New York State Climate Justice Working Group

Draft Disadvantaged Communities Criteria and List Technical Documentation

March 9, 2022

Table of Contents

List of Tables

List of Figures

1. INTRODUCTION

On July 18, 2019, New York State (State) signed into law the Climate Leadership and Community Protection Act (Climate Act). The Climate Act is among the most ambitious climate legislation enacted in the United States, not only for its bold greenhouse gas (GHG) reduction and renewable energy requirements, but also with respect to the law's incorporation of statewide equity considerations. A cornerstone of the Climate Act is identifying and considering disadvantaged communities in regulatory actions and implementation of the Climate Act. Under the Climate Act, disadvantaged communities (DACs) are defined as "communities that bear burdens of negative public health effects, environmental pollution, impacts of climate change, and possess certain socioeconomic criteria, or comprise high-concentrations of low- and moderate- income households, as identified pursuant to section 75-0111 of this article."

New Yorkers do not experience environmental burdens or climate change vulnerabilities equally across the State. Climate change is a threat multiplier, which is further exacerbated by additional factors, or stressors that can add increasing burdens to local communities. To identify these stressors and develop criteria around disadvantaged communities, the Climate Justice Working Group (CJWG), staff from the New York State Department of Environmental Conservation (NYSDEC), the New York State Energy and Research Development Authority (NYSERDA), the New York State Department of Health (NYSDOH), and the New York State Department of Labor (NYSDOL) (collectively, State Agencies), and consultants ILLUME Advising and Abt Associates (Consultants) outlined the geographic boundaries appropriate for identification, established an iterative process for criteria selection, identified methodologies for comparing communities, and captured the burdens of existing Environmental Justice communities in addition to the vulnerabilities anticipated by climate change.

Consistent with the Climate Act, the CJWG, established as part of NYSDEC, voted on December 13, 2021, to approve draft criteria that will be used to identify DACs for the purposes of co-pollutant reductions, GHG emissions reductions, regulatory impact statements, and the allocation of investments related to Article 75 of the Environmental Conservation Law (ECL). The draft criteria and draft list of census tracts of identified DACs are available for public comment as part of the 120-day public comment period, including a public participation process. The CJWG will meet to finalize the DAC criteria and list following the public comment period. Details of this process are in Section VII of this document.

This Technical Documentation was prepared by New York State Agencies and Consultants, who assisted and guided the CJWG in the technical development of the draft DAC list and criteria. The purpose of this Technical Documentation is to provide technical details on the draft DAC list and criteria for public comment.

2. CLIMATE LEADERSHIP AND COMMUNITY PROTECTION ACT

2.1 Climate Leadership and Community Protection Act

Responsibility for Developing Criteria to Identify Disadvantaged Communities

The Climate Act created the CJWG, which is comprised of 13 members, including environmental justice community representatives from New York City (NYC), Upstate urban communities, rural communities, and four state agencies, NYSDEC, NYSERDA, NYSDOH, and NYSDOL. The CJWG, in consultation with NYSDEC, NYSERDA, NYSDOH, NYSDOL, is responsible for establishing the criteria for identifying DACs. Meeting recordings and materials documenting this process may be found on the New York State Climate Act website (climate.ny.gov).

To develop draft criteria, including data, a scoring approach, analysis, and maps, the CJWG was supported by a team of staff and subject matter experts from the State Agencies and Consultants (hereinafter the "Technical

Team"). For certain topics or data, the Technical Team consulted or partnered with the New York State Department of State (NYSDOS), Office of Housing and Community Renewal (HCR), New York State Department of Transportation (NYS DOT) and other agencies. The Technical Team also consulted with experts in other state and federal agencies involved in California's Priority Populations definition (including CalEnviroScreen 4.0), Disadvantaged Vulnerable Communities Definition, the federal Justice40 Initiative (including developers of the Climate and Economic Justice Screening Tool (CEJST) and the federal Department of Energy's definition of Disadvantaged Communities, the United States Environmental Protection Agency (EPA) EJScreen, Washington State's Health Disparities Map, and nationally-known experts in environmental justice.

Climate Act Guidelines for Identifying Disadvantaged Communities

As outlined in the Climate Act (ECL § 75-0111), DACs will be identified:

"...based on geographic, public health, environmental hazard, and socioeconomic criteria, which shall include but are not limited to:

1. Areas burdened by cumulative environmental pollution and other hazards that can lead to negative public health effects;
2. 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
3. Areas vulnerable to the impacts of climate change such as flooding, storm surges, and urban heat island effects."

The CJWG included all the above criteria outlined in the legislation in the draft criteria for identifying DACs.

2.2 Applications of the DAC Criteria

The DAC criteria will be used for four statutory purposes:

- Co-pollutant reductions;
- Greenhouse gas emissions reductions;
- Regulatory impact statements; and
- Allocation of clean energy and energy efficiency investments

With respect to "allocation of investments," the DAC criteria will be used by State entities to direct clean energy and/or energy efficiency investments in a manner to ensure that disadvantaged communities receive no less than 35% of benefits, with a goal of 40% of benefits.

In addition to the geographic criteria for identifying disadvantaged communities, the CJWG also included vulnerable households outside of designated DACs that report annual total income below 60% of the State Median Income or are otherwise eligible for low-income programs, to ensure that these residents remain a priority in the clean energy transition. The CJWG considered the 35% target and 40% goal to be minimums and encourage State agencies to invest more in disadvantaged communities and low-income and climate-vulnerable households within and outside of designated DACs.

3. KEY OPERATING TERMS

Terms used in this document, and the interpreted or defined meanings are summarized below. The Technical Team looked for definitions in the Climate Act where available and worked with State Agency staff to clarify these terms when needed.

Table 1. Definitions

	Definition

General Terms	
Census tract	Statistical subdivisions of a county or equivalent entity that are updated by local participants prior to each decennial census. The U.S. Census Bureau delineates tracts to provide a stable set of geographic units for the presentation of statistical data.
Component	The seven Factors are grouped into two sets, referred to as Components: (1) Environmental Burdens and Climate Change Risks and (2) Population Characteristics and Vulnerabilities.
Criteria	The set of Census tract level indicators and rules to identify draft disadvantaged communities, including the approach for using scores calculated from the data and indicators, and the process for using those scores to identify communities.
Designation	The process of identifying census tracts to be included in the draft set of disadvantaged communities.
Factor	The 45 selected Indicators are grouped into seven sets, referred to as Factors, to bundle similar concepts for weighting purposes: (1) Potential Pollution Exposures, (2) Land Use associated with historical discrimination or disinvestment, (3) Potential Climate Change Risks, (4) Income, (5) Race/Ethnicity, (6) Health Impacts & Burdens, and (7) Housing, Energy, and Communications.
Indicator	A variable created from raw data to represent the presence, direction, or magnitude of a characteristic or circumstance of interest. In the disadvantaged communities criteria, the Indicators are designed to adjust for the size of the census tract (area or population) to enable relative scoring (comparisons) of census tracts.
List of Disadvantaged Communities	Census tracts identified (designated) as draft disadvantaged communities using the disadvantaged communities criteria and scoring approach.
Scoring Approach	The methodology used for estimating the relative level of Environmental Burdens and Climate Change Risks and Population Characteristics and Health Vulnerabilities associated with each census tract. These values are intended to represent the extent to which a census tract is disadvantaged relative to other tracts.
Environmental Burdens (including exposures, pollutants, risks, threats, hazards, etc.)	
Burdens	Something that affects health or quality of life. An overburdened community is one with multiple stressors including both environmental and socio-economic. A community burden affects quality of life, and a pollution burden has the potential to affect health. DACs have a disproportionate burden of the negative environmental consequences (environmental exposure or indicators), characteristics related to increased vulnerability, and health outcomes relative to other communities.
Cumulative Impacts	Encompasses all stressors, environmental and population-based, in a community. DAC layers would provide a framework for assessing cumulative impacts by combining environmental indicators, community burdens and population indicators through a mechanism that mathematically combines them.
Environmental Effects	Are a type of stressor on a community. Could be an exposure indicator or community burden.
Environmental Indicator	Represent the potential presence of pollutants in a community from sources known to be associated with its release. The indicator does not represent a direct exposure to pollutants. For many of the environmental layers under consideration, there are a lot of uncertainties in the dataset. For example, the location of the site or facility may not have been verified. The amount and types of pollutants released may be unknown or incorrectly characterized. The status of the site may

	be unknown for example has it been completely remediated or is it a closed landfill. Regardless of these uncertainties, there are other known environmental degradation and ecological effects that these indicators place on a community. These indicators also affect people by limiting their ability to make use of ecosystem resources (e.g., eating fish or swimming in local rivers or bays). Also, living in an environmentally degraded community can lead to stress, which may affect human health. In addition, the mere presence of a contaminated site or high-profile facility can have tangible impacts on a community, even if actual environmental degradation cannot be documented. Such sites or facilities can contribute to perceptions of a community being undesirable or even unsafe.
Exposures	Known contact (breathing, ingestion, dermal absorption) such as a chemical or biological agent. Not all exposures are hazardous. Need to know the amount of exposure and whether the agent can cause harm.
Hazards	Something physical (chemical, or biological) that has the potential for damage, harm, or adverse health effects. The mere presence of a waste site or facility is not a direct hazard unless specific information is known. For example, a Superfund site may be a hazard if it is releasing chemicals and people have been exposed. A Superfund site that is cleaned up is not a hazard. Types of chemical releases, amount of chemical, toxicity of the chemical and whether there's a completed exposure pathway for the public help to determine a hazard.
Pollution	Introduction of substance (chemical, noise, heat, or light) in the environment (air, water, or soil) that has the potential to cause harmful effects.
Risks	Chance of harmful effects to human health from environmental exposures, burdens, or climate change. To understand the chance for potential risk, the magnitude and frequency of the exposure and outcome are necessary. For example, risk of harmful effects from environmental exposure requires knowing how much chemical is in the environment, how much contact people have (exposure) and the toxicity of the chemical. For example, benzene is a hazard (we know it is toxic) but health risk depends on how much people are exposed to and how they are exposed (e.g., breathing, skin contact, drinking). Generally, risks involve quantitative analysis.
Population Characteristics and Health Vulnerabilities	
Health Outcomes	For the purposes of this work, measures that may signify vulnerabilities, e.g., a lack of access to resources and/or increased risk from the impacts of climate change. Many health outcomes are multifactorial and may be impacted by personal behaviors, environmental, and genetic factors.
Indigenous Communities	For the purpose of the DAC criteria, census tracts where greater than or equal to 5% of land owned by an Indigenous Nations or recognized as Reservation Territory.
Low-income households	Households that have an annual income of less than or equal to 60% of State Median Income (SMI). For purposes of determining categorical eligibility for low-income energy programs, NYS also deems participation in the Home Energy Assistance Program (HEAP) or Weatherization Assistance Program (WAP) as establishing a household to be low-income.
Sensitive Populations	Groups experiencing a biological or physiological condition such as genetic predisposition, general health status, low socioeconomic status, and possible interactions with certain medications, that increases susceptibility to environmental factors that may lead to increased negative health outcomes.
Sociodemographic Characteristics	Socio-demographic characteristics are a combination of social and demographic factors that define people in a specific group or population. In general, socio-

	demographics include age, education, religion, employment, marital status, income levels, migration background, race, and ethnicity.
Social Vulnerability	The susceptibility of social groups to the adverse impacts of external stresses on human health. Such stresses include natural hazards or human-caused disasters, or disease outbreaks. Impacts may include disproportionate injury, death, loss, or disruption of livelihood.
Vulnerability	Population characteristics that may be indicators of susceptibility to climate change, certain factors that impact community health, or pollution exposures. A population's vulnerability is influenced by socioeconomic factors and may also consider health outcomes. Examples of vulnerability include a high proportion of low-weight births, earning less than 80% of Area Median Income, limited English proficiency, or poor access to health insurance.

