental risks on low income and minority populations (Bullard, 1994; Mikati et al., 2018). Moreover, research documents how socioeconomic inequalities intersect with, and often compound, environmental and health inequalities, as individuals with socioeconomic privilege possess a greater capacity to reduce their risk at an individual or family level through relocating away from areas with greater environmental exposures (Pellow & Brulle, 2005). For more information about New York State environmental justice history and scholarship see Supplemental Section 1.

Given the emphasis of environmental justice activists and scholars on the centrality of geographic disparities in environmental exposures, it is perhaps unsurprising that a central focus for redressing these harms has been on the use of location-sensitive screening tools to identify populations that face greater vulnerability from current or potential environmental burdens. In theory, these tools, which integrate GIS-based mapping with population-level data, constitute a critical methodological bridge that enables decision-makers to integrate environmental justice considerations into local, state, and federal policy. In the words of environmental justice pioneer Charles Lee, "EJ mapping discourse holds the potential to more precisely characterize and operationalize the concept of disproportionate impacts" (Lee, 2020).

1.1 Defining Environmental Justice and Identifying PEJAs in NY

In the 30 years since Love Canal, its themes have remained central to fights for environmental justice across New York state and the country. In July of 2019, the New York State Assembly passed two historic bills addressing issues of climate and environmental justice: S2385 and S6599, or the Climate Leadership and Community Protection Act (CLCPA). S2385 will update Commissioner's Policy 29 on Environmental Justice and Permitting (CP-29) of 2003, which was the first official New York state policy to explicitly incorporate environmental justice considerations. The general goal of CP-29 was to "promote the fair involvement of all people in the DEC environmental permit process" (DEC, 2003). Perhaps most significantly, CP-29 amended the pre-existing DEC environmental permit process by requiring developers of proposed hazardous waste emitting facilities to identify PEJA near the project (DEC, 2003). If a PEJA is present, developers must also identify potential adverse health impacts to PEJA, mitigation strategies to address these impacts, and alternative siting locations. Additionally, among the 15 directives of CP-29, developers are required to share information with members of these communities about proposed projects in their area and to produce enhanced public notification and participation plans (DEC, 2003).

In 2011, New York state expanded the scope of CP-29 through the introduction of the Power NY Act, which requires siting approval by a state siting board for power plants with over 25MW capacity (New York State Environmental Justice Advocacy Group, 2002). Additionally, Part 487 of Article 10: Analyzing Environmental Justice Issues in Siting of Major Electric Generating Facilities requires developers to identify PEJA within a half mile of their project area and to produce air quality and environmental impact risk assessments as well as mitigation plans if these communities are present (Westlaw, 2017). The drafters of the Power NY Act intended to streamline the permitting process first outlined in CP-29, and to empower communities to participate in the process and further improve the environment and public health (Cuomo, 2011).

Although the policy's drafters stated their commitment to "lead the nation in environmental justice" through the realization of CP-29, both the DEC and environmental justice organizations have acknowledged that few of the initial objectives were realized (Calma, 2019). Furthermore, CP-29 lacked robust metrics for the identification of PEJAs. This hampered the implementation of most directives in the policy, which were only triggered when proposed facilities are proximate to PEJAs. Most significantly, CP-29 led to no discernable increase in enforcement of PEJA protections (Liang, 2016). For more discussion about the limitations of CP-29 and rationale for developing a new system, see Supplemental Section 2.

In 2017, the DEC Office of Environmental Justice agreed to revise CP-29. As the agency wrote in a 2008 newsletter, the revision of CP-29 was necessary "to ensure it provides opportunities for meaningful participation in the permitting process for concerned residents and meaningful interactions between DEC and environmental justice communities" (NY DEC, 2017). To that end, the agency convened a series of meetings and hearings around the state to solicit input from community groups, leaders, and non-government organizations.

This process eventually culminated in 2019 with the passage of A1564/S2385, which amended CP-29 to establish a permanent environmental justice advisory group and an environmental justice interagency coordinating council. At the same time, the New York state legislature also passed the historic Climate Leadership and Community Protection Act (CLCPA), which mandates that the state reach net zero emissions by 2050, with 85% accounted for by emissions reductions below 1990 levels, and the remaining 15% from offsets (The State of New York, June 18, 2019). For more information about the passage of these regulations and a comparison of A1564/S2385 to CP-29, see Supplemental Section 3.

Heralded as "the most ambitious emissions reduction legislation in the country" (McKinley & Plumer, 2019), the CLCPA will ostensibly ultimately result in the collection of millions of dollars through sales of renewable energy credits to numerous load serving entities throughout the state. Pursuant to section 75-0117 of the CLCPA, between 35% and 40% of these funds are earmarked for distribution to disadvantaged communities. Pursuant to section §75-0111, a climate justice working groups is to be appointed and charged with identifying these communities using the following criteria:

> "§75-0111.C Disadvantaged communities shall be identified based on geographic, public health, environmental hazard, and socioeconomic criteria, which shall include but are not limited to:
>
> > i. Areas disadvantaged by cumulative environmental pollution and other hazards that can lead to negative public health effects;
> > ii. Areas with concentrations of people that are of low income, high unemployment, high rent burden, low levels of home ownership, low levels of educational attainment, or members of groups that have historically experienced discrimination on the basis of race or ethnicity; and
> > iii. Areas vulnerable to the impacts of climate change such as flooding, storm surges, and urban heat island effects." (The State of New York, June 18, 2019)

Ultimately, the potential of CLCPA and S2385 to both create opportunities and alleviate threats for communities most impacted by environmental harms hinges on the accurate identification of PEJAs. Efforts to implement both the CLCPA and S2385 thus invoke longstanding debates regarding how best to define environmental justice, measure disparate impacts of environmental harms, and apply these understandings in the context of legacy policy (see, for example, Mohai et al. 2009). While the EPA has attempted to define and develop a screening method for investigating environmentally disadvantaged communities (see EPA's EJSCREEN), they have not defined a precise way to do so. The historical absence of such a metric at the federal level led states to develop and utilize a wide range of screening tools, which can serve as valuable laboratories for developing and articulating cutting-edge environmental justice policies (Lee, 2020).

The passage of the CLCPA and S2385 creates an opportunity for New York state to innovate on its existing methodology for delineating PEJAs. For more information on critiques of the current screening method, see Supplemental Section 4. Since the issuance of CP-29 in 2003, the New York state DEC has utilized a "three-factor" method for identifying PEJAs using a clustering technique to delineate thresholds based on Census 2000 block groups data related to race, poverty, and rural or urban status (see CP-29 for more details). Liang (2016) critiqued this method as unable to address intersectional vulnerability and Lewis and Bennett (2013) pointed out that this demographic-based method may not adequately identify areas of cumulative disadvantage, because it "fails to integrate an awareness of distributive concentrations of toxins."

We present NYenviroScreen, a new screening tool and method for identification of PEJAs in New York that integrates these and other critiques and also draws on the most up-to-date praxis in this arena. Of specific relevance to New York, the EPA, the state of California, and the state of Maryland have all developed PEJA screening metrics that integrate a cumulative approach to risk assessment. Although individual algorithms vary, these metrics, called cumulative risk assessment (CRA) tools, utilize a common methodology. First, they identify a multitude of factors that indicate environmental risk, including exposure sources, outcomes related to disease, and characteristics of vulnerability. Second, for the purposes of risk screening and assessment, CRAs combine these factors to estimate cumulative effects (Holifield, Chakraborty & Walker, 2017). For detailed information on the specific CRA tools developed by the EPA, California, and Maryland, see their technical descriptions in EJSCREEN Technical Documentation, CalEnviroScreen 3.0 Technical Report, and MD EJ Screen.

We intend for NYenviroScreen to be utilized as a reference point for New York's Climate Justice Working Group and Environmental Working group. The methodology utilizes publicly available datasets and the code for accessing and creating datasets used to develop the tool is openly available. We hope this open access tool will assist decision makers in creating an efficient, accessible, and updatable program for identifying disadvantaged communities under the CLCPA.

2. Materials and methods

2.1 Data gathering and synthesis

Data was gathered from several publicly available sources to capture a wide variety of population stressor metrics for all of New York state. Methods used to obtain each dataset are included on our GitHub page (https://github.com/mdpetron/NYenviroScreen). We synthesized variables into five groups: environmental exposures, environmental hazards, sensitive populations, physical vulnerability, and health (See Supplement Table 1). Many of these indicators were chosen based on the availability of the data, and their inclusion in other EJ mapping tools and do not provide a complete analysis of population vulnerability. A list of desired indicators that we were unable to gather can be found in the discussion (Table X).

Environmental exposures are numerous and vary across New York State. This category attempts to synthesize available indicators related to the hazardous amount of potential exposure from air and water pollutant release sources. Most of the environmental exposure indicators come from EJSCREEN, an environmental justice screening and mapping tool created by the United States Environmental Protection Agency (EPA, 2020). These census block group level indicators include:

I. Traffic proximity- specifically the count of vehicles at major roads within 500 meters of the census block group, divided by distance in meters;
II. Ozone concentration- measured as the summer seasonal average of daily maximum 8-hour concentration in air in parts per billion;
III. Lead paint indicator- specifically the percent of housing units built pre-1960, as an indicator of potential lead paint exposure;
IV. Particulate matter concentration- represented by PM2.5 levels in air measured as an annual average of μg/m3;
V. Hazardous air pollutant concentrations- specifically three different indicators derived by EJSCREEN from the 2014 National Ambient Air Toxics Assessment (NATA): the respiratory hazard index, diesel particulate matter level, and air toxic cancer risk;
VI. Drinking water quality- we developed a basic indicator to rank drinking water quality from public water systems for New York counties using drinking water information from the New York Department of Health. This indicator ranks each county by the population weighted maximum concentration of arsenic, nitrate, trihalomethanes, and haloacetic acids for 2009, the most recent year data is available (New York Department of Health, 2020). Each chemical concentration rank was summed into a county level drinking water score and assigned to each block group within the county. The method is similar to that employed by CalEnviroScreen 3.0 (California Office of Environmental Health Hazard Assessment, 2017).

Environmental hazards include sources of potential risk for populations. These pollution hazards may not present an obvious exposure pathway but do contribute to adverse conditions and degradation of the local environment. Each of these indicators are available at the census block group level. This grouping contains four indicators from EJSCREEN:

I. Proximity to risk management plan (RMP) sites, which are those sites with potential chemical accident management plans - specifically the count of RMP facilities within five kilometers, or the nearest facility beyond five kilometers, each divided by the distance in kilometers;
II. Proximity to hazardous waste facilities- specifically the count of hazardous waste treatment, storage and disposal facilities (TSDFs) and large quantity generators

(LQGs) within five kilometers (or the nearest facility beyond five kilometers), each divided by the distance in kilometers;

III. Proximity to national priorities list (NPL) sites- specifically the count of proposed or listed NPL - also known as Superfund - sites within five kilometers (or the nearest facility beyond five kilometers), each divided by the distance in kilometers;

IV. Proximity to wastewater discharge- specifically the modeled toxic concentrations at stream segments within 500 meters, divided by distance in kilometers (km) obtained from EPA's Risk Screening and Environmental Indicators (RSEI).

The sensitive populations group contains indicators related to physical vulnerability from weather-related hazards, as well as population age and access to grocery stores. Tract level indicators were assigned to all block groups within the tract.

I. Potential sensitivity to flooding hazards is measured at the census tract level as the percentage of homes within the 100-year and 500-year Federal Emergency Management Agency (FEMA) designated flood plains. This data was obtained for the State of New York from FloodzoneData.us, a project of the New York University Furman Center (2020). This dataset contains estimates from census tracts within 30 out of the total 62 New York counties.

II. Vulnerability to extreme heat is measured by the New York State Heat Vulnerability Index, a census tract indicator combining multiple risk factors like population age, disability, and land cover characteristics. This indicator is developed by the New York State Department of Health and is not available for census tracts within the five boroughs of New York City (2020).

III. Low-income and low-food-access census tracts were identified using the United States Department of Agriculture Economic Research Service's Food Access Research Atlas for the year 2015. These tracts have a 20% or greater poverty rate and a population of more than 500 individuals or 33% of the tract total that live more than 1 mile (10 miles for rural tracts) from the nearest supermarket, supercenter, or large grocery store (ERS, 2015).

IV. For age-related vulnerability, we gathered block group percentages of individuals under 5 years old and over 64 years old within each block group from EJSCREEN.

Populations with high rates of pre-existing health conditions are vulnerable to environmental stressors and areas with larger burdens of disease should be considered first when allocating revitalization efforts (Nichols et al., 2013). The health group of indicators contains several variables from the NYSDOH pertaining to county level disease incidence rates. All data were assigned to each block group within the respective geographic levels of the data origin. Listed in order, these include four items from the NYSDOH County Level Prevention Agenda Tracking Indicators, one indicator from the NYS Heat Vulnerability Index, and another from the NYSDOH Cancer Mapping dataset:

I. Asthma- specifically the asthma emergency department visit rate per 10,000 population in 2014;

II. Heart Attacks- specifically the age-adjusted heart attack hospitalization rate per 10,000 population in 2014, (ii) percentage of preterm birth in 2016;
III. Premature Deaths- specifically the percentage of premature deaths (before age 65 years) in 2016;
IV. Disability Percentage- specifically tract level percent disability from the NYS Heat Vulnerability Index dataset; and
V. Cancer incidence disparities- specifically a measure of different than expected total cancer incidences 2011-2015 from the NYSDOH Cancer Mapping dataset (NYSDOH, 2015). Total incidences were subtracted from expected incidences to obtain an estimate of different than expected cancer cases for each block group.

Last, we assembled indicators that reflect social or economic disadvantage. Increased socioeconomic vulnerability indicates an area more susceptible to adverse impacts from stressors like disasters and disease outbreaks. We utilize six measures derived from the Census American Community Survey 2017 five-year estimates. Tract level estimates are assigned to each block group within the tract. These indicators include;

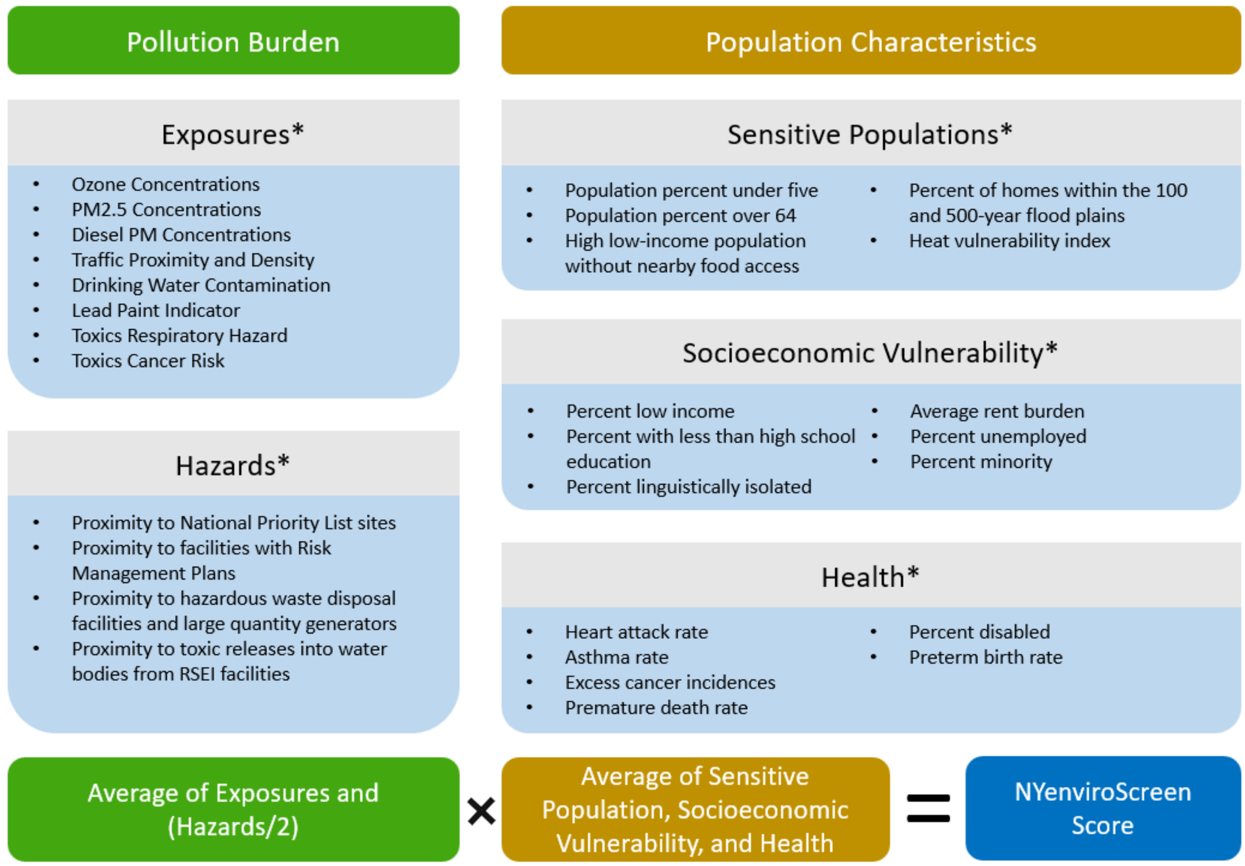
I. Low income percentage- specifically less than twice the federal poverty level
II. Less than high school education- specifically the percent of people age 25 or older in a block group who do not possess a high school diploma
III. Linguistic isolation- the number or percent of people in a block group living in linguistically isolated households
IV. Rent burden- specifically the average rent paid as percentage of average income in a block group
V. Unemployment percentage- derived from census tract estimates and taken from the NYS Heat Vulnerability Index
VI. Minority percentage- Specifically the percent of individuals in a block group who list their racial status as a race other than white alone and/or list their ethnicity as Hispanic or Latino.

Together, the above indicators comprise the information necessary to craft our cumulative impact model. Additional data were gathered for the purposes of clustering and comparing classified areas with the potential environmental justice areas (PEJA) designated in 2003 by CP-29. PEJA from CP-29 were accessed from the NY Department of Environmental Conservation website (2020). Census shapefiles were obtained for counties, block groups, urban areas, and tribal areas (federally and state-recognized Native American reservations) using the Tigris package (Walker, 2020) in R version 3.4.2 (2017-09-28) (R Core Team, 2013). We identified if block groups were inside or bordering tribal or urban areas using the polygon intersect utility of the sf package (Pebesma, 2018). We classified block groups as urban if 50% or more of the land and water area was inside an urban area.

2.2 Model development

We employ a hierarchical modelling approach to designate disadvantaged communities using cumulative impacts and clustering of three key variables. For the cumulative disadvantage model, the data were combined using a framework adapted from CalEnviroScreen 3.0, a screening tool for identifying conditions that reflect population vulnerability to environmental pollutants (2017). Similar models have been proposed for screening communities in Maryland (Driver et al., 2019) and the Houston-Galveston-Brazoria region of Texas (Bhandari et al., 2020). This cumulative impact model relies on percentile ranks of each indicator described in the previous section. These percentiles are then grouped into five categories previously mentioned (see Figure 1). Category scores are derived by taking the mean of each percentile within the group, which gives equal weight to each indicator. If a particular data element is missing within the group for any block group, this item is ignored when calculating the mean. The environmental exposures and hazards groups are combined into a pollution burden score by averaging the means of each while half weighting the hazard category. Hazards are half weighted because they do not contribute directly to the pollution burden in a given area. This practice aligns with CalEnviroScreen (2017). Next, pollution burden and population characteristic scores are scaled by dividing each score by the maximum block score across the state, then multiplying this scaled value by ten. To derive the NYenviroScreen score, these two values are multiplied (Figure 1) to reflect the increased effect of socioeconomic vulnerability on producing adverse outcomes from pollution exposure. For example, in a review of epidemiological studies linking air pollution to cardiovascular disease, Tibuakuu and colleagues found that studies consistently showed correlation between adverse outcomes resulting from exposures to air pollution among certain vulnerable subgroups (2018).

Figure 1: Visual representation of the cumulative impact model depicting the process of deriving the NYenviroScreen Score at each block group in NY. The schematic overviews two groups (Pollution Burden and Population Characteristics), five categories (Exposures, Hazards, Sensitive Populations, Socioeconomic Vulnerability, and Health) and the category components. Each component is the state percentile rank of the displayed indicator, and the category score is the average of these percentile ranks. Group scores are found by aggregating and multiplying category scores.