4. DRAFT DISADVANTAGED COMMUNITIES CRITERIA

4.1 Summary of Draft Criteria

In determining the criteria to identify DACs, the CJWG identified 35% of census tracts in New York as DACs, meaning 1,721 of New York's 4,918 census tracts would be considered Geographic DACs. The majority of these tracts are identified on the basis of 45 indicators (data) about "Environmental and Climate Change Burdens and Risks" and "Population Characteristics and Health Vulnerabilities" (Tables 2 and 3 below). The draft DAC list also includes 19 census tracts that are federally designated reservation territory or State-recognized Nation-owned Land.

The scoring approach is detailed in Section V. It considers each census tract's relative burden, risk, vulnerability, or sensitivity based on these indicators. The percentile ranks of these indicators for each census tract was combined to produce a value that measures a census tract's score relative level of Environmental Burdens and Climate Change Risks as well as Population Characteristics and Health Vulnerabilities relative to other tracts. Tracts with higher scores relative to (a) other tracts in the State, or (b) their region (NYC or Rest of State) were identified as DACs. Census tracts must rank relatively high in terms of both "Environmental and Climate Change Burdens and Risks" and "Population Characteristics and Health Vulnerabilities" (or very high on one of these) to be identified as a DAC (Figure). Since the types and concentration of exposures, burdens, risks, historical discrimination, and vulnerabilities experienced by New Yorkers can vary considerably between NYC communities and communities in the rest of the State, the draft criteria also consider each census tracts' relative score compared with other tracts in two broad regions: NYC (five counties of NYC; 43% of population) and Rest of State (57 counties; 57% of population).

The draft geographic DAC criteria can be used for all purposes of ECL § 75-0111: co-pollutant reductions, GHG emissions reductions, regulatory impact statements, and the allocation of clean energy and energy efficiency investments. About 35% of the population and 35% of households in New York State are included in the draft geographic DAC list.

Additionally, for the purpose of State agencies investing or directing a percentage of clean energy and energy efficiency programs, projects, or investments to DACs, pursuant to ECL § 75-0117, the draft DAC criteria includes **low-income households located anywhere in the State**, defined as households reporting annual total income at or below 60% of State Median Income, or are otherwise categorically eligible[1] for low-income programs (i.e., Home Energy Assistance Program).

[1] Categorical eligibility refers to New York State Energy programs allowing for automatic eligibility if a household is receiving one or more of various social benefits such as SNAP, Temporary Assistance, or SSI.

Table 2. Environmental Burdens and Climate Change Risks: Draft Indicators

Environmental Burdens and Climate Change Risk		
Potential Pollution Exposures	**Land use and facilities associated with historical discrimination or disinvestment**	**Potential Climate Change Risks**
Vehicle traffic density diesel truck and bus traffic	Proximity to remediation sites	Extreme heat projections
Particulate matter ($PM_{2.5}$)	Proximity to regulated management plan sites	Flooding in coastal and tidally influenced areas (projected)
Benzene concentration	Proximity to major oil storage facilities	Flooding in inland areas (projected)
Wastewater discharge	Proximity to power generation facilities	Low vegetative cover
-	Proximity to active landfills	Agricultural land
-	Proximity to municipal waste combustors	Driving time to hospitals or urgent/critical care
-	Proximity to scrap metal processors	-
-	Industrial/manufacturing/mining land use	-
-	Housing vacancy rate	-

Table 3. Population Characteristics and Health Vulnerabilities: Draft Indicators

Population Characteristics and Health Vulnerabilities			
Income	**Race and Ethnicity**	**Health Outcomes & Sensitivities**	**Housing Mobility & Communications**
Percent <80% Area Median Income	Percent Latino/a or Hispanic	Asthma emergency department visits	Percent renter-occupied homes
Percent <100% of Federal Poverty Line	Percent Black or African American	COPD emergency department visits	Housing cost burden (rental costs)
Percent without bachelor's degree	Percent Asian	Heart attack (MI) hospitalization	Energy poverty / cost Burden
Unemployment rate	Percent Native American or Indigenous	Premature deaths	Manufactured homes
Percent single-parent households	Limited English proficiency	Low birthweight	Homes built before 1960
-	Historical redlining score	Percent without health insurance	Percent without internet
-	-	Percent with disabilities	-
-	-	Percent adults age 65+	-

4.2 Characteristics of Draft Disadvantaged Communities

The draft criteria identify approximately 35% of census tracts in the State as geographic DACs. As designed, the communities covered by the draft geographic DAC criteria have far more low-income, Black and African American, and Hispanic/Latino households (Table 5).

Table 4. Comparison of Draft Geographic DACs (35% of tracts) with non-DACs (65% of tracts)

	Indicator or Metric	Not draft DACs (65% of state)	Draft geographic DACs (35% of state)
Household Income	Household income <80% Area Median Income (relative to household size)	35%	61%
	Household income <100% of Federal Poverty Line (relative to household size)	9%	23%
Race and Ethnicity	Black or African American Population	11%	29%
	Hispanic and Latino Population	11%	34%
	Asian Population	10%	8%
	Native American, Pacific Islander or Indigenous Population	1%	2%
Component Scores	Environmental Burden and Climate Change Risk Score Percentile (Average)	40	68
	Population Characteristics and Health Vulnerabilities Score Percentile (Average)	36	76

Source for race, ethnicity, and income relative to Federal Poverty Line: US Census American Community Survey data, 2015-2019. Source for 80% AMI data: US Department of Housing and Urban Development, 2015. Source of relative indicator scores: Technical Team analysis.

Because of regional differences in sociodemographic characteristics, health, environmental burdens, and climate change risks, some State regions have relatively more or fewer DACs than others. Table 6 below shows that while on average 35% of the State is identified as geographic DACs, in the five NYC counties about 45% of census tracts are identified as DACs, while some regions have fewer than 35% of census tracts identified as draft DACs.

Table 5. Percentage of census tracts within each region designated a draft DAC

Region	Percent of tracts identified as draft DACs
New York City	45%
Long Island	12%
Mid-Hudson	45%
Western NY	32%
Finger Lakes	35%
Capital Region	22%
Central NY	36%
Southern Tier	18%
Mohawk Valley	19%
North Country	15%
Total	**35%**

Regions correspond with Regional Economic Development Council (REDC) regions. For a list of counties within each region, see https://regionalcouncils.ny.gov/. Chart is sorted from most to least populous regions.

A second way to understand the regional distribution is looking at the share of New York's population in each region, and its share of DAC designated census tracts.

Table 6 shows that the five NYC counties are home to approximately 43% of New York's population (as well as 51% of New York's low-income population) and comprise about 59% of all census tracts designated as Draft DACs. This means that NYC has proportionally more DACs relative to its population size. This is because, when considering all 45 indicators in the draft criteria, NYC census tracts scored relatively higher on the combined indicators. Similarly, Mid-Hudson communities hold a relatively greater proportional share of DAC tracts. Three regions – Western New York, Finger Lakes and Central New York – have roughly proportional shares of New York's population and DAC census tracts. Long Island, Southern Tier, Mohawk Valley, and North Country have relatively fewer DAC census tracts compared to their share of population. This is because, when considering all 45 indicators in the draft criteria, their census tracts scored relatively lower on the combined indicators, compared to other census tracts in the Rest of New York State (per above, combined scores are ranked relative to the "Rest of State" region as well as statewide).

The draft map of DACs that illustrate the draft list of census tracts identified as DACs on climate.ny.gov website allows viewers to see the indicator percentiles and each tract's percentile rank for "Environmental and Climate Change Burdens and Risks" and "Population Characteristics and Health Vulnerabilities" and the combined percentile rank, to understand why some tracts were identified as DACs and some were not.

Table 6. Share of each region's population, low-income population, and draft DAC census tracts

Region	Share of NY Total Population	Share of NY Low Income Population	Share of Draft DAC Census Tracts
New York City	43%	51%	56%
Long Island	13%	7%	4%
Mid-Hudson	11%	9%	14%
Western New York	8%	8%	7%
Finger Lakes	7%	7%	6%
Capital Region	6%	5%	4%
Central New York	4%	4%	5%
Southern Tier	4%	4%	2%
Mohawk Valley	3%	3%	2%
North Country	2%	3%	1%
Total	**100%**	**100%**	**100%***

Chart is sorted from most to least populous regions.
*Percentages may not add up to 100% due to rounding

The scoring approach for draft criteria includes several methods to balance rural and urban burdens and vulnerabilities, including indicators for rural vulnerabilities (e.g., manufactured/mobile homes, distance to healthcare facilities), the regional approach to scoring (i.e., separating "Rest of State" from "New York City" tracts and designating the top-scoring tracts in each). These help to include more tracts outside of NYC, though even in "Rest of State," the combination of indicators selected by the CJWG generally results in lower scores in rural areas. Even with these methods, relatively fewer rural tracts were identified as DACs (15%) compared with suburban tracts (26%) and urban tracts (47%).

4.3 Low-Income Households as DACs for Purpose of Directing Clean Energy and Energy Efficiency Investments

In addition to the geographic component of identifying DACs, the CJWG voted to include households that report total household income at or below 60% of State-Median Income (SMI) into the criteria solely for the purpose of State agencies investing or directing a percentage of clean energy and energy efficiency programs, projects, or investments to DACs, pursuant to ECL § 75-0117. This additional criterion allows investments in individual

households outside of census tracts identified as DACs making at or below 60% SMI to be included in the accounting process.

The Technical Team estimates that slightly more than half (52%) of low-income households live in DACs, while slightly less than half (48%) live outside of DACs. Expanding the DAC criteria (for investment purposes only) to include low-income households outside of census tracts identified as DACs adds at least one million households (likely more) to the designation of DACs and increases the percentage of the State designated as DACs from 35% (geographic criteria only) to about 50% of the State. The exact counts are difficult to determine at any point in time given the lag between the US Census American Community Survey (ACS) and the present, and changes in low-income criteria (e.g., state median income) from year to year.

Like the regional share of geographic DACs, there are regional differences in the coverage of this expanded DAC criteria. In general, the expanded designation allows relatively more households in rural areas to be included as DACs for State agency clean energy and energy efficiency investment purposes. Table 7 below shows how many households may be included in the draft DAC criteria for the purposes of allocating investments, when low-income households are considered in addition to geographic DACs. The number of DAC households in more rural regions (Southern Tier, Mohawk Valley, and North Country) increases more than two-fold such that more than 40% of households in those regions (either geographic DACs or low-income households outside of DACs) are identified as DACs.

Table 7. Increase in number of households included in DAC criteria for purposes of allocating energy efficiency and clean energy investments, by Region

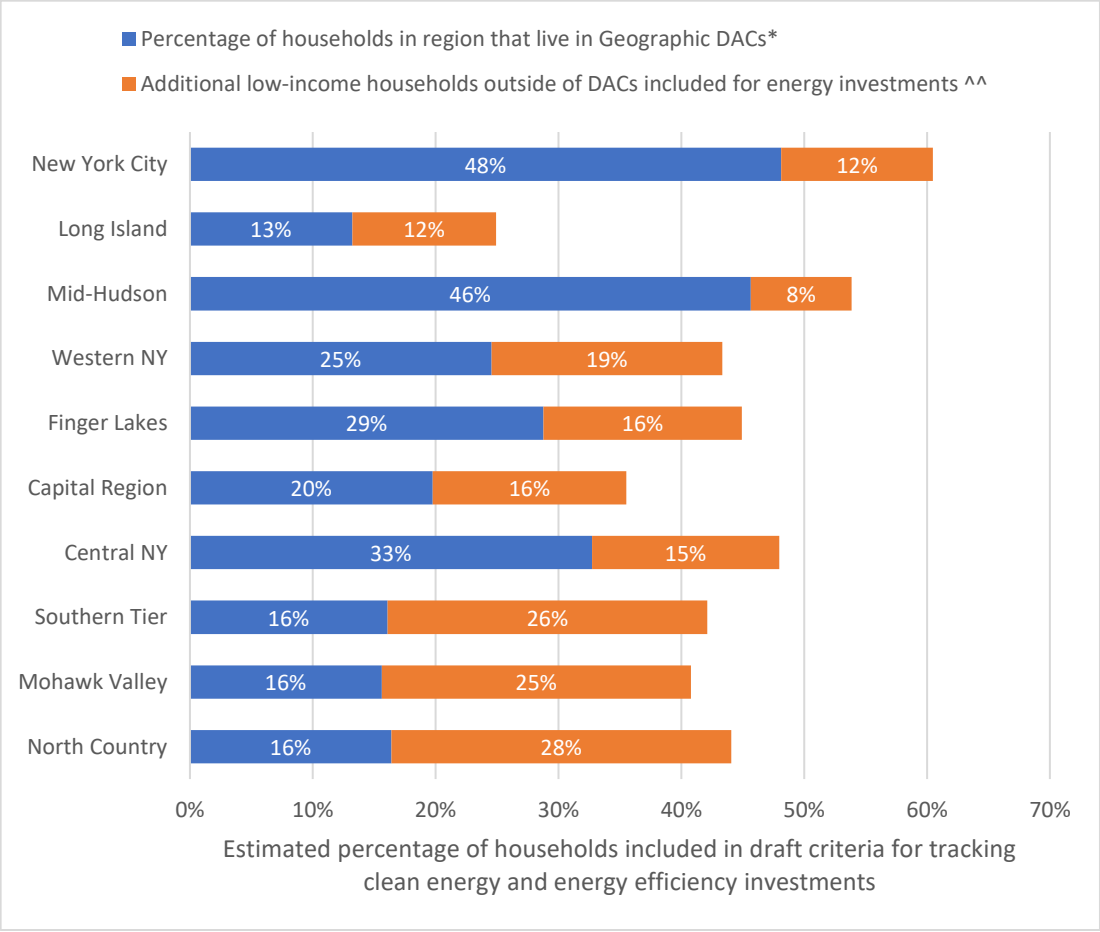


Chart is sorted from most to least populous REDC regions.

* The percentage of households that live in DACs within each region may vary slightly from the percentage of tracts identified as DACs within each region (Table 5) because of slight variation in the population of tracts by region.

^^Source: American Community Survey (2015-2019) and Technical Team analysis. Estimated using 200% of Federal Poverty Line as a proxy for 60% State Median Income. Actual counts may be slightly higher since 60% of state median income is higher than 200% of the federal poverty line.

The actual number of eligible and included households may vary depending on household incomes in and after 2020, though it is expected that at least 50% of households will be included (35% within geographic DACs and at least 15% outside of geographic DACs) for the purpose of investing or directing clean energy and energy efficiency programs, projects, or investments to DACs.

5. CLIMATE JUSTICE WORKING GROUP DISADVANTAGED COMMUNITIES SCORING AND SELECTION

5.1 Scoring and Designation Approach

This section describes the approach used to calculate relative scores for census tracts, and how those scores are used to designate specific census tracts as draft DACs. The process for designating DACs involved the following steps:

1. **Identify the appropriate geographic unit of analysis:** Select the geographic unit of analysis based primarily on the availability, reliability, and stability of data for each unit and how NYS agencies might manage actions or spending.
2. **Find and screen statewide data for inclusion:** Identify, consider, and evaluate indicators based on data coverage and granularity, data quality, data modeling, correlations with other indicators, and technical guidance from State agencies.
3. **Obtain or calculate census tract level values for each tract for each indicator:** For each tract, calculate a percentile rank for each of the 45 selected Indicators
4. **Calculate Factor Scores:** Calculate 7 Factor Scores from the weighted averages of sets of selected Indicators
5. **Calculate Component Scores:** Calculate 2 Component Scores from the weighted averages of sets of Factor Scores
6. **Calculate Combined Scores:** Calculate a single Combined Score for each tract by multiplying the Component Scores together
7. **Calculate Combined Score Percentile Ranks and Designate Tracts:** Calculate the values that are compared against each tract's scores to determine the DAC designation for each tract
8. **Calculate Combined Score Percentile Ranks and Designate DACs**: Assign a Combined Score Percentile Rank, which is the highest value between its Statewide Combined Score Percentile Rank and its Regional Combined Score Percentile Rank
9. **Indigenous Communities**: including Indigenous Communities while respecting the sovereign, government to government relationship between Nations and NYS
10. **Low Population Areas**: The inclusion of census tracts that have household counts or population counts that are too low for reliable sociodemographic data

These steps for calculating tract scores and designating DACs are described in the following sections.

5.1.1 Geographic Unit of Analysis

The CJWG and the Technical Team considered three different units of analysis: (1) block group, (2) census tract, and (3) NYS aggregate area, and selected census tract as the level of analysis for the geographic component of the

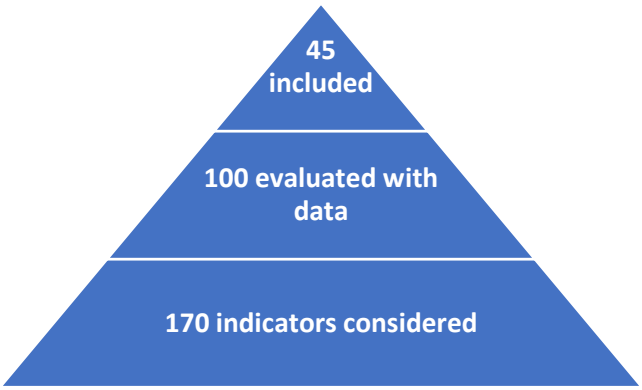
DAC criteria. There are 4,918 census tracts in New York, each with about 3,989 people and 1,488 households, on average. Census tracts are commonly used for neighborhood-level analysis and EJ and DAC screen tools.

Three primary considerations informed this decision: (1) the availability, reliability, and stability of data for each geographic unit, (2) how NYS Agencies might manage actions or decisions that affect how spending or benefits flow to a community, and (3) selecting an area that people might identify as a community. We also reviewed technical documentation from EJScreen, CalEnviroScreen, NYS Department of Health, and NYC Planning about trade-offs and limitations of using small census geographies like the block group and conferred with NYSDOH on data availability for key health outcomes. For additional detail on the decision to use census tract and the trade-offs and limitations associated with different units of analysis, please refer to Appendix A.

5.2.2 Finding and Screening Statewide Data

The CJWG and Technical Team considered over 170 indicators, obtained and analyzed data for 100 indicators, and prioritized 45 indicators for inclusion in the draft DAC criteria (Figure 1). Section VII describes the CJWG and Technical Team process for selecting indicators in more detail, including a preliminary rubric developed to prioritize indicators. This section describes the process of obtaining data, calculating indicators, and screening indicators analytically.

Figure 1. Indicator Counts by Process Step



After the CJWG and Technical Team and Agency subject matter experts identified higher-priority indicators, the Technical Team found data and assessed availability or feasibility of calculating at the census tract level. Where possible the Technical Team found data sets that were published by the US Census Bureau, US Environmental Protection Agency (EJScreen), National Air Toxics Assessment (NATA), New York State, the U.S. Department of Energy, and other public sources with detailed technical documentation. Data sets that were publicly downloadable and available at the census tract level or lower for all of New York State were prioritized for evaluation by the Technical Team and subject matter experts NYSDEC (for emissions), NYSDOH (for vital statistics), NYS Department of State (for climate), and New York State Homes and Community Renewal (for land use).

After the Technical Team obtained or calculated all available indicators (about 100), with support from Agency staff, they evaluated indicators for inclusion or exclusion based on how well they meet the criteria listed below:

- **Data coverage and granularity:** Are data available statewide at the geographic level needed? Because census tracts are the unit of analysis and geographic definition of a community, data need to be available for all census tracts in New York State.
- **Data quality:** Are the data considered current and accurate, with limited measurement or sampling error? Measurement error can come from, for example, small or non-representative samples or models with general or non-localized assumptions.

- **Modeled vs. collected or measured primary data:** How directly does the indicator represent the factor or concept that it is intended to represent? For example, is it a direct measure of the factor or concept or an indirect or proxy measure?
- **Correlations:** How essential and unique is the indicator to the DAC criteria? Does it contribute something essential and unique to the DAC definition or is it highly correlated with other indicators? Where overlap between indicators exists, we selected the indicator with the best data quality that most directly represents the factor or concept intended.
- **Pre-existing indices:** Numerous indices of environmental, climate and health vulnerability were suggested. Each index is composed of several underlying indicators, which in some cases were already included as stand-alone indicators. For indices that seemed valuable, we searched for data representing the separate components, to avoid redundancy and overlap.[2]
- **Technical guidance:** What indicators do State agencies (e.g., NYSDEC, NYSDOH, NYSDOS) familiar with the subject matter (e.g., health, environment, climate) and available data sources advise as the best way to represent or measure the subject or concept the CJWG is interested in?

Data evaluation included statistical diagnostics, such as completeness, skewness and outliers, and correlation with other indicators prioritized for inclusion by the CJWG. This helped identify potential indicators that were highly correlated with other indicators to streamline the variable list and eliminate some overlap. However, because many indicators of economic and health vulnerability, historical discrimination or disinvestment, and environmental burdens are highly correlated, some strong correlations remain in the final dataset.