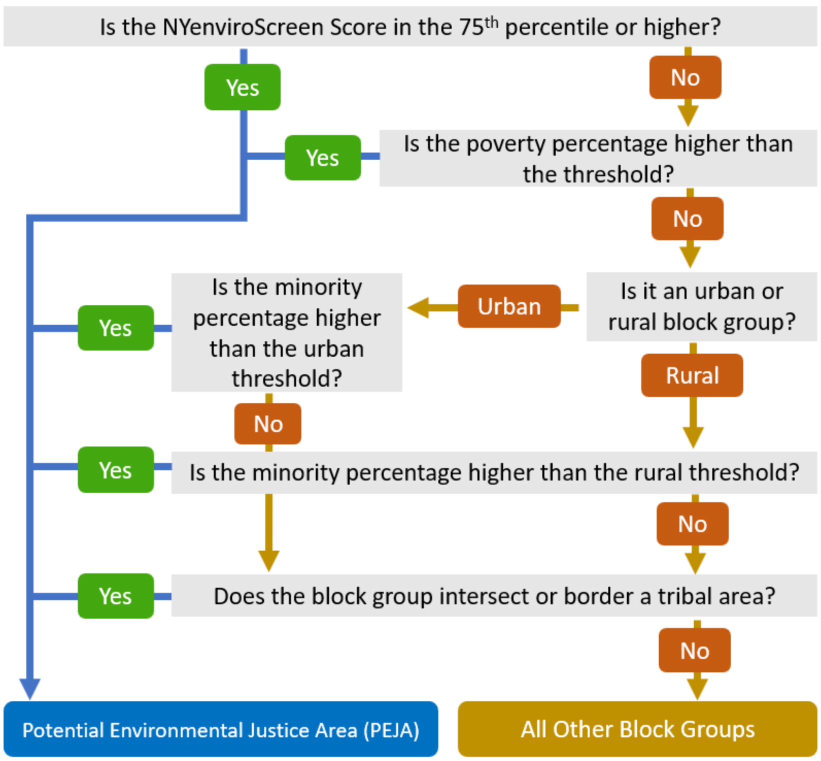


* Each group score is based on the average of the percentile ranks for each metric within the State of New York

Next, mirroring the method used to demarcate Potential Environmental Justice Areas (PEJA) in 2003, we identified six clusters using the Jenks algorithm (1977). Using a repeated sample of group means, this algorithm identifies ‘natural’ breaks in variable distributions. In this application, we utilize Jenks via the ‘classInt’ R package (Bivand, 2020) to find two clusters within the New York State distribution of poverty percentage, urban minority percentage, and rural minority percentage. Rural and urban block groups are designated by intersecting block group shape files with 2010 census urban area shapefiles using the ‘sf’ package (Pebesma, 2018). If 50% or more of a block group’s area falls within an urban area, then it is designated as an urban block group. This process defines the thresholds which determine Potential Environmental Justice Areas (PEJA).

The last designation is based upon tribal areas. Tribal areas have a history of environmental issues. If a block group contains or borders a tribal area, then this block group is determined to be a PEJA. These three qualifiers are combined to designate 2020 PEJA using a decision tree (Figure 2). If a block group’s NYenviroScreen score is in the top 25 percent of all scores (in other words, ranks above the 75 percentile) it is a PEJA. If neither of these criteria are met, it will also be deemed a PEJA if it has a poverty percentage higher than the threshold or, depending on the urban or rural classification, a higher minority percentage than the threshold. Finally, if it does not meet any of these criteria, a block group will be considered a PEJA if it borders or contains a tribal area.

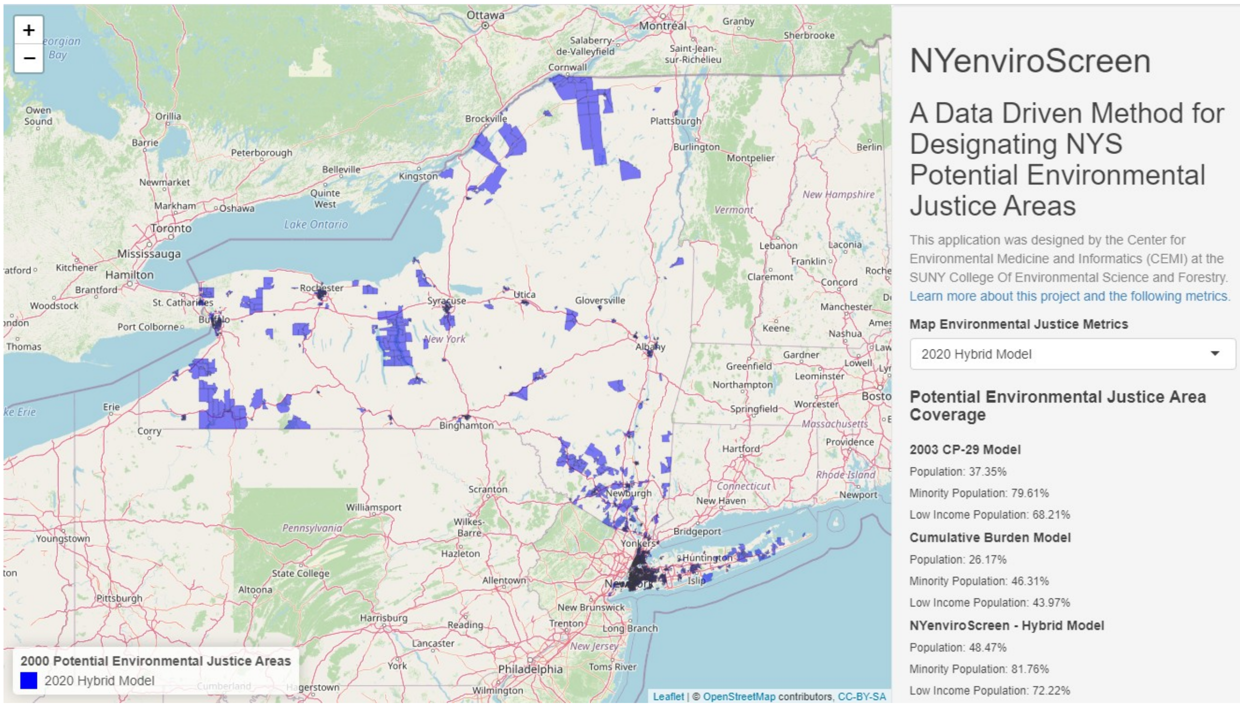
Figure 2: Visual representation of the Potential Environmental Justice Areas (PEJA) decision tree. New York block groups are classified as a PEJA if they meet any of the following criteria: (1) If their NYenviroScreen Score, an indicator of cumulative impact, is higher than 75% of other block groups in the state; (2) if the poverty percentage is higher than the threshold determined by the clustering procedure; (3) if the minority percentage is higher than the clustering procedure depending on urban or rural status; or (4) if the block group intersects, borders, or contains a tribal area.



2.3 Application Development

To encourage participation and discourse about our cumulative impact strategy as well as to facilitate access to our results, we have developed a publicly available online mapping tool (Figure 3). This tool provides web access to the data gathered for this study, which allows for anyone with internet access to explore the geographic distribution of results and make comparisons between various approaches. By creating this mapping tool as well as by making publicly available the code that we used to develop our analysis and mapping application, we aim to increase the equitable treatment of all stakeholders within the decision making process and to facilitate procedural justice efforts. We intend our tool to be used as a starting point for facilitating a public process to finalize a new system in New York for identifying Potential Environmental Justice Areas (PEJA), also referred to as disadvantaged communities. The viewer was developed in the R environment (R core team) using the following packages: 'shiny' (Chang et al., 2020), 'leaflet' (Cheng et al., 2019), 'sp' (Bivand et al., 2013), and 'dplyr' (Wickham et al., 2020).

Figure 3: Screenshot from the online data viewer application for NYenviroScreen: https://mdpetron.shinyapps.io/NYenviroScreen-app/. This application allows users to map all of the metrics utilized in the development of NYenviroScreen as well as compare coverages between the different components of the NYenviroScreen model.



3. Results

3.1 Cumulative Impact Model

The cumulative impact model integrates 29 indicators of population disadvantage to create the NYenviroScreen score. Figure 4 displays the Lorenz curve of NYenviroScreen scores for 15,166 block groups in New York State, which represents a visualization of the proportion of cumulative impact across the distribution. This figure also reports the GINI coefficient, a measure of inequality, with a score of 1 representing perfect inequality and 0 representing perfect equality. The GINI for NYenviroScreen scores is 0.29. Figure 5 reports (a) the cumulative distribution of NYenviroScreen scores with four examples: (b) the block group with the highest score; (c) the rural block group with the highest score (rural block groups are defined as a block group with less than 50% of its total area within an urban cluster); (d) the block group with the median score; and (e) the block group with the lowest score. These radar charts display the percentiles of each component of the NYenviroScreen score for all four cases.

Figure 4: The Lorenz curve and GINI coefficient of the NYenviroScreen score for 15,166 block groups. The blue curved line represents each block group plotted by NYenviroScreen percentile rank (x-axis) and cumulative NYenviroScreen score (y-axis).

The GINI coefficient indicates unequal distribution of cumulative impacts throughout the state as measured by the NYenviroScreen score.