Please see the Appendix in Section 8 for a list of considered indicators and some of the data limitations for each. As part of the annual review process, the CJWG may request or search for additional data or data updates.

5.2.3 Calculating Indicator Values per Census Tract

For each indicator, each census tract is assigned a "raw" value from the source dataset (e.g., vehicle traffic density per square meter; percent of land area zoned as industrial or manufacturing; percentage of housing units occupied by renters; average annual rate for asthma over five years). For some indicators, estimates for each census tract were readily available at the census tract level, but most required data cleaning, analysis, or transformations. For numerous environmental burden and climate change risk indicators, obtaining values per census required geographic information system (GIS) analysis to estimate normalized values per census tract from statewide data sources (e.g., DEC databases or GIS Shapefiles) or climate models. For the following types of indicators, while underlying data was available to create indicators, the data was not calculated or estimated at the census tract level, and the Technical Team and staff experts from State agencies developed approaches for the data preparation of those indicators:

- DEC provided classification and locational data for several types of environmental burdens sites (which needed custom calculations to represent at the census tract level)
- DOH compiled and calculated health outcomes data at the sub-county level for 1,274 aggregate areas (which are less granular than the census tract level) and the consultant team applied aggregate area values to census tracts.
- The Consultants, in consultation with NYS DOS and NYSDEC, developed methods to estimate climate change risks and projections at the census tract level from existing climate models at different geographic levels

[2] One example is heat vulnerability indices. Several heat vulnerability indices consider land use factors like building density or intensity, vegetative cover or undeveloped land, as well as socioeconomic factors. Most socioeconomic factors were already suggested (or included) as separate indicators, and building density is highly correlated with several other indicators including traffic density and NATA modeled air toxics (e.g., PM 2.5, benzene), though the draft DAC criteria include areas with low vegetative cover to represent that element of heat vulnerability.

- HCR compiled land use classification data at the tax parcel and property level and aggregated to census tract level.
- Other indicators required other custom analytical approaches.

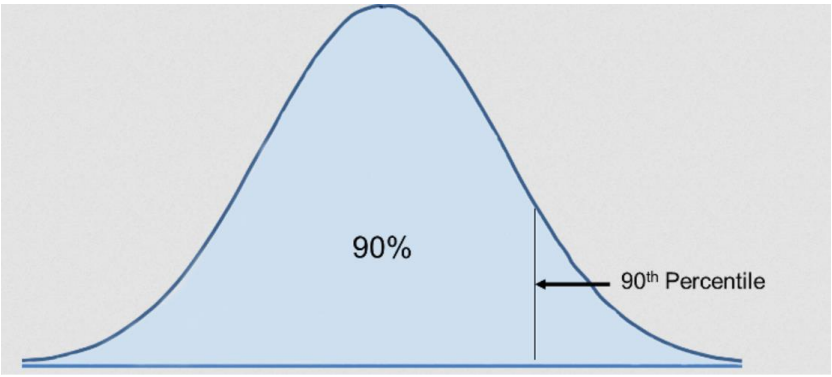
The Selected Indicators section details calculation methods for each indicator.

Every indicator's raw data is measured in different units and requires a common scale to combine and compare the data within and across indicators. For example, vehicle traffic density is measured as average annual daily traffic and is scaled to distance from a census block centroid, while Hispanic and Latino population is measured as a count of people, expressed as a percentage scaled by population. In some cases, data needed to be normalized to census tract land area or population (since tracts have varied sizes). Examples of normalizing indicators include expressing count-based data as percent of populations, households, or tract area, or of an area-based metric (like square miles of agricultural land) as a percentage of tract area.

5.5.4 Calculate Indicator Percentile Ranks

After cleaning and normalizing the raw datasets, the Technical Team re-scales the data by calculating a percentile rank ("percentile") for each census tract on each indicator. For data to be used in a single scoring system, it must be re-scaled to a common scale (like 0-100), so that the data can be added, averaged, or combined. The Technical Team considered several re-scaling approaches including statistical normalization (e.g., z-scores), min-max normalization, and percentile ranks. The Technical Team recommended percentile ranks because they are a straightforward way to represent the relative burdens or vulnerabilities between census tracts, smooth out potential measurement, sampling, or modeling error for some indicators,[3] and align with current EJ scoring approaches used by California, the U.S. EPA, the Washington State Health Disparities Map, and the Social Vulnerability Index of the Center for Disease Control and Agency for Toxic Substances and Disease Registry.

Figure 22. Illustrative example of a percentile interpretation, where an observation in the 90th percentile is greater than 90% of the other observations of the indicator.



The Technical Team also assessed how data sets represent missing data or "no impact" observations, e.g., if zeros in the data mean that the value was missing, not evaluated, or represents no disadvantage for the indicator. In

[3] All three of these methods preserve and reflect the relative ranking (relative differences) between census tracts. Both z-scores and min-max normalization also preserve the relative magnitude of differences in values between census tracts (relative shape of the distribution), while percentile-based methods rank without preserving the magnitude of differences. In making the recommendation to use a percentile-based approach, the Technical Team considered how the many different types of data used in the DAC criteria were generated (e.g., based on models or samples vs. direct or complete measurement) and the potential for error (and published margins-of-error, if published). While for some indicators that are more precisely and comprehensively measured (e.g., land area zoned as industrial or manufacturing use), many are based on relatively small samples (e.g. Census ACS data samples about 2%-3% of the population each year), models, or are disaggregated from coarser-grained data. This could mean that the magnitude of some of the differences between tracts may be due to measurement or modeling area and, in some cases, we confirmed this by looking at margins-of-error of extreme (low or high) values, such that for some indicators the magnitude of differences between tracts may not represent significant or meaningful differences. A rank-based approach essentially smooths out the magnitude of some of the differences, which has pros and cons depending on the indicator.

some cases, raw data was missing from the original source because it was never collected or calculated.[4] In other cases, data was missing because the exposure, burden or risk was not present, and to understand the relative exposure, burden, or risk between tracts, a "zero" value would better reflect the census tracts' statuses. For example, coastal flooding risk was only calculated for coastal tracts, and to reflect their risk versus other tracts, data was modified reflect zero coastal flooding risk in non-coastal tracts. The Technical Team modified missing data to be included or excluded as zeros, as necessary.

To calculate the percentile rank for each of the 45 selected indicators we ranked all non-zero data points of each indicator from smallest to largest. Observations (raw value data points) of zero were assigned a percentile rank of zero. Missing observations were not included in the percentile calculation. Percentile rank was then only calculated for those census tracts with a score above zero. The first non-zero percentile value is dependent on the number of non-zeros observations. The first value is 100 divided by the number of non-zero observations. Each subsequent rank is a multiple of that number. In the event of a tie, every observation in the tie was assigned the maximum percentile rank. Census tracts with fewer than 100 people that are not designated as Indigenous Communities are excluded from the calculation of Indicator Percentile Ranks (see "Low Population Areas" for additional details).

The example below includes 10 non-zero observations. Therefore, the lowest ranked observation would be assigned the 10th percentile. But, in this case, the lowest ranked observation is tied with one other observation. The Technical Team assigned the maximum rank for observations that were tied. The maximum rank is multiplied by the count of non-zero values for the final percentile score.

Table 8. Example percentile calculation with random data. For illustrative purposes only.

Tract	Raw observations in ascending order	Rank of non-zero values, or max of rank if tie	Count of non-zero values	Final percentile score
0001	0	0	10	0
0002	14.6	2	10	20
0003	14.6	2	10	20
0004	24.6	3	10	30
0005	35.6	4	10	40
0006	37.8	5	10	50
0007	37.9	8	10	80
0008	37.9	8	10	80
0009	37.9	8	10	80
0010	38	9	10	90
0011	50.2	10	10	100
0012	NA	NA	10	NA

The percentile approach to scoring created a relative ranking of census tracts on each indicator. This allowed all 45 indicators to be on the same scale so they could be added or averaged together in a scoring approach. The scoring approach did not specify a threshold or cut-off to say that one community faced a high burden or risk, and one did not. While it may be possible to find scientific documentation of what air pollution exposure level may cause a threat to human health, it is difficult (and subjective) to say what climate projections, land use, sociodemographic, or health outcomes may make a community "disadvantaged."

[4] While the Technical Team prioritized data with statewide coverage, some valuable indicators have missing data for several reasons (e.g., for Historic Redlining that is based on 1930s home appraisals and neighborhood rankings, some areas, including more rural areas were not rated). Census tracts do not have an Indicator Value for one or more of the 45 Indicators. These blank Indicator Values are referred to as NULL Indicator Values.

Percentile rank calculations were performed for all selected indicators as well as considered indicators screened and analyzed for potential inclusion.

5.5.5 Calculate Factor Scores

The 45 selected Indicators are grouped into seven sets, referred to as **Factors**, to bundle similar concepts for weighting purposes. Factors include:

Environmental Burdens and Climate Risks:

(1) Potential Pollution Exposures
(2) Land Use Associated with Historical Discrimination or Disinvestment
(3) Potential Climate Change Risks

Population Characteristics and Health Vulnerabilities:

(4) Income, Education, and Employment
(5) Race, Ethnicity, and Language
(6) Health Outcomes and Sensitivities
(7) Housing, Energy, and Communications

The 45 Indicators are split into these seven Factors to calculate seven **Factor Scores**. Each Factor Score for a given census tract is calculated as a weighted average of **Indicator Percentile Ranks** for that Factor's associated Indicators. To calculate this weighted average, each Indicator associated with the Factor is assigned an **Indicator Weight**, which is multiplied by the Indicator's Percentile Rank. Dividing this product by the sum of the Indicator Weights yields the Factor Score for that Factor. If a tract has a missing value for an indicator, the value for that indicator and the weight for that indicator are excluded from the calculation of Factor Scores. For details about the indicators comprising each factor see Section 6 Indicators in Draft Criteria.

For example, the "Potential Pollution Exposures" factor comprises five indicators: Vehicle Traffic Density, Diesel Truck and Bus Traffic, Fine Particulate Matter ($PM_{2.5}$), Benzene Concentration, and Proximity to Wastewater Discharge. Each of these five indicators are weighted equally (i.e., they all have a weight of 1 within the factor). To calculate the Potential Pollution Exposures Factor Score for a hypothetical tract:

- Assume that the five Indicator Scores for this Factor are 25, 40, 90, 80, and 70 for this tract
- Each of this tract's Indicator Percentile Ranks for the five Indicators in this Factor are multiplied by their Indicator Weights: (25*1) = 25, (40*1) = 40, (90*1) = 90, (80*1) = 80, and (70*1) = 70
- These products are summed: 25 + 40 + 90 + 80 + 70 = 305.
- The weights for the five indicators are summed: 1 + 1 + 1 + 1 + 1 = 5.
- The weighted average is the sum of the weighted Indicator Percentile Ranks divided by the sum of Indicator Weights: 305 / 5 = 61.
- This yields a Potential Pollution Exposures Factor Score of 61 for this hypothetical tract.