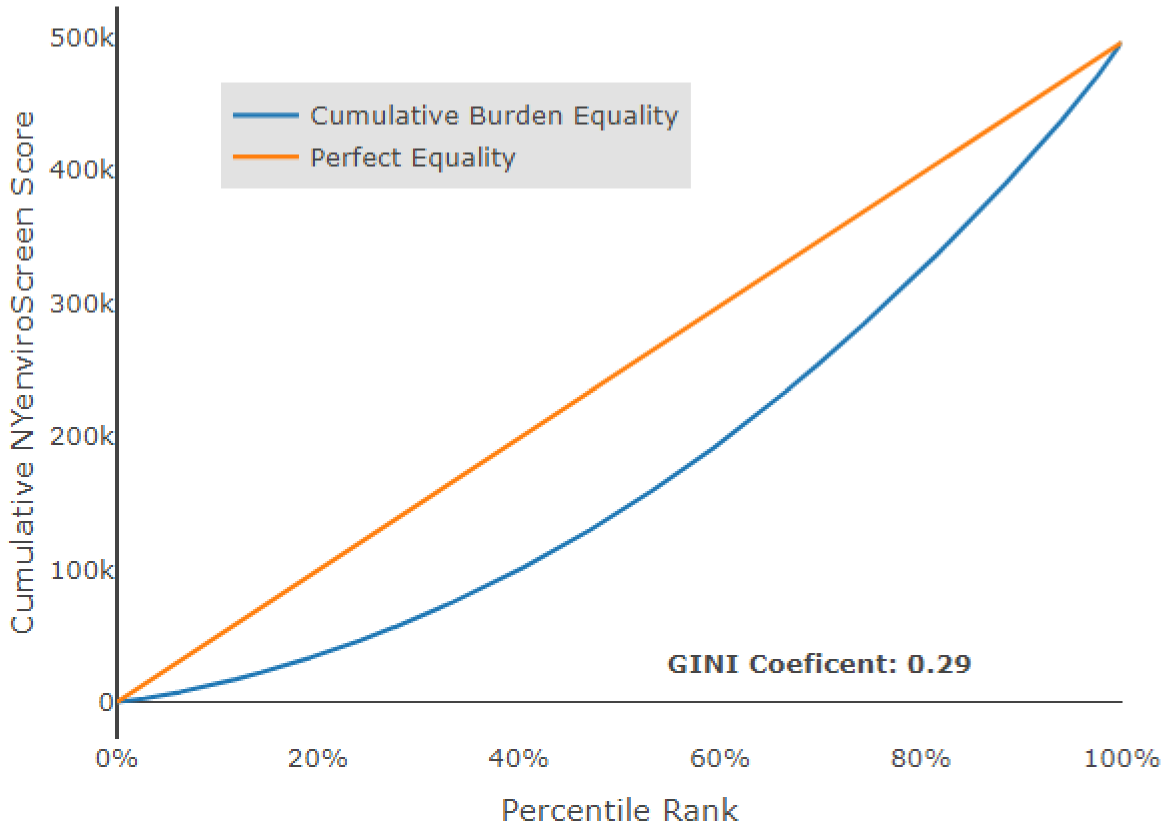
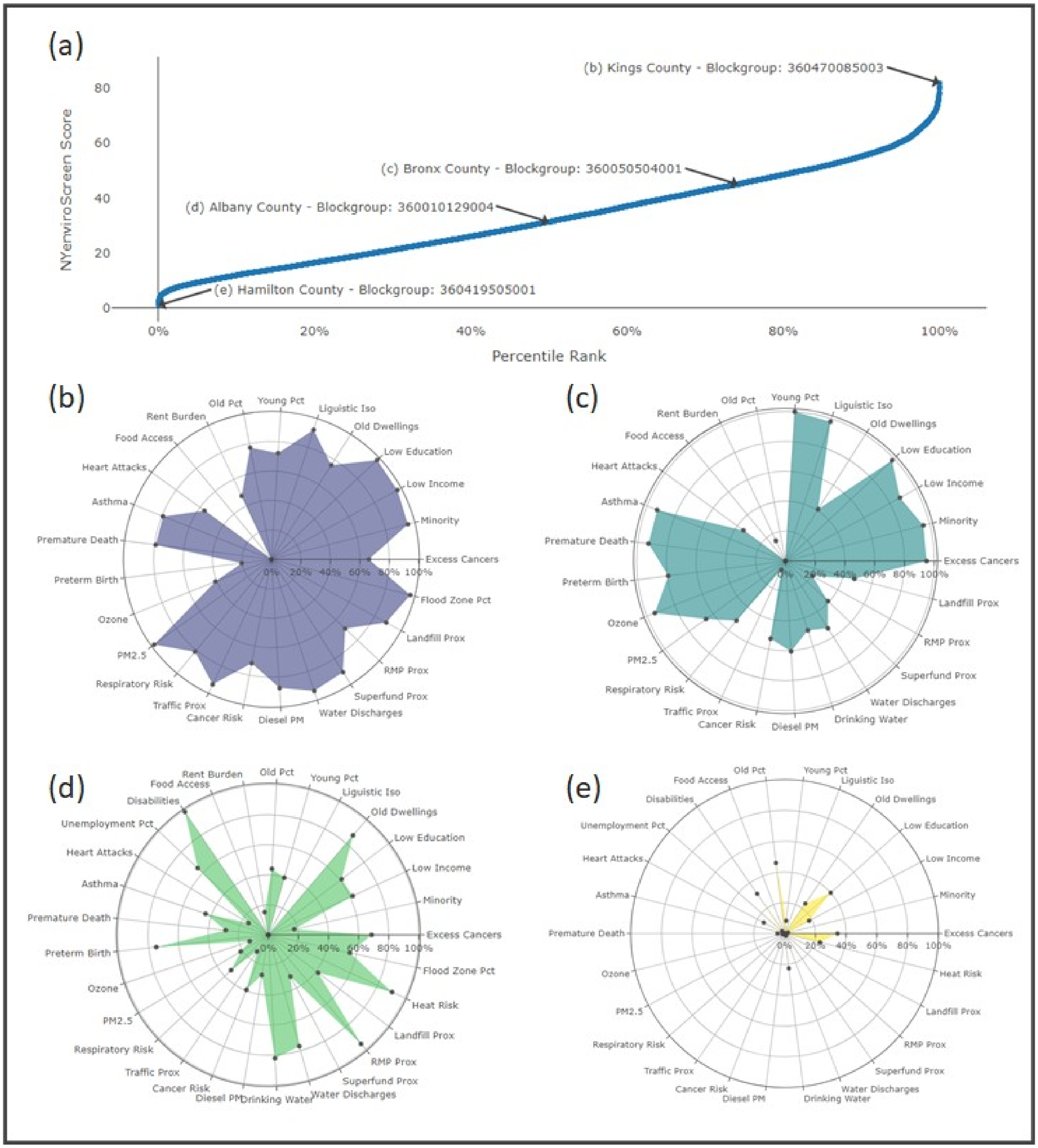


Figure 5: The cumulative distribution of NYenviroScreen scores (a) with examples of four block groups displaying the percentiles of each component of the NYenviroScreen score. (b) Block group 360470085003 in Kings County with the highest score, (c) Block group 360050504001 in Bronx County with the highest rural score. (d) Block group 360010129004 in Albany County with the median score, and (e) Block group 360419505001 in Hamilton County with the lowest score. Spider chart examples provide context on the components of the NYenviroScreen score.

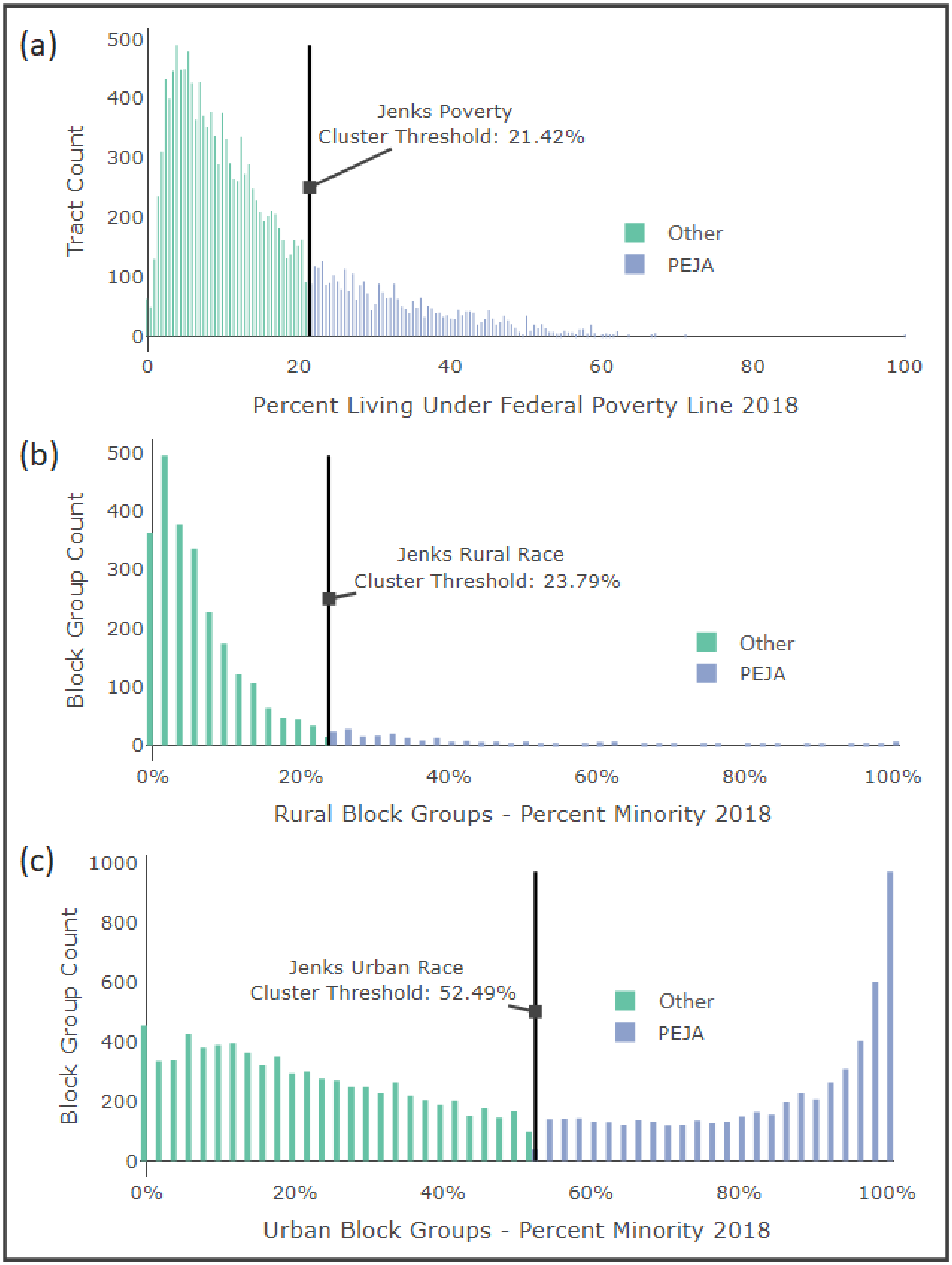


3.2 Hybrid Model

The Hybrid Model is composed of the cumulative impact model alongside a clustering model and tribal qualifier. The following model defines PEJA for this study. If a block group is in the top 25% of all NYenviroScreen scores, it is defined as a PEJA. It is also a PEJA if it intersects or borders a federally defined tribal area. Lastly, an area is designated as a PEJA if it meets one of the following thresholds determined using Jenks clustering analysis: 1) For the poverty percentage, defined as the estimated percent of individuals with income less than the federal poverty level in a census tract for 2018, the threshold is 21.42 percent. This result is lower than the 23.59 percent adopted in CP-29. 2) For the minority percentage, defined as the estimated percent of individuals identifying as not white alone in a block group for 2018, the threshold result is 52.49 percent in urban block groups and 27.39 percent for rural block groups. CP-29 thresholds were 51.1 percent and 33.8 percent respectively. These thresholds and the distribution of these variables are displayed in Figure 6.

Figure 7 and Figure 8 display the state-wide spatial distribution of Hybrid Model PEJA block groups compared to the 2003 PEJA block groups. These figures help to display which block groups were classified at each level of the Hybrid Model decision tree. They also allow for a visual inspection of the coverage differences between the 2003 and 2020 approaches. Figure 9 provides a numerical comparison between the block group PEJA coverage with 14 different metrics. These metrics include six racial identifiers and four income bracket identifiers as well as land area, total population, and urban/rural block group coverage.

Figure 6: Histograms of each potential environmental justice area (PEJA) threshold indicator divided into two clusters by the Jenks Natural Breaks Algorithm. The first graph (a) depicts the 2018 poverty percentage by census tract and marks the cluster threshold of 21.42 percent. The second (b) displays 2018 minority percentage in rural block groups and the 23.79 percent threshold. The last (c) shows the histogram of 2018 urban block group minority percentage and the threshold of 52.49 percent. These thresholds are similar to those which were calculated for CP-29, but 2020 thresholds for poverty and rural minority percentages are lower than past thresholds.



(a)
Tract Count
Jenks Poverty
Cluster Threshold: 21.42%
Other
PEJA
Percent Living Under Federal Poverty Line 2018
(b)
Block Group Count
Jenks Rural Race
Cluster Threshold: 23.79%
Other
PEJA
Rural Block Groups - Percent Minority 2018
(c)
Block Group Count
Jenks Urban Race
Cluster Threshold: 52.49%
Other
PEJA
Urban Block Groups - Percent Minority 2018

Figure 7: Northern New York Potential Environmental Justice Areas (PEJA) from (a) CP-29's cluster analysis developed in 2003 and (b) the Hybrid Model presented in this study. Hybrid Model block groups are colored by the decision tree step which qualifies them as a PEJA. 2020 PEJA coverage is expanded in rural areas from 2003.

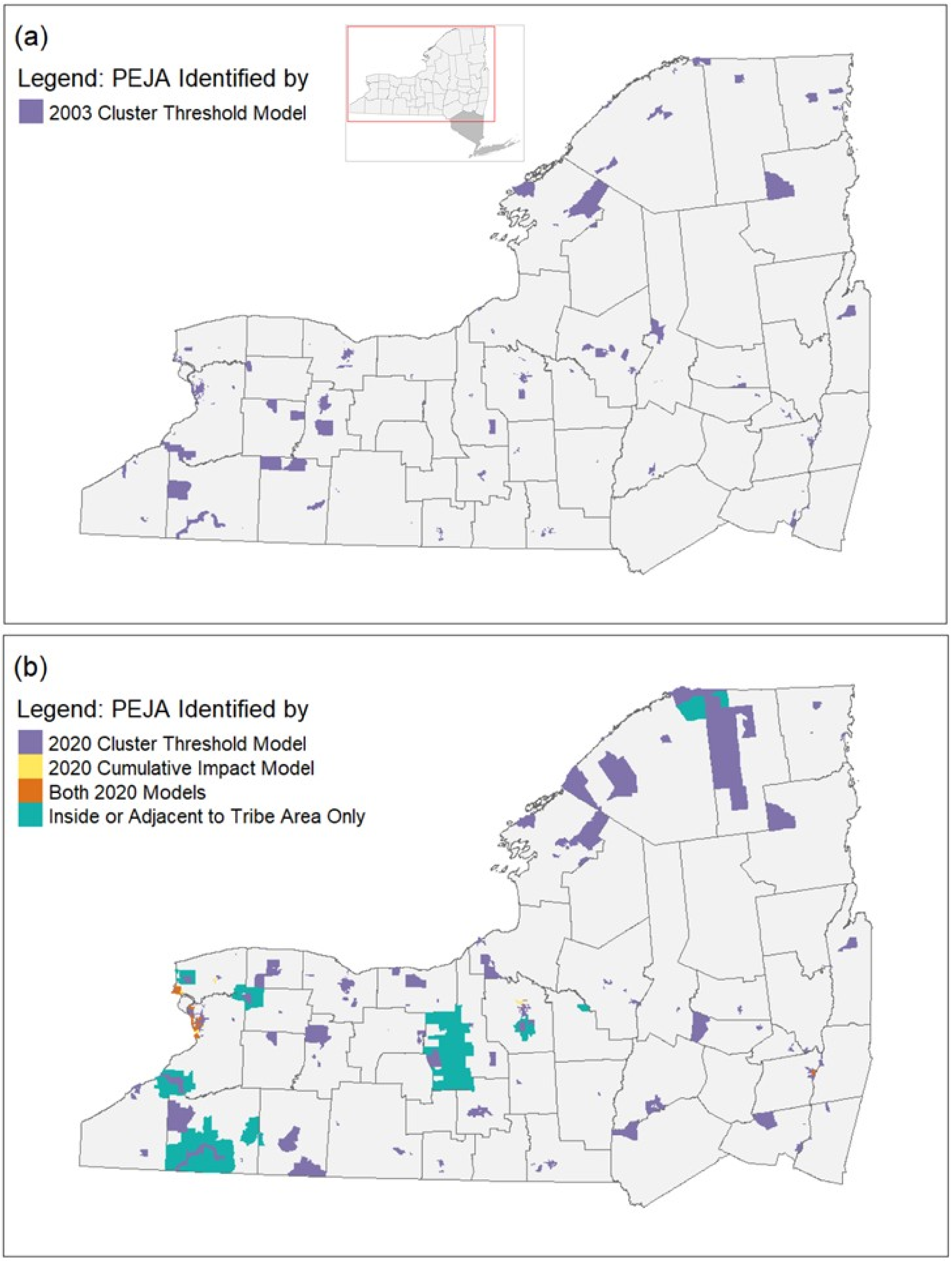


Figure 8: Southern New York Potential Environmental Justice Areas (PEJA) from (a) CP-29's cluster analysis developed in 2003 and (b) the Hybrid Model presented in this study. Hybrid Model block groups are colored by the model step which qualifies them as a PEJA. 2020 PEJA coverage is expanded in rural areas from 2003.

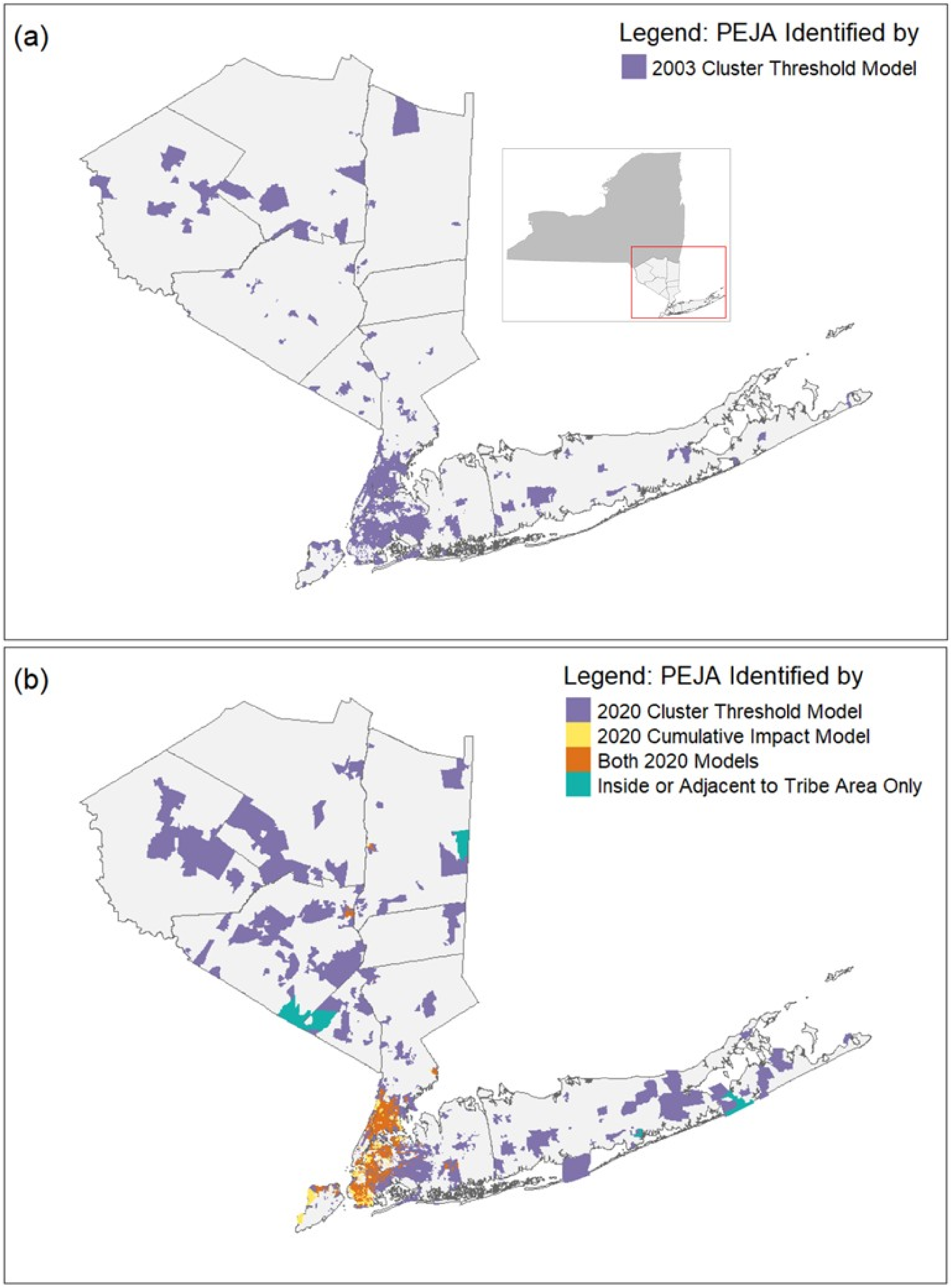
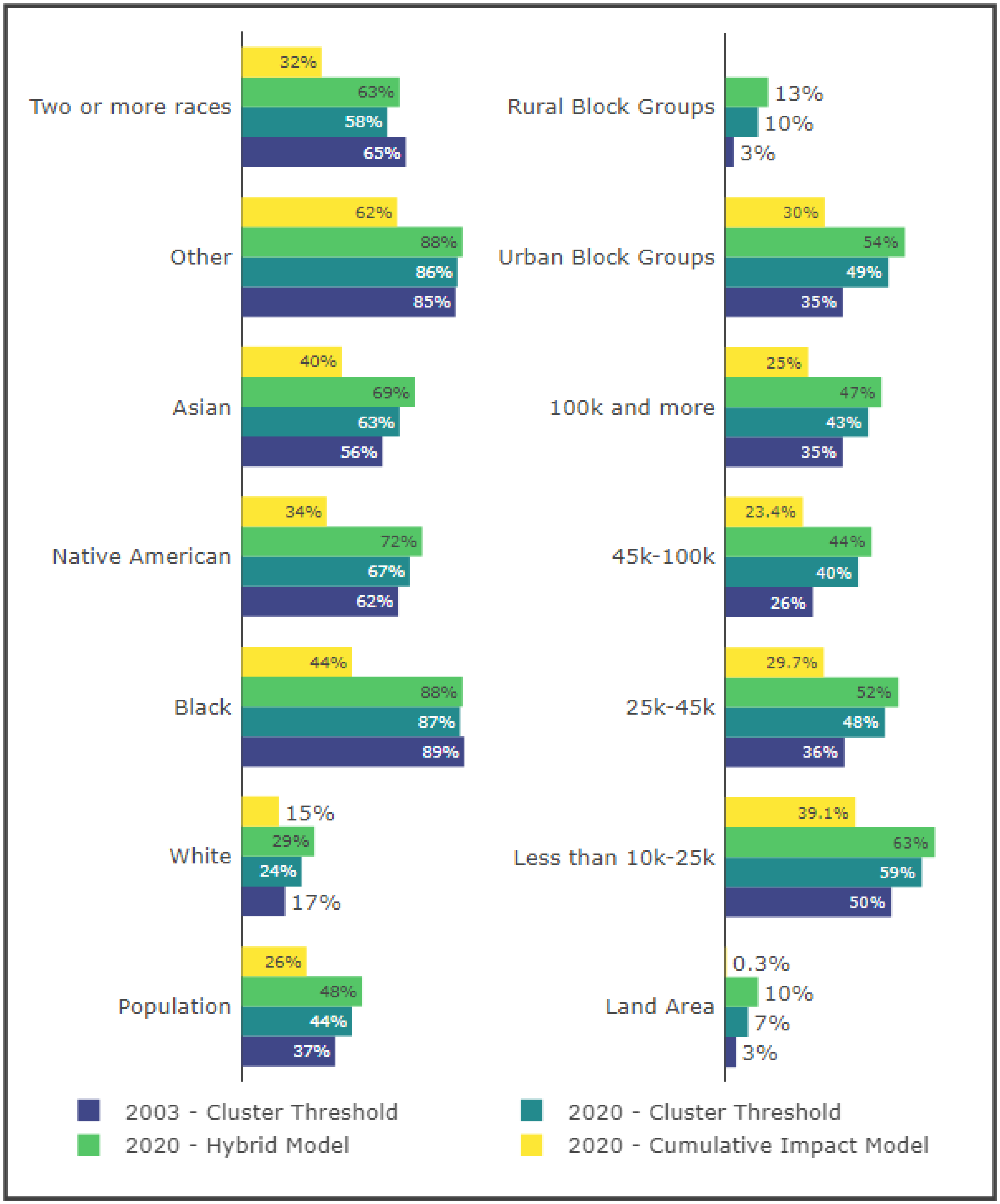