A summary of factor scores by census tract and example calculation are included in the Appendix and on https://data.ny.gov/ as part of the Disadvantaged Community documentation.

5.5.6 Calculate Component Scores

Next, the seven Factors are grouped into the following two sets, referred to as Components:

(1) Environmental Burdens and Climate Change Risks
(2) Population Characteristics and Vulnerabilities

The "Environmental Burdens and Climate Change Risks" Component comprises three of the seven factors, and the "Population Characteristics and Vulnerabilities" Component comprises four factors. Tracts are assigned a

Component Score using a similar process to that used for calculated the Factor Score. To calculate the Component Score for a tract, the seven Factors are then split into two Components – Environmental Burdens & Climate Change Risks and Population Characteristics & Health Vulnerabilities. The figure below shows how the seven Factors are combined into two overarching Components: (1) Environmental Burdens and Climate Change Risks, and (2) Population Characteristics and Health Vulnerabilities.

Figure 3. Two Components and their Associated Factors

Each Component Score for a given census tract is calculated as a weighted average of **Factor Scores** for that Component's associated Factors. To calculate this weighted average, each Factor associated with the Component is assigned a **Factor Weight**, which is multiplied by the Factor's Factor Score. Dividing this product by the sum of the Factor Weights yields the Component Score for that Component.

The two figures below show how the two components are calculated from Factor Scores and Factor Weights. Figure 4 shows how the Environmental Burdens and Climate Change Risks Component is calculated by multiplying each of its three constituent Factor Scores by their weights and dividing the sum of those products by the sum of the Factor Weights.

Figure 4. Calculating the Environmental Burdens and Climate Change Risks Component

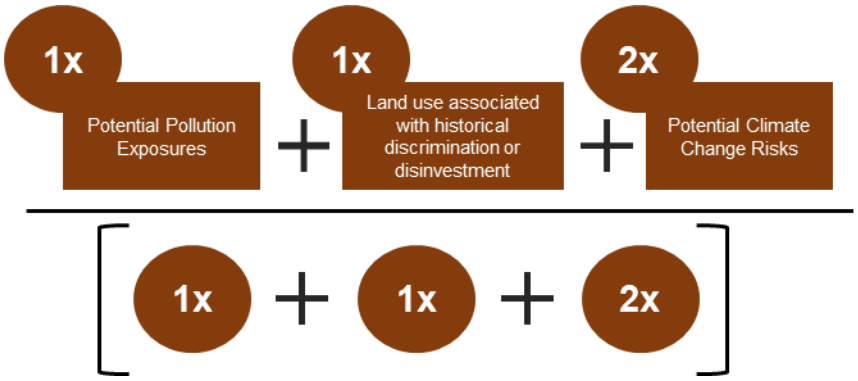
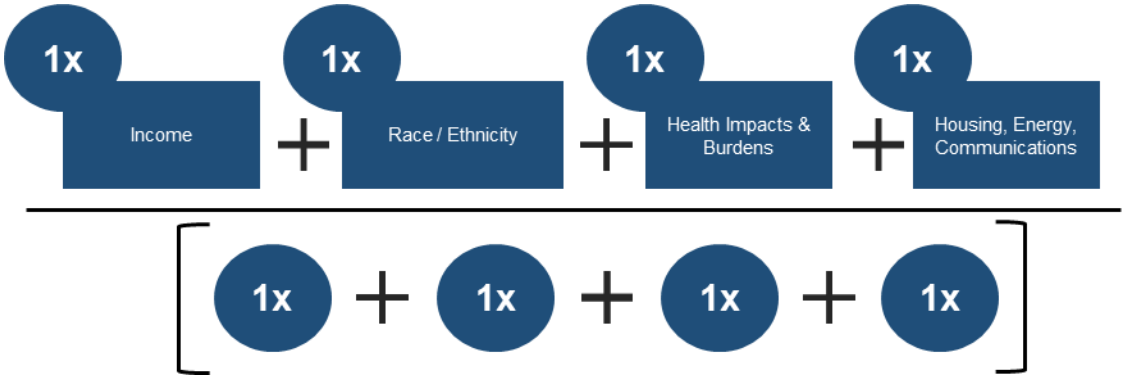


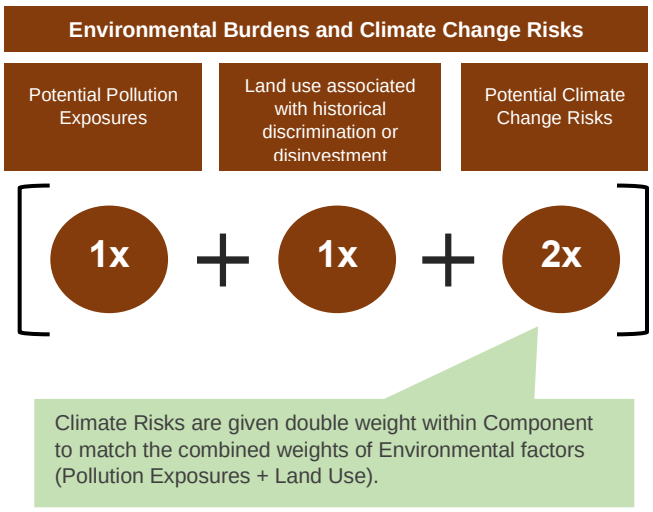
Figure 5 shows how the Population Characteristics and Health Vulnerabilities Component is calculated by multiplying each of its four constituent Factor Scores by their weights and dividing the sum of those products by the sum of the Factor Weights.

Figure 5. Calculating the Population Characteristics and Health Vulnerabilities Component



The method for calculating Component Scores and Factor Scores takes a balanced approach to weighting. Within the Environmental Burdens and Climate Change component, the CJWG agree that Environmental considerations ("Exposures" and "Land Use and Facilities"), together, should have the same weight as "Potential Climate Change Risks." To achieve this, since there are two Environmental factors, the "Potential Climate Change Risks" factor is given a weight of two (2x) to match the combined weight of the two environmental factors (1x + 1x) (Figure 6).

Figure 63. Climate Justice Working Group Meeting Slide Excerpt Documenting Double Weight for "Potential Climate Risks" Factor



It is worth mentioning that, because there are fewer "Environmental Exposures" indicators (4) than "Land Use and Facilities Indicators" (9), each environmental exposure indicator has slightly more than double the weight of environmental burdens. This approach aligns with CalEnviroScreen, California's environmental justice mapping tool, and was recommended by DEC, because the environmental exposures represent potential contact with estimated pollutant concentrations and risk could be quantitatively assessed. Whereas the land use and facilities indicators represent proximity to potential pollution where the amount and type of pollutant released is less certain and risk is not possible to calculate.

The calculation of the "Environmental Burdens and Climate Change Risks" Component for a hypothetical tract illustrates the approach. This Component comprises three Factors: Potential Pollution Exposures, Land Use Associated with Historical Discrimination or Disinvestment, and Potential Climate Change Risks. The Potential Climate Change Risks Factor is given double weight, and the other two Factors are both given a weight of one.

Figure above depicts the calculation for this Component score. To calculate the Environmental Burdens and Climate Change Risks Component for a hypothetical tract:

- Assume that the three Factor Scores for this Component are 60, 80, and 75 for this tract.
- Each of this tract's Factor Scores for the three Factors are multiplied by their Factor Weights: (60*1) = 60, (80*1) = 80, (75*2) = 150.
- These products are summed: 60 + 80 + 150 = 290.
- The weights for the three Factors are summed: 1 + 1 + 2 = 4.
- The sum of the weighted Factor Scores is then divided by the sum of Factor Weights: 290 / 4 = 72.5.
- This yields an Environmental Burdens and Climate Change Risks Component Score of 72.5 for this hypothetical tract.

5.5.7 Calculate Combined Score per Tract

The final **Combined Score** for a census tract is calculated by multiplying its two **Component Scores** together. For example, a Combined Score for a hypothetical tract with a Component Score of 60 for "Environmental Burdens and Climate Change Risks" and 40 for "Population Characteristics and Health Vulnerabilities" would have a Combined Score of 2,400 (i.e., 60 * 40). This process is depicted in Figure 7.

Figure 7. Calculating a Combined Score by Multiplying the Two Component Scores

This approach of multiplying Environmental/Climate Burdens with Population/Health Vulnerabilities is aligned with the CalEnviroScreen approach. This approach incorporates the "effect modifier" of each component, whereby sociodemographic characteristics or health sensitivities may exacerbate or mitigate place-based exposures, burdens, or risks. For example, studies have shown that the risk of health effects from exposure to air pollution is greater in people with lower socioeconomic status.

The 138 census tracts in New York state with low household or population counts (fewer than 300 households or fewer than 500 people) are considered Low Population Areas and have only NULL **Indicator Values** and NULL **Factor Scores** for the "Population Characteristics and Vulnerabilities" Component. The resulting NULL "Population Characteristics and Vulnerabilities" Component Score for these Low Population Area also yields a NULL Combined Score for these tracts.

5.5.8 Calculate Combined Score Percentile Ranks and Designate DACs

Each tract is then assigned a **Combined Score Percentile Rank**. A tract's Percentile Score Rank is defined as the highest value between its Statewide Combined Score Percentile Rank and its Regional Combined Score Percentile Rank, which both range from 0 to 100. A tract's Statewide Combined Score Percentile Rank is calculated by ranking its Combined Score in relation to all other census tracts in New York state with Non-NULL Combined Scores. A tract's Regional Combined Score Percentile Rank is calculated by ranking its Combined Score only in relation to other Non-NULL Combined Scores of census tracts in its region – either NYC or Rest-of-State (all other tracts).

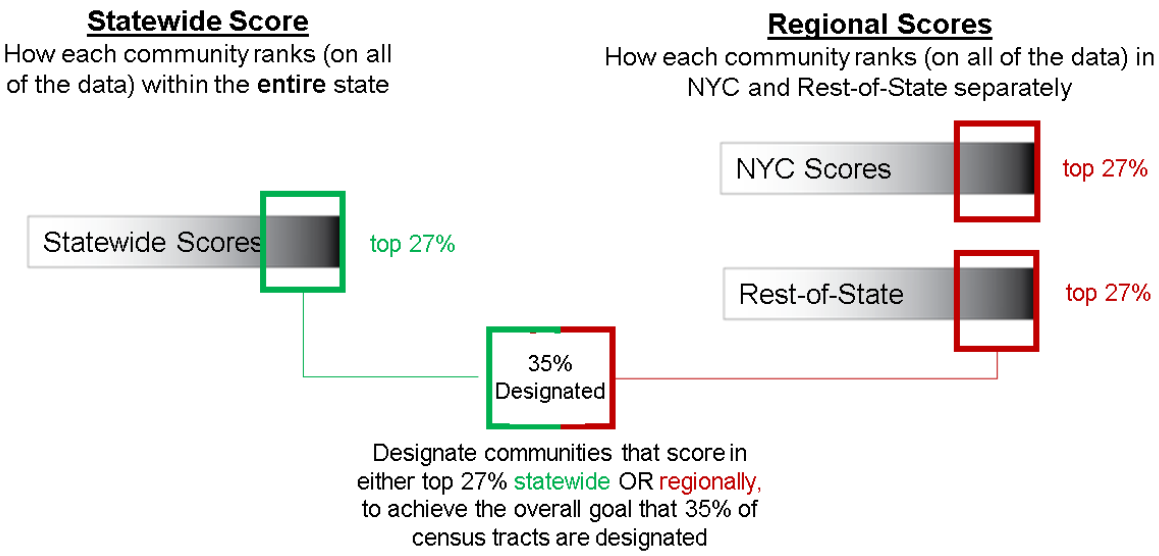
Tracts considered to be Low Population Areas are assigned a **Burden Score Percentile Rank**, defined as the highest value between its Statewide Burden Percentile Rank and Regional Burden Percentile Rank. These Burden Percentile Ranks are calculated by comparing a Low Population Area tract's "Environmental Burden and Climate Change" Component Score with that Component Score for all other tracts across the state (for the Statewide Burden Percentile Rank) or in the tract's region – either NYC or Rest-of-State (for the Regional Burden Percentile Rank).

The last step in the process is to determine whether each tract's combined score falls above the threshold for inclusion in the 35% of census tracts to be designated as Draft Geographic DACs. To achieve the CJWG's goal of designating 35% of the state as DACs and ensure an equitable share of tracts outside of NYC are identified as DACs, this approach designates a tract as a DAC if its combined score ranks about the **DAC designation threshold** either statewide or regionally.

- Combined Score is within top X% of the statewide distribution
- Combined Score is within top X% of its regional distribution (NYC or Rest-of-State)

The **DAC designation threshold** is the percentile above which census tracts are included in the draft DAC list, to achieve the overall goal of designating 35% of the state as a draft DAC. A tract is designated as a DAC if its Combined Score Percentile Rank is greater than 72.6. A Combined Score Percentile Rank of 72.6 or greater would indicate that the census tract's Combined Score is within the top 27.4% of all tracts across the state or within the tract's region. A tract considered to be Low Population are designated as a DAC if its Burden Score Percentile Rank is greater than 72.6. A Burden Score Percentile Rank of 72.6 or greater would indicate that the Low Population Area census tract's Burden Score is within the top 27.4% of all tracts across the state or within the tract's region. Figure 8 below summarizes this process.

Figure 8. DAC Designation Using Statewide and Regional Score Thresholds



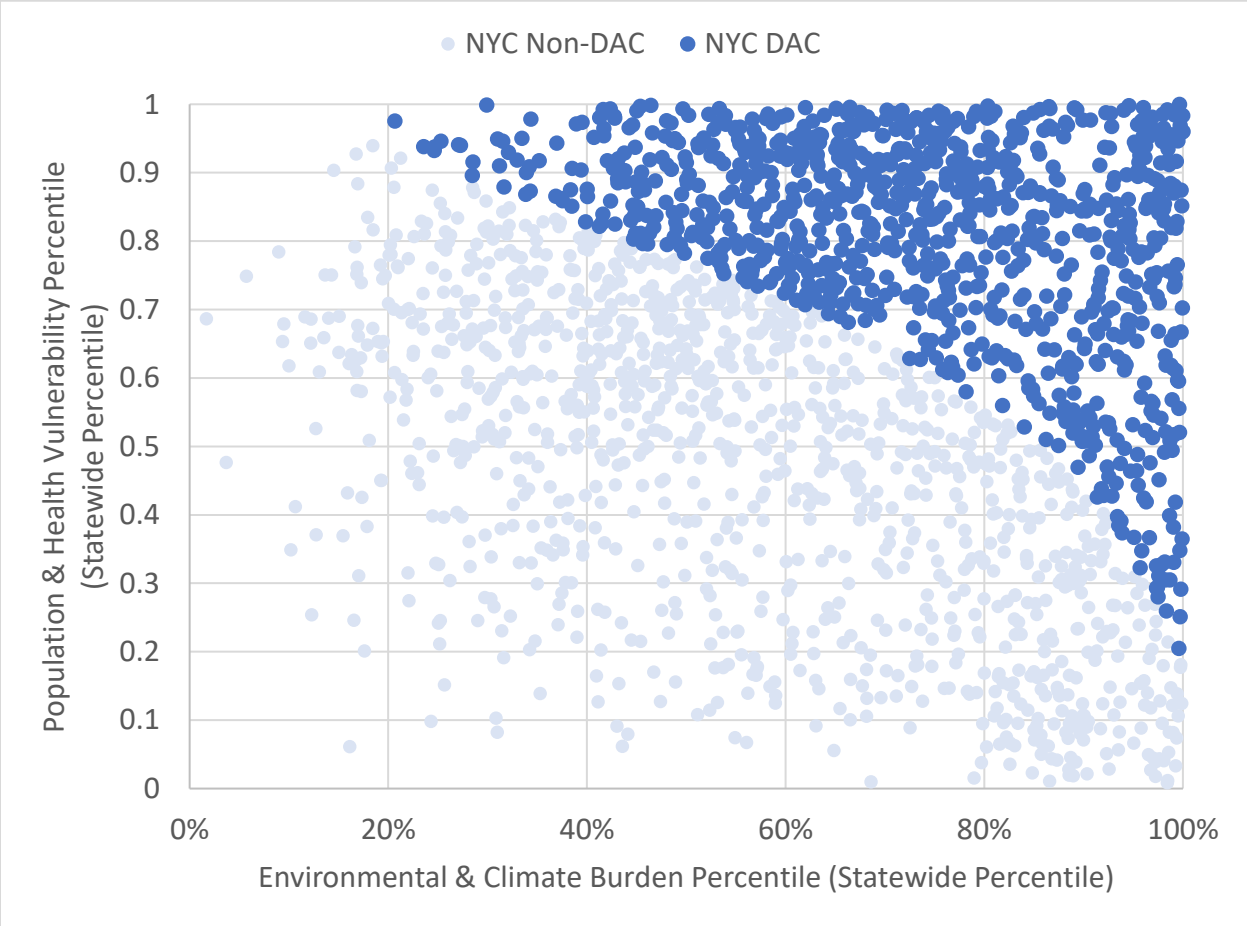
To designate 35% of tracts as DACs, the DAC designation threshold must be set slightly higher, to 27.4%. This threshold is set at 27.4% instead of 35% to adjust for two factors:

- Census tracts can be designated as a DAC based on the rank of their Combined Score relative to both statewide and regional sets of tracts. Selecting the top 35% of Combined Scores for both statewide and regional distributions would designate more than 35% of tracts as DACs.
- The tracts identified as Indigenous Communities and those identified as Low Population Areas, are subject to special rules for DAC designation. As the designation of these communities is not based on their Combined Scores, these tracts add to the number of DACs without changing the Combined Score ranks of other census tracts. This would result in designating more than 35% of the state as DACs without adjusting the threshold for other tracts.

In addition, the CJWG has determined that Indigenous Communities should be represented in the DAC criteria. DEC identified Indigenous Nation census tracts (19 total) that are included as part of the 35% of census tracts identified for the draft criteria.

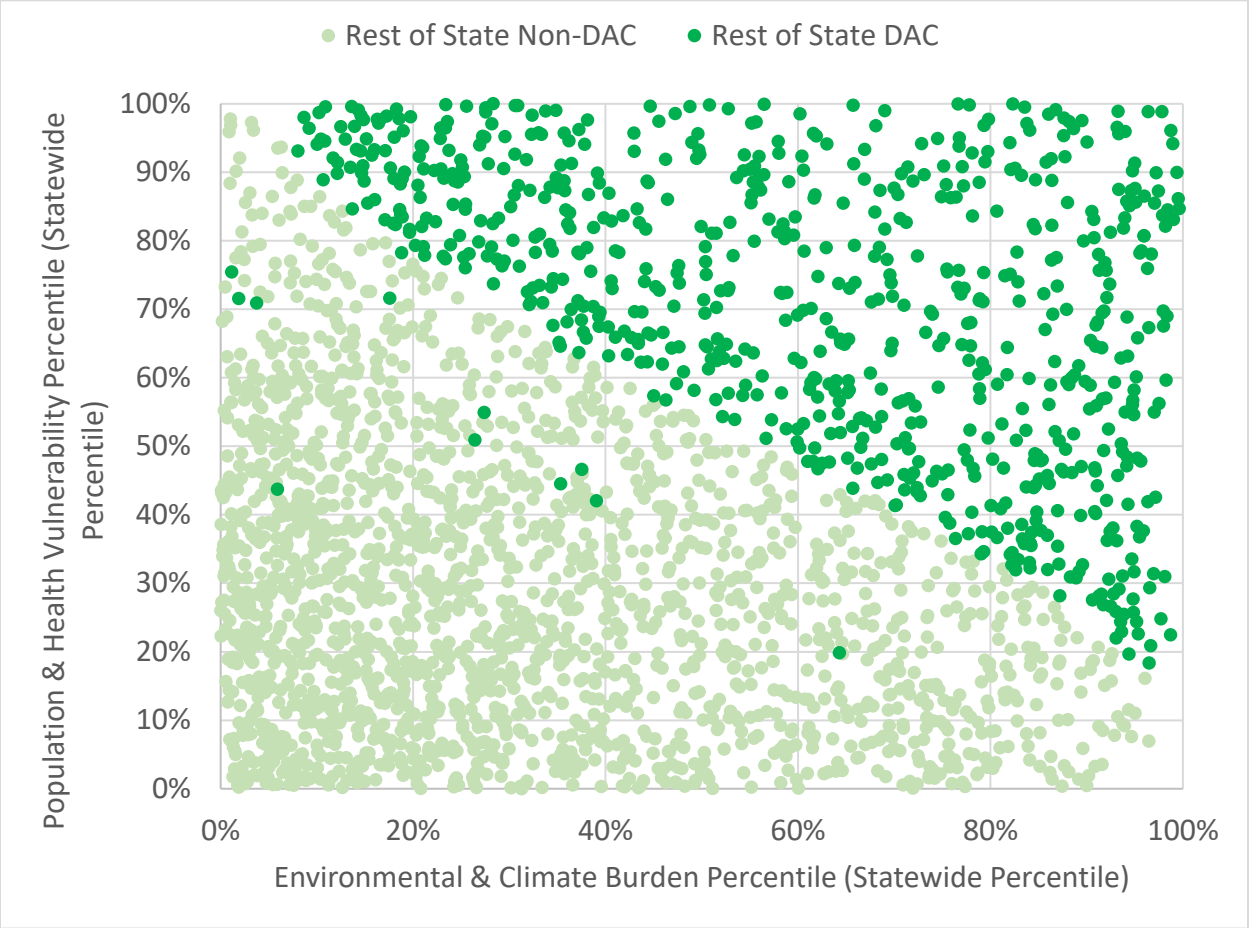
Figure 9 and Figure 10 show how the percentile ranks of the two component scores relate to the draft DAC designation. Both figures plot the statewide percentile ranks for simplicity, though in practice both statewide and regional percentile ranks were used in designating draft DACs.[5] The dark dots in both figures show that draft DACs to have either (a) high-to-moderate scores on both components, or (b) a high score on one component, and moderate score on the other component. The light dots in the top left of each figure show tracts with high Vulnerability scores but low-to-moderate Burdens scores that were excluded. Low-income households in these tracts are still included for investment purposes. The light dots in the bottom-right of both figures show tracts with high environmental or climate burdens (e.g., proximity to exposure or hazard; flooding risk) with low population and health vulnerabilities.