Figure 9: Coverage comparison between models for 14 different metrics spanning racial, income, and land characteristics. This figure displays the coverage benefits of combining cumulative impact techniques with cluster threshold techniques, which helps to ensure that rural areas are eligible to be covered by the policy.



4. Discussion

This study introduces a method of accounting for cumulative impacts while classifying Potential Environmental Justice Areas (PEJA, also referred to as disadvantaged communities) in New York state and aims to provide a straightforward, reproducible, and publicly available methodology utilizing publicly available data. We hope this tool will be used to enable the integration of community input in the development of a final classification strategy. The implementation of a robust environmental justice (EJ) mapping tool in New York can help to integrate environmental justice considerations more effectively into government decision-making. The implementation of such a tool is also necessary for the success of the CLCPA.

Our results indicate that environmental exposures and hazards, as well as socioeconomic, health and population vulnerabilities, are not equally distributed throughout New York state (Figure 4). The cumulative impact model details how some areas are disproportionately impacted by these dis-amenities and population vulnerabilities (Figure 5). Following their identification, these areas can now be targeted for efforts related to co-pollutant reductions, greenhouse gas emissions reductions, regulatory impact statements, and the allocation of community investments. A cumulative impact model not only classifies areas as PEJA; it also can help stakeholders to identify the types of disadvantage a community faces and how communities rank in comparison to others in the state. These details may enable the development of more nuanced and targeted risk mitigation and support strategies.

Despite the advantages of the cumulative impact model incorporating environmental, health, and population vulnerability risks, we found, when using the 75 percentile threshold for classifying PEJAs, that this approach did not incorporate any of the state's rural block groups. To address this omission, and to provide continuity between CP-29 and this new method, we added additional screening criteria, including the incorporation of federally and state recognized tribal areas. The resulting Hybrid model designates nearly half the population of New York state as living in a PEJA. If this model were adopted, these areas would be covered by CP-29's requirement for expanded public participation in permitting processes for proposed polluting facilities. They would also be eligible for additional funding from state programs - specifically, funding designated in the CLCPA for disadvantaged communities. If the Hybrid model is utilized, future industrial developments located in or near these PEJAs could face additional permitting barriers.

While the utility of this tool for decision makers and contemporary working groups is clear, it also has broader translational potential. For example, while the tool's direct use could be in the prioritization of areas for funding, we envision that the tool could be adapted as new needs from decision makers and community makers emerge. Further, the tool is updateable, as new science or methodological innovations are available. Finally, the tool is wholly transparent, with all data, algorithms, and visualizations freely available to anyone interested in them.

Building off existing EJ mapping tools like CalEnviroScreen, the tool presented here attempts to provide unique indicators for assessing cumulative impacts, including flooding risk, heat vulnerability, and cancer incidence disparities. Some indicators, however, lack definition on smaller spatial scales, and many of the health indicators are assigned to each block group from the county average. Other indicators, like the heat vulnerability index, are only available in some regions of the state. This inhibits the capacity of NYenviroScreen to pinpoint areas that experience or manifest larger health disparities. We recommend a criterion be developed for the inclusion of indicators which incorporate the total coverage of block groups (or tracts) as well as the spatial resolution provided. This effort may lead to the development of additional indicators by state agencies for use in the official EJ mapping tool. This was the experience with CalEnviroScreen (Lee, 2020). A 2018 case study of the Maryland Environmental Justice Screening tool elicited feedback from stakeholders to develop a list of additional indicators to add to EJ tools in the future (Driver et al., 2019). For the purposes of facilitating further discussion about what indicators to develop for the purposes of identifying disadvantaged communities in New York State, we have included a list of additional indicators and sources to reference their importance for environmental justice and equity investment policy applications (See Supplemental Table 2).

5. Conclusion

Demographics and financial positions of New York residents have changed significantly over the nearly two decades since CP-29, the state's first environmental justice policy, was enacted. These policies must be written to adapt and update with new data, methods, and input from stakeholders. This effort has been costly, but new tools, some of which are showcased in this study, may reduce the time and effort needed to achieve up-to-date protections for disadvantaged communities. Available software and investments in public datasets have enabled this type of data driven decision making for state governments.

We developed a data synthesis procedure, a model for assessing cumulative impact, and a framework for providing public online access to inputs and results. This effort aims to provide an accessible guide for future environmental justice and equity investment policy decision making, not just in New York State, but also for other states and communities attempting to implement policies like New York's Climate Leadership and Community Protection Act.

This model should not be implemented without significant input from stakeholders and communities which it will serve. Input is critical for achieving procedural justice but was beyond the scope of this project. We seek to enable this process by providing step by step guidance for developing a model that is easy to change, simple to update, and publicly available to all.

6. Data Availability

No new data were created for this study. All datasets were accessed and curated in the R coding environment. The code developed to perform this analysis, including data access, model development, and figure design are available here:
https://github.com/mdpetron/NYenviroScreen

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NYenviroScreen: An Open Source Data Driven Method for Identifying Potential Environmental Justice Communities in New York State

Supplemental Report

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Declaration of competing financial interests
The authors declare that they have no competing financial interests.

Supplemental Table 1: A complete list of NYenviroScreen indicators including references to source locations, descriptions of what they measure and at what level, as well as the assigned group within the cumulative impact model. All data were retrieved from sources on July 23, 2020.

Group	Indicator	Description, Units, and Resolution	Reference
Environmental Exposures	Drinking Water Contamination	Summed county percentile for 2009 population weighted concentrations of arsenic, nitrates, trihalomethanes and haloacetic acid	NYS Department of Health - Drinking Water Contaminants Data
Environmental Exposures	National Air Toxics Assessment (NATA) Air Toxics Cancer Risk	2014 census tract lifetime cancer risk from inhalation of air toxics	National Air Toxics Assessment (NATA) via EPA EJSCREEN
Environmental Exposures	NATA Respiratory Hazards Index	2014 census tract ratio of exposure concentration (μg/m^3) to respiratory health-based reference concentration	NATA via EPA EJSCREEN
Environmental Exposures	NATA Diesel PM	2014 census tract estimated concentration of diesel particulate matter (μg/m^3)	EPA EJSCREEN
Environmental Exposures	Particulate Matter	2016 block group $PM_{2.5}$ levels in the air, μg/m^3 annual avg.	EPA, Office of Air and Radiation (OAR) fusion of model and monitor data via EPA EJSCREEN
Environmental Exposures	Ozone	2016 block group summer seasonal average of daily maximum 8-hour concentration in air in parts per billion	EPA, OAR fusion of model and monitor data via EPA EJSCREEN
Environmental Exposures	Traffic Proximity and Volume	2017 block group count of vehicles (AADT, avg. annual daily traffic) at major roads within 500 meters, divided by distance in meters (not kilometers (km))	Calculated from 2017 U.S. Department of Transportation (DOT) traffic data via EPA EJSCREEN
Environmental Exposures	Lead Paint	2019 block group percent of housing units built pre-1960, as indicator of potential lead paint exposure	Calculated based on Census/American Community Survey (ACS) data, retrieved from 2019 EPA EJSCREEN
Environmental Hazards	Proximity to Risk Management Plan (RMP) Sites	2019 block group count of RMP (potential chemical accident management plan) facilities within 5 km (or nearest one beyond 5 km),	Calculated from EPA RMP database, retrieved 06/20/2019 via