Figure 9. Scatterplot of Statewide Percentile Ranks of NYC Census Tracts



[5] Since NYC tracts typically have higher scores on both components, the percentile ranks of draft DAC tracts in NYC are typically higher than in the rest of the state. For tracts in the rest of the state, their regional Combined Score percentile ranks (calculated using only tracts outside of NYC) allowed more tracts to score in the top percentiles regionally.

Figure 10. Scatterplot of Statewide Percentile Ranks of Rest-of-State census tracts



5.5.9 Indigenous Communities

Indigenous (Native) peoples live throughout the area now called New York State and have for at least 13,000 years. They live in Nation territories (reservations), suburban, and urban places. In fact, New York City has one of the largest populations of Indigenous people in the United States. It is important that we consider the unique histories of racism and discrimination experienced by Indigenous people, particularly in a colonial context such as the United States. Therefore, Indigenous people are considered in the Disadvantaged Community Definition according to two methods:

- As individual members of census tracts: As counted by the U.S. Census Bureau in their counts of American Indian and Alaska Native population (a selected indicator)
- As citizens of sovereign Nations or residents of Nation controlled territory: If the Nation controlled territory (either sovereign territory or owned) exceeds 5% of the area of a census tract, the census tract will be designated a DAC regardless of criteria scores.

By including Indigenous people according to the two aforementioned methods, we have established a baseline for inclusion during this draft period. Since 2019, New York State has asked leadership for the Indigenous Nations how they would like to interact on this topic both now and moving forward. DEC has provided information on the Environmental Justice Act of 2019, the Climate Act, and the development of the draft criteria to identify disadvantaged communities during annual meetings with Nations leadership. DEC and NYSERDA have reached out both formally and informally in many ways.

In respect for the government-to-government relationship between the State and the various Indigenous Nations, the Nations will decide their involvement in this process, including whether Nation territories should be included within the final designation of disadvantaged communities. Regardless of the Nations' individual decisions, DEC and NYSERDA are willing to continue discussing these topics with leadership if desired.

5.5.10 Low Population Areas

There are 138 census tracts that have household counts or population counts that are too low for reliable sociodemographic data (fewer than 300 households or fewer than 500 people) from the US census or DOH (either the data has large margins-of-error, or it is not available for a small geographic). Therefore, we do not use sociodemographic or health data, and do not calculate "Population Characteristics and Vulnerabilities" scores. However, these tracts still have "Environmental Burden and Climate Change" Component Scores. These tracts are scored based on Environmental/Climate Burdens alone (if their Burdens score fall about the **DAC designation threshold** for NYC or Rest-of-State, similar to the approach for designating DACs from Combined Scores for other tracts) if their population is at least 100 people. There are 81 tracts in New York State with fewer than 100 people, and these tracts are not considered at any stage in the scoring process. The only exceptions are tracts considered to be Indigenous Communities, which are still included in the scoring process even if they have fewer than 100 people.

6. INDICATORS IN DRAFT CRITERIA

6.1 Indicator Prioritization and Selection

As part of the process of developing criteria to identify DACs, CJWG members and the Technical Team identified many potential indicators to include in the draft criteria. The process of identifying and prioritizing indicators included the following steps:

- Review other state and federal screening tools, environmental and climate data, including CalEnviroScreen 3.0 and 4.0, EPA EJScreen, Justice40 Interim Guidance, FEMA Natural Hazard Risk Index, CDC Social Vulnerability Index, and emerging state definitions.
- Brainstorm and refine list with CJWG (initial brainstorm plus continual additions throughout the process)
- Agency subject matter expert guidance (State Agencies)
- Initial scoring rubric to prioritize indicators (described above)
- Obtaining data and calculating indicators for prioritized indicators (described above)
- Data review and statistical screening for all indicators for which data was obtained or calculated (described above).

The CJWG and the Technical Team identified more than 170 indicators for consideration. Many were not (a) supported by sufficient, high-quality, granular statewide data, or (b) as applicable to the goals or applications of the disadvantaged communities' definition in the CLCPA as other indicators. The Technical Team advised that having fewer (but stronger) indicators in the criteria may lead to a stronger, simpler, and more transparent definition. With fewer indicators, each indicator will make a larger, more meaningful contribution to the DAC definition. As the list grows, each indicator affects the definition less. Further, additional indicators may be highly correlated with each other, and thereby not adding any additional nuance to the definition.

Prior to obtaining data and calculating indicators, the Technical Team ran indicators proposed by the CJWG a prioritization rubric. The rubric identifies indicators (and associated metrics and data) that are better candidates for including in the Disadvantaged Communities definition, namely:

- Relevance and applicability to CLCPA objectives, legislative language, and purposes (applications) of the DAC criteria.
- Data availability, sufficiency, and quality – What data is available at a granular geographic level (census tract or below)? What is the data quality and sufficiency, including statewide coverage, missing values, and potential for measurement or modeling error?
- How well the data fits or represents what CJWG members and Technical Team believe it should represent

The Technical Team used the rubric for an initial assessment of proposed DAC indicators and identify high-priority indicators. Rubric scores can also help explain why some indicators were prioritized over similar indicators (e.g., because of scores for data availability and quality).

After the Technical Team found and calculated census tract level estimates and percentile ranks (Section VI.B and IV.C), they performed further data review and statistical analysis to identify potential data gaps or quality concerns and look at correlations between the indicators most likely to be included.

The following pages contain details on each of the 45 indicators included in the draft criteria, including:

- Metric Definition
- Data Source
- Calculation Method
- Rationale for Inclusion
- Potential Limitations
- Data References

6.2 Environmental Burden and Climate Change Risk Indicators

The Technical Team generated all of indicator data below using the calculation methods described below to generate "raw" value, and then we calculated the percentile rank of each indicator using the approach described in Section 5.

Potential Pollution Exposures

Particulate Matter (2.5) Air Concentration

Metric Definition: Annual average $PM_{2.5}$ (particulate matter 2.5 microns or less in diameter) modeled ambient air concentrations

Data Source: USEPA EJSCREEN (Office of Air and Radiation) downloaded from file created May 2019 for 2016 estimated concentrations (USEPA, 2016).

Calculation Method: EJSCREEN uses USEPA modeled air concentrations at the census tract level. They use a combination of air quality monitoring data and modeling with a Bayesian space-time downscaling fusion model to estimate ambient, annual average $PM_{2.5}$ concentrations (Diao, 2019). They assign all block groups in the census tract the same data value. We again rolled up the block group-level EJSCREEN data to the tract-level by using the tract level value that had been assigned to every block group.

Rationale for Inclusion: Studies have demonstrated that exposures to fine particulate matter (2.5 microns and less in size) illicit health effects, including elevated risk of premature mortality from cardiovascular diseases or lung cancer, and increased health problems such as asthma (USEPA, 2019). A recent study found that people of color are disproportionately affected by $PM_{2.5}$ across nearly all major emissions categories and regardless of income (Tessum, 2021).

Potential Limitations and Future Improvements:

$PM_{2.5}$ modeled concentrations are based on 2016 estimates and may not reflect current conditions. USEPA's National Emissions Inventory (NEI) was used in the modeling along with air monitoring results. There are always uncertainties in developing a national emissions inventory. Emissions inventory development for structural and wildfires is less certain than development of emissions information for certain industry sectors where reporting of

emissions information is required. Estimates in areas with greater density of air monitoring, such as New York City, may have less modeling uncertainty. The estimates are annual averages. Short-term averaging times may have been used in studies where health effects have been documented.

References:

Diao, Minghui, et. al., *Methods, availability, and applications of $PM_{2.5}$ exposure estimates derived from ground measurements, satellite, and atmospheric models*. Journal of Air and Waste Management Association. December 2019. 69(12), 1391-1414.

Tessum, Christopher, et. al., *$PM_{2.5}$ polluters disproportionately and systemically affect people of color in the United States*. Science Advances. April 28, 2021. 7(18).

US Environmental Protection Agency (USEPA). *Technical Information about Fused Air Quality Surface Using Downscaling Tool: Metadata Description.* July 11, 2016. Online: https://www.epa.gov/sites/default/files/2016-07/documents/data_fusion_meta_file_july_2016.pdf. Accessed 1/18/2022.

US Environmental Protection Agency (USEPA). *Integrated Science Assessment (ISA) for Particulate Matter (Final Report, Dec 2019*). EPA/600/R-19/188.

Benzene Air Concentration

Metric Definition: Benzene modeled ambient air concentrations.

Data Source: USEPA's National-scale Air Toxics Assessment (NATA), benzene concentrations for data year 2014.

Calculation Method: USEPA developed outdoor air concentration estimates using a complex computer program called a dispersion model that merges the emissions data with meteorological data, such as wind speed and wind direction, to estimate pollutant concentrations in ambient air. This modeling accounted for emissions from large industrial facilities, such as power plants and manufacturing facilities; smaller facilities, such as dry cleaners and gas stations; mobile sources such as motor vehicles, trains, planes/airports, ports and boats; and farming and construction equipment. USEPA also accounted for pollution due to residential wood burning, wildfires, agricultural burning, and structural fires. Benzene concentrations in micrograms per cubic meter, at the census-tract level were obtained.

Rationale for Inclusion: Benzene is a known human carcinogen (USEPA, 1998) and ambient concentrations are primarily from petroleum storage facilities, gasoline service stations, motor vehicle exhaust and fuel, and industrial facilities (ATSDR, 2007). Long-term exposure to benzene can lead to harmful effects in the tissues that form blood cells and excessive exposure can harm the immune system (ATSDR, 2007). Outdoor air concentrations tend to be higher in population dense areas due to the density of mobile sources. Concentrations of benzene could be used as a metric to demonstrate improvements of air quality as the use of fossil fuel decreases in the State.

Potential Limitations and Future Improvements:

Represents historical emissions from 2014 and may not accurately reflect current conditions. Emissions inventory was developed from surrogate information such as population density and not an actual count of vehicles or gasoline-powered equipment. EPA cautions against using census-tract level comparisons to draw conclusions about individual exposures. Monitored benzene concentrations in New York show a decrease in ambient benzene levels since 2014.

References

US Department of Health and Human Services Agency for Toxic Substances and Disease Registry (ATSDR). *Toxicological Profile for Benzene*. August 2007. Online: https://www.atsdr.cdc.gov/toxprofiles/tp3.pdf, Accessed 1/19/2022.