		each divided by distance in km	EPA EJSCREEN
Environmental Hazards	Proximity to Hazardous Waste Facilities	2019 block group count of hazardous waste facilities (Treatment, Storage and Disposal Facilities - TSDFs and Large Quantity Generators - LQGs) within 5 km (or nearest beyond 5 km), each divided by distance in km	TSDF data calculated from EPA RCRAInfo database, retrieved 07/25/2019 via EPA EJSCREEN
Environmental Hazards	Proximity to National Priorities List (NPL)	2019 block group count of proposed or listed NPL - also known as superfund - sites within 5 km (or nearest one beyond 5 km), each divided by distance in km	Calculated from EPA CERCLIS database, retrieved 07/17/2019 via EPA EJSCREEN
Environmental Hazards	Wastewater Discharge	2018 block group RSEI modeled Toxic Concentrations at stream segments within 500 meters, divided by distance in km	Calculated from RSEI modeled toxic concentrations to stream reach segments, created 05/2019 via EPA EJSCREEN
Sensitive Populations	Heat Vulnerability	2006-2012 census tract composite score of health vulnerability indicators derived from the American Community Survey and National Land Cover Database	NYS Department of Health (DOH) Heat Vulnerability Index
Sensitive Populations	Flooding Risk	2018 census tracts percentage of housing units in the 100 and 500 year floodplains	NYU Furman Center's Floodzonedata.us via the Federal Emergency Management Agency's National Flood Hazard Layer
Sensitive Populations	Food Insecurity	2015 census tracts classified as a low income and low access tract measured at 1 mile for urban areas and 10 miles for rural areas	USDA Food Access Research Atlas https://www.ers.usda.gov/data-products/food-access-research-atlas/
Sensitive Populations	Percent Elderly	2018 percent of people in a block group over the age of 64	American Community Survey via EPA EJSCREEN
Sensitive Populations	Percent Young	2018 percent of people in a block group under the age of 5	American Community Survey via EPA

			EJSCREEN
Socioeconomic Vulnerability	Linguistic Isolation	2018 percent of people in a block group living in linguistically isolated households, defined as a household in which all members age 14 years and over speak a non-English language and also speak English less than "very well" (have difficulty with English).	American Community Survey via EPA EJSCREEN
Socioeconomic Vulnerability	Educational Attainment	2018 percent of people age 25 or older in a block group whose educational attainment is less than a high school diploma.	American Community Survey via EPA EJSCREEN
Socioeconomic Vulnerability	Unemployment Rate	2006-2012 census tract composite of percent of population (18-64 years) that are unemployed	NYS Department of Health (DOH) Heat Vulnerability Index
Socioeconomic Vulnerability	Low Income Percentage	2018 percent of people in a block group in a household reporting an income level of less than twice the federal poverty rate	EPA EJSCREEN from ACS 2019
Socioeconomic Vulnerability	Rent Burden	2018 block group average rent as percentage of income	ACS 2019
Socioeconomic Vulnerability	Percent Minority	2018 block group percent non-white	American Community Survey via EPA EJSCREEN
Health	Disability	2006-2012 census tract composite of percent of population (18-64 years) that has a disability	NYS Department of Health (DOH) Heat Vulnerability Index
Health	Asthma	Asthma emergency department visit rate per 10,000 population	NYS DOH Prevention Tracking Indicators 2013-2019
Health	Heart Attack	Age-adjusted heart attack hospitalization rate per 10,000 per county	NYS DOH Prevention Tracking Indicators 2013-2019
Health	Preterm Birth	Percentage of preterm birth per county	NYS DOH Prevention Tracking Indicators 2013-2019
Health	Premature Deaths (before 65)	Percentage of premature death per county	NYS DOH Prevention Tracking Indicators 2013-2019
Health	Cancer Incidence Disparity	Sex and age adjusted expected incidences minus observed cancer incidences 2011-2015 by block group	NYS DOH Cancer Mapping 2011-2015

Supplemental Table 2: Like the approach of Bhandari et al., we have provided a non-exhaustive selection of additional indicators that were not used in the NYEnviroscreen model (2012). While we were not able to include these indicators, either because of a lack of data or an inability to quantify them, they provide information on wellness, equity, and environmental exposure within a community and are useful factors to consider in community investment and issues of environmental and social justice.

Category	Indicator	Description
Salutogenic Infrastructure	Healthcare Access	Physical proximity and comprehensive access to immediate care (i.e. hospitals) as well as preventative care (i.e. primary care providers). (Comber et al., 2011; Hartley et a.l, 1994; Health Resources and Services Administration, 2020; Dasphutre et al., 2020).
Salutogenic Infrastructure	Mental Health Care Access	Access to behavioral and psychological support such as counseling, addiction support, etc. (Alegría et al., 2016; Lê Cook, 2016).
Salutogenic Infrastructure	Urban Green Space	Physical access to physical and psychological benefits of urban green space, with meaningful citizen involvement and autonomy in greening processes. (Wolf et al., 2020; Wolch et al., 2014; Watkins and Gerrish, 2020; Checker, 2011; Nesbitt et al. 2018; Jennings et al., 2012)
Salutogenic Infrastructure	Parks and Recreational Facilities	Proximity to parks and recreational facilities such as soccer fields and tennis courts. (Moore et al. 2012; Rigolon et al., 2018)
Salutogenic Infrastructure	Transportation	Access to public transportation and transportation infrastructure investments i.e. subways, buses). Options for active transportation (i.e. walkability, bike lanes) are available (Karner and Marcantonio, 2018; Lee et al., 2015).
Pathogenic Infrastructure	Tobacco Vendors	Density of tobacco vendors and prevalence of marketing towards young adults (Healton and Nelson, 2011; Lee et al., 2012; Lee et al., 2015).
Pathogenic Infrastructure	Liquor Stores	Density of liquor stores (Romley et al., 2014; Shimotsu et al. 2012; LaVeist and Wallace, 2000).
Pathogenic Infrastructure	Fast Food Restaurants	Density of fast food restaurants (Morland and Evenson, 2009; Hilmers et al., 2012).
Pathogenic Infrastructure	Predatory Financial Institutions	Density of predatory financial institutions (i.e. pawn shops, pay-day loans, etc.) (Redmond, 2015; Gallmeyer and Roberts, 2008).
Pathogenic	Food Swamps	Areas where there is a disproportionately high saturation of

Infrastructure		‘fast food’ restaurants and retail stores that sell food that are high calorie and low in nutrient density (Phillips and Rodriguez, 2020; Goodman et al., 2020; Cooksey-Stowers et al., 2017)
Pathogenic Infrastructure	Food Mirages	Areas where there is an ‘illusion’ of healthy, culturally relevant food access. Areas with full service grocery stores and restaurants that are economically out of reach for many residents or do not carry culturally relevant foods (Breyer and Voss-Andreae, 2013).
Health Indicators	Low Birth Weight Infants	Frequency of infants carried to term with birth weight below five pounds, five ounces (Campo et al., 1997, Center for Disease Control: National Vital Statistics System, Center for Disease Control: Reproductive and Birth Outcomes).
Health Indicators	Maternal Mortality	Frequency of maternal pregnancy-related deaths (Howell, 2018; MacDorman et al., 2016)
Health Indicators	% Uninsured	Prevalence of community members without health insurance. (Griffith et al., 2020; Buchmueller and Levy, 2020)
Environmental Hazards	Climate Change Sensitive Region	Long term exposure risk to climate change related environmental hazards such as urban heat island effect, hurricanes, sea level rise, coastal erosion,and drought (Herreros-Cantis et al., 2020; Hsu et al., 2012; Burns et al., 2007; Takahashi et al., 2016; Garner et al., 2017)
Environmental Exposure	Occupational Exposure to Biocides	Occupational exposure to biocides including fungicides, pesticides, herbicides, and rodenticides. (Kim et al., 2017; Rim, 2017; Kaur and Kaur, 2018)
Environmental Exposure	Non-occupational Exposure to Biocides	Non-occupational community exposure to biocides, particularly communities in close proximity to agricultural operations. (Ye et al., 2017; Dureumeaux et al., 2020; Deziel et al., 2017; López-Gálvez et a., 2019)

Supplement Section 1: Urban Bias in New York State Environmental Justice Scholarship

In the 30 years since Love Canal, its themes have remained central to fights for environmental justice across New York state and the country. However, the scholarship focusing on Love Canal - which is in a small town in western New York - is a rare exception within the overall body of research on New York state environmental justice issues. While scholarship about New York City is itself disproportionately small in comparison to the volume of work on environmental justice issues in other large cities American (Sze, 2007), this scholarship is far more extensive than that addressing areas of New York outside the metro area. In an in-depth analysis of environmental justice campaigns in New York City, Sze (2007) documents the intersectional politics of race and class in the context of multiple community-based struggles, focusing on campaigns related to the siting of waste facilities. Sze highlights the continuity of environmental justice campaign themes across time and neighborhood: the two areas of focus are the siting of industrial facilities, especially waste disposal facilities, and health impacts from racially and socioeconomically disproportionate exposures to environmental (and especially airborne) toxins.

Other researchers echo these themes in shorter treatments, documenting the fight against the Brooklyn Navy Yard (Checker, 2001); cross-racial alliance building (Greenberg, 2000); cumulative impacts to specific vulnerable communities, such as Puerto Ricans (Gandy, 2002) and residents of the South Bronx (Maroko & Pavilonis, 2018); the role of urban planning in both thwarting and realizing environmental justice (Rosan, 2012); and issues related to climate change (Bautista et al., 2015). Another strand of scholarship, including Jason Corburn's book "Street Science" (2005), emphasizes the central role of citizen science in providing health data to support New York City-based campaigns for environmental justice.

While there is less scholarly work documenting New York State environmental justice struggles outside of New York City, those that have been written, as well as journalistic accounts and reports authored by advocacy and community groups, document the relevant issues affecting rural New York communities and smaller urban centers. Multiple environmental justice campaigns outside of the New York City metro area have centered on Indigenous communities. Residents of the Akwesasne and St. Regis Mohawk reservations in the northwestern corner of the state have fought for decades to hold accountable the companies whose upstream dumping poisoned their waters and their cultural practices of fishing, gathering, and hunting. These sites, three of which have been deemed Superfund sites, are also linked to elevated rates of cancer (Hoover, 2017). In Central New York, residents including members of the Onondaga Nation, have fought to remediate decades of industrial dumping that caused Onondaga Lake to be labeled "the most polluted lake in America" (Onondaga Nation, 2018). Other notable examples include the fight by residents of the town of Tonawanda to clean up toxic emissions released by the Tonawanda Coke facility (Clean Air Coalition of Western New York, No date), and the ongoing campaign by residents of Hoosick Falls to hold Saint-Gobain Performance Plastics and Honeywell responsible for contaminating their drinking water with carcinogenic per and polyfluoroalkyl substances (PFAS) (NY DEC, 2020). In addition to Hoover (2017), Ducre (2012) provides one of very few book-length discussions of environmental justice issues in New York outside of New York City in her examination of race, gender, and environmental justice in Syracuse.

The disproportionate emphasis on New York City-based environmental justice issues within the scholarly literature may reflect the widely-cited phenomenon of urban bias (Rao, 1980), in which disproportionate political, economic, and cultural resources are directed to urban centers to the detriment of rural communities. While a full history of environmental justice movements in New York state is beyond the scope of this paper, the movements centered outside of New York City illuminates a parallel disparity in the official designation of environmental justice communities, and thus the additional layers of regulatory oversight and protection available to such communities. In light of the 2019 passage of the historic legislation known as the CLCPA and the Environmental Justice law S2385, which mandates an overhaul of the state’s environmental justice permitting process, the criteria used to designate environmental justice communities has gained additional regulatory and monetary significance.

Supplement Section 2: Rationale for NYenviroscreen

As environmental justice advocacy groups have noted, passage of the CLCPA and the Environmental Justice bill create meaningful opportunities for environmental and climate justice in New York's historically marginalized and disadvantaged communities (Cohen, 2019). Beyond increasing regulatory oversight and enhancing opportunities for public education and participation in the permitting process, this legislation could potentially steer hundreds of millions of dollars to fund the creation of green jobs and infrastructure in environmental justice communities (McKinley and Plumer, 2019). Economists at the University of Massachusetts - Amherst calculated extensive potential economic gains from the bill, including an estimated $5.8 billion annual increase in income from direct and indirect clean energy jobs for working-class New Yorkers in the state economy over a decade (Pollin et al., 2017). However, as New York Renews stated in their Equity Memo, the translation of these opportunities into tangible changes depends on equitable and effective implementation of the bills' provisions, and specifically on identification of appropriate communities and allocation of earmarked funds to these communities. Perhaps unsurprisingly, the final bill lacks detailed mechanisms for operationalizing these goals (Calma, 2019; Storrow, 2020).

The legislation also potentially creates additional threats for communities already disproportionately impacted by environmental harms. Evidence from other states' efforts to transition toward a non-fossil fuel-based economy suggests that such shifts do not uniformly benefit historically marginalized communities. In some cases, patterns of racially and socioeconomically disparate environmental impacts have been replicated in the transition toward a "green" generally and "green" energy production specifically. A recent study examining the environmental justice implications of the Clean Power Plan in California concluded that even among "green" infrastructure projects, polluting facilities, environmental hazards, and other unwanted land uses are more likely to be sited in communities of color and low-income communities, furthering already existing disproportionate exposure to air pollution (Baptista & Armanath, 2017).

Moreover, a recent evaluation of air pollution equity outcomes from California's carbon pricing policy revealed that 52% of regulated, in-state facilities reported higher greenhouse gas and co-pollutant emissions after five years (Cushing et al., 2018). Increasers were more likely to be located near higher proportions of non-white and socioeconomically disadvantaged residents (ibid). In response to this study, Boyce and Ash (2018) have called for integrating greenhouse gas and co-pollutant databases into climate change mitigation policy, as well as further interrogation of how climate policy design influences the magnitude and distribution of public health co-benefits. Ultimately, environmental justice advocates in New York were successful in maintaining requirements to mitigate some of these potential threats; for example, the bill contains language to ensure that the 15% of carbon offsets allowed will not cause additional harm to communities historically burdened by excess emissions (Calma, 2019). Still, groups like NY Renews have continued to voice their fear that the legislation may fall short of realizing a "just transition" that integrates racial and economic equity goals with the move to a green economy (Calma, 2019).

As both scholars and advocates have pointed out, a central inefficacy of the original policy was the absence of clear enforcement mechanisms. Moreover, the Environmental Justice Advisory Group was never made permanent, which further reduced the NYDEC's capacity to implement the policy’s directives and incorporate recommendations of working groups (Lewis & Owley, 2014). While CP-29 ostensibly created more access to public participation, it failed in removing barriers to participation affecting the most disenfranchised populations (Lowry, 2013).

Supplement Section 3: The CLCPA, S2385, and the Fight for A Just Transition in New York State

The process to update and revise CP-29 informed the writing of a proposed bill, A1564/ S2385, which was eventually passed in July 2019 after extensive legislative haggling. While the final version of S2385 replicates many provisions from the earlier CP-29, there are several key differences. As with the earlier iteration of CP-29, its mission is broadly stated as the realization of equity in the distribution of environmental impacts, such “that no group of people, including a racial, ethnic, or socioeconomic group, bears a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of federal, state, local, and tribal programs and policies” (State of New York, January 24, 2019). However, in contrast to the 2003 policy, the 2019 bill mandates the creation of a permanent Environmental Justice Advisory Group within the DEC, and provides greater detail regarding how the group should enact equity guidelines within state agencies (Ibid.)

Specifically, by the end of 2020, the Advisory Group must develop and share a model environmental justice policy with all New York state agencies, which will then have six months to either accept the model policy or create their own version. The Advisory Group will also be empowered to monitor for compliance with these policies, in part through establishing an environmental justice interagency coordinating council. Additionally, S2385 stipulates that the Advisory Group is required to advise state agencies on decisions with significant environmental justice impacts - for example, land-use permits for fossil fuel projects - and to monitor their adherence to environmental justice policies (Calma, 2019). Unlike the earlier CP-29, this legislation is binding. However, as critics have pointed out, mechanisms for enforcement are still unclear (Ramirez, 2020). Moreover, the COVID-19 pandemic has likely impacted the timeline for full implementation of both the CLCPA and S2385.

Additionally, thanks to a successful coalitional organizing campaign by New York Renews, this legislation also includes multiple elements intended to guarantee that the shift toward a non-fossil field-based economy is equitable for all communities (New York Renews, 2018). New York Renews fought to incorporate language from an “Equity Memo” developed with input from their stakeholders representing economically and racially marginalized communities across the state. While several aspects were ultimately eliminated or moderated, the final language includes significant elements from the original memo: an equity screen for all proposed projects, which weights consideration of equity outcomes equally alongside climate outcomes; a mandate that emission reduction requirements also address co-pollutants, including criteria pollutants and fine particulate matter; a requirement that at least 35% of the state’s clean energy funds are spent in “disadvantaged” communities throughout the state; and a stipulation that future programs funded through the CLCPA must assess barriers to accessing renewable energy, energy efficiency, weatherization, zero- and low-emission transportation, and adaptation (Ramirez, 2020).

Supplement Section 4: Critiques of the current NY EJ screening tool

Ultimately, the potential of CLCPA and S2385 to create both opportunities and threats for communities most impacted by environmental harms hinges on the accurate identification of PEJAs, which will allow for both pre-empting the siting of additional environmental bads in these communities and also the targeted investment of "green" infrastructure funds. However, as both environmental advocacy groups and Governor Andrew Cuomo have pointed out (Ramirez, 2020), the legislation does not offer concrete guidance in this regard. Rather, the creation of detailed metrics for defining and identifying PEJAs are assigned to a working group specifically created to manage these tasks. As S2385 states, the working group "will establish criteria to identify disadvantaged communities for co-pollutant reductions, greenhouse gas emissions reductions, and investment opportunities. Disadvantaged communities will be identified based on geographic, public health, environmental hazard, and socioeconomic criteria" (The State of New York, June 2019).

Since the issuance of CP-29 in 2003, the New York state DEC has utilized a "two-factor" method for identifying PEJAs. According to this method, in 2017, over 7 million New Yorkers lived in places identified as PEJAs. This designation resulted from an analysis performed by the NYS DEC and EPA Region 2 based on Census 2000 census block group data. Thresholds for determining whether a block group contained Potential Environmental Justice Communities were determined by performing a cluster analysis on percentages of individuals living below the federal poverty line for each block group and on percentages of minority identification in both rural and urban block groups. This method objectively determines natural breaks in the data where the maximum differences in mean values of two groups are achieved for each of three data sets. Following the 2010 Census, the thresholds originally determined in 2003 were found to still apply. Thus, the thresholds used in 2017 to identify and maps PEJAs were as follows:

- At least 51.1% of the population in an urban area reported themselves to be members of minority groups; or
- At least 33.8% of the population in a rural area reported themselves to be members of minority groups; or
- At least 23.59% of the population in an urban or rural area had household incomes below the federal poverty level (DEC, 2003).

Critiques of the two-factor identification method utilized by New York state to identify PEJAs have emphasized its weakness in accounting for cumulative risk exposure. Lewis and Bennett (2013) have pointed out that the geographic designation of environmental justice communities based exclusively on demographic data may not adequately identify areas of cumulative vulnerability, because it "fails to integrate an awareness of distributive concentrations of toxins." Moreover, because of its overreliance on demographic data, the two-factor method fails to account for the cumulative risk experienced by individuals and populations who face multiple forms of social and economic vulnerability. Liang (2016) notes that, while the metric used by New York adheres to the technical requirements of CP-29, "it may not fully redress environmental inequities faced by vulnerable societal members, which are intersectional phenomena engendered by a variety of environmental, health, and demographic factors."

Anticipating the opportunity created by the passage of S2385 for the articulation of a new screening method, the advocacy group NY Renews proposed guidelines for a cumulative risk assessment (CRA) tool that draws on the Cal Enviro-Screen System but adapts this approach to New York state (New York Renews, 2018). The CRA proposed by NY Renews would identify the following geographic entities as PEJAs: areas burdened by cumulative environmental pollution and other hazards that can lead to negative public health effects; areas with concentrations of people that are of low income, high unemployment, high rent burden, low levels of home ownership, low level of educational attainment, or members of groups that have historically experienced discrimination on the basis of race or ethnicity; areas vulnerable to the impacts of climate change such as flooding, storm surges, and urban heat island effect; and areas that are economically reliant on energy intensive and fossil fuel based industries.

As previously discussed, the history of scholarship on environmental justice issues in New York state reveals the outsized power of New York city and the metro area to command public and legislative attention, and to the relative erasure of issues impacting other parts of the state - specifically rural and tribal communities. Any screening tool that can accurately identify PEJAs and support the equitable allocation of funding to New York communities must integrate metrics that reflect sensitivity to this historic skew. Indeed, New York Governor Cuomo has directly addressed this concern in his public remarks on S2385 (Calma, 2019), indicating that the political viability of any new screening tool also hinges on its capacity to equitably capture the cumulative environmental vulnerability of all New Yorkers.

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