US Environmental Protection Agency (USEPA). *Carcinogenic Effects of Benzene: An Update*. April 1998. EPA/600/P-97/001F

US Environmental Protection Agency (USEPA). *Technical Support Document, EPA's 2014 National Air Toxics Assessment*. August 2018. Online: https://www.epa.gov/sites/default/files/2018-09/documents/2014_nata_technical_support_document.pdf. Accessed 1/19/2022.

Proximity to Wastewater Discharge

Metric Definition: Toxicity-weighted stream concentrations at stream segments within 500 meters, divided by distance in kilometers (km).

Data Source: USEPA EJScreen Toxic Release Inventory (TRI) Risk Screening Environmental Indicators (RSEI) downloaded from file created May 2019 for the data year of 2017 (USEPA, 2020).

Calculation Method: The EJScreen indicator considers proximity from the stream reaches within 500 meters of a census block centroid, divided by distance in meters, presented as the population-weighted average of blocks in each block group (USEPA, 2019). Stream discharge monitoring reports from EPA's Toxic Release Inventory (TRI) were used in an EPA model called Risk Screening Environmental Indicators (RSEI). The model incorporates chemical toxicity and fate and transport to estimate concentrations of pollutants in downstream water bodies and derive a toxicity-weighted concentration. In this way it accounts for proximity and toxicity-weighted stream concentrations of pollutants with potential human health effects. We rolled up the block group-level EJSCREEN data to the tract-level by taking a weighted average of the block group observations, weighted by the proportion of the census tract population that was in the block group.

Rationale for Inclusion: Water pollutants can have adverse human health and ecological effects, depending on concentrations and toxicity of the pollutant. People may come into contact dermally by engaging in recreational activities such as swimming or boating, through inhalation by volatilization of pollutants or by eating contaminated fish. If pollutants are not removed from drinking water sources, people may come into contact by drinking contaminated water. This indicator captures proximity and toxicity-weighted stream concentrations of pollutants with potential human health hazards.

Potential Limitations and Future Improvements: The RSEI model calculates results for direct water releases from facilities to streams and waterbodies. The results may not represent actual population exposures. Individuals would need to come into contact with the contaminated water either by dermal exposure through swimming, inhalation of volatized pollutants, drinking contaminated water, or by eating contaminated fish. The modeled results reflect estimates from 2017 reports and may not capture emerging contaminants reported to TRI after the modeled year.

References

US Environmental Protection Agency (USEPA), EJScreen: Technical Documentation. September 2019. Obtained online: https://www.epa.gov/sites/default/files/2021-04/documents/ejscreen_technical_document.pdf. Accessed January 2022.

US Environmental Protection Agency (USEPA), EJScreen: Environmental Justice Screening and Mapping Tool. Data obtained online at: https://www.epa.gov/ejscreen/download-ejscreen-data. Accessed March 2020.

Diesel Trucks and Bus Traffic

Metric Definition: This indicator quantifies the annual average daily count of diesel trucks and buses occurring on the roads within each census tract. Following the assumption used by other researchers that assumes most vehicles within classes 4 – 13 are diesel powered (Levy, 2003; NYSDEC, 2019) using the Federal Highway Administration's vehicle category classification (USDOT, 2013).

Data Source: NYS Roadway Inventory System, NYS DOT Traffic Viewer, Annual Average Daily Traffic, (Federal Highway Administration classes 4-13) (NYSDOT, 2019).

Calculation Method: Calculations were based on New York State Department of Transportation (NYSDOT, 2019) annual average daily diesel vehicle counts by road segment, including designated truck routes and truck access highways for which higher diesel vehicle counts are expected. For this analysis, the count of diesel vehicles was summed by road segment. A buffer of 150-meters was generated around each census tract (US Census, 2019) to estimate the extent of diesel emissions. The buffers were overlaid with the NYSDOT roads and counts of diesel vehicles was length-weighted to the portion of road segments located within the buffer. Within each tract's buffer, the total of the length-weighted annual average daily diesel vehicle count was divided by the total length of all roads in the buffer. Tracts without roads within the 150-meter buffer were recorded as 0 truck traffic. Tracts comprised of only open water were recorded as -999 for traffic, including for cases where the tracts 150-meter buffer extended on land and included roads outside the tract boundary.

Rationale for Inclusion: Studies on diesel exhaust exposures have document increased asthma symptoms and attacks along with decreases in lung function for children and individuals with existing respiratory disease (Brunekreef et al., 1997; McCreanor et al., 2007). For asthmatic children attending schools in heavy diesel truck traffic areas, associations between diesel particulate matter exposure and exacerbation of asthma symptoms have been documented (Patel et al., 2013).

Studies also found associations between cardiovascular effects, including coronary vasoconstriction and premature death from cardiovascular disease from diesel particulate matter exposure (Krivoshto et al., 2008). One

study looked of diesel exhaust inhalation by healthy non-smoking adults and found an increase in blood pressure and other potential triggers of heart attack and stroke (Krishnan et al., 2013).

Although diesel emissions have been reduced, newer diesel engines still emit ultrafine particulate matter (Liati et al., 2018). Smaller size particles (aerodynamic diameter less than 0.1 $\mu g/m^3$ are of concern because they penetrate deeper into the lungs, have greater surface area, and are more biologically reactive than larger particles (Betha and Balasubramanian, 2013; Nemmar et al., 2007).

Potential Limitations and Future Improvements:

Traffic count is one variable influencing the magnitude of emissions. A notable limitation with this method is the assumption of a uniform distribution within the buffer zone of vehicle class and emissions. Other variables including vehicle mix, vehicle speed, traffic flow, meteorology, built environment, and vegetation may cause considerable variation in exposure to emissions around roads. In addition, the traffic counts are limited by data collected at only NYS DOT site locations and assumptions are being made that they represent high traffic areas for trucks and buses. This indicator may overlook areas with a higher density of vehicles and emissions ("hotspots") such as bus stops or highways with slow moving vehicles, especially in larger census tracts. A diluted count may result when the buffer is applied to an entire census tract boundary and includes other roads within the census tract that reduce the impact of the of the higher density of vehicles and emissions.

Further refinements of this first approximation of traffic density could include:

1) Vehicle speed to better estimate traffic density (vehicle-km hr./buffer zone)
2) "Hotspots" could be defined as an area of less than 100 meters of a bus stop or highways with a high propensity for slow-moving traffic
3) The influence of other variables (vehicle mix, meteorology, built environment, and vegetation) to compare census tracts on a more granular level
4) Peak hour traffic data to analyze traffic congestion within buffer zones.

References

Betha R, Balasubramanian R. *Emissions of particulate-bound elements from biodiesel and ultra-low sulfur diesel: size distribution and risk assessment*. Chemosphere. March 2018. 90(3):1005-15.

Brunekreef, Bert, et al., *Air pollution from truck traffic and lung function in children living near motorways*. Epidemiology. May 1997. 8(3). 298-303.

Krishnan RM, et al. (2013). *A randomized cross-over study of inhalation of diesel exhaust, hematological indices, and endothelial markers in humans*. Particle and Fibre Toxicology. March 2013. 10:7.

Krivoshto IN, Richards JR, Albertson TE, Derlet RW. *The toxicity of diesel exhaust: implications for primary care*. Journal of the American Board Family Medicine. January 2008. 21(1):55-62.

Levy, Johnathan, et.al., *Influence of traffic patterns on particulate matter and polycyclic aromatic hydrocarbon concentrations in Roxbury, Massachusetts*. Journal of Exposure Analysis and Environmental Epidemiology. September 2003. (13), 364- 371.

Liati A, Schreiber D, Dasilva YAR, Eggenschwiler PD. *Ultrafine particle emissions from modern Gasoline and Diesel vehicles: An electron microscopic perspective*. Environmental Pollution. August 2018. 239:661-9.

McCreanor, James, et al. *Respiratory effects of exposure to diesel traffic in persons with asthma*. New England Journal of Medicine. December 2007. 357(23):2348-58.

Nemmar, Abderrahim, et al., *Cardiovascular and lung inflammatory effects induced by systemically administered diesel exhaust particles in rats.* American Journal of Physiology-Lung Cellular Molecular Physiology March 2007. 292(3):664-70.

NYS Department of Environmental Conservation (NYSDEC), (https://www.dec.ny.gov/chemical/108978.html) October 2019

NYS Department of Transportation (NYSDOT). *NYSDOT Roadway Inventory System, Geodatabase*. 2019. Online: http://gis.ny.gov/gisdata/inventories/details.cfm?DSID=1302. Accessed March 2020.

Patel, Molini, et al., *Traffic-related air pollutants and exhaled markers of airway inflammation and oxidative stress in New York City adolescents*. Environmental Research. February 2014. 121:71-8.

US Census Bureau, Department of Commerce, Geography Division. 2019. TIGER/Line Shapefile, New York 2019. Online: https://catalog.data.gov/dataset/tiger-line-shapefile-2019-state-new-york-current-census-tract-state-based. Accessed March 2020.

US Department of Transportation (USDOT), Federal Highway Administration. *Traffic Monitoring Guide, Appendix C. Vehicle Types.* September 2013. Online: https://www.fhwa.dot.gov/policyinformation/tmguide/tmg_fhwa_pl_13_015.pdf. Accessed 1/21/2022.

Vehicle Traffic Density

Metric Definition: Count of vehicles (average annual daily traffic) on major roads.

Data Source: 2019 version of USEPA EJScreen, calculated from 2017 USDOT traffic data (USEPA, 2020).

Calculation Method: Measures of traffic proximity in EJSCREEN are based on average annual daily traffic estimates in the Highway Performance Monitoring System (HPMS) dataset in the US Department of Transportation's (USDOT) National Transportation Atlas Database. The HPMS highway data are maintained by states and compiled by USDOT. Vehicle counts (average annual daily traffic) at major roads (i.e., all interstate, principal arterials, and other collector highways in the national highway system) within 500 meters of a census block centroid, are divided by distance of the census block centroid in meters to the road. The results are population-weighted average to the census block group level (weighted by 2015-2019 ACS population). Since block group-level EJSCREEN data were obtained, they were aggregated to the tract-level by taking a weighted average of the block group observations, weighted by the proportion of the census tract population that was in the block group.

Rationale for Inclusion: Traffic proximity is being used as a surrogate for exposure to traffic-related air pollution. Motor vehicles are a significant source of air pollution with documented health effects. Studies have shown that exposure to these pollutants aggravates asthma and upon long-term exposure causes childhood asthma onset and is associated with increased mortality rates (Baumann, 2011; HEI, 2010).

Additionally, studies have found associations with other respiratory symptoms, reduced lung function, increased risk of pre-term birth, cardiovascular and neurocognitive effects (Anderson et al., 2013; Clifford et al., 2016; Pederson et al., 2014; Power et al., 2016; Tzvian et al., 2015; Thurston et al., 2020).

Potential Limitations and Future Improvements:

500 meters may be too great of a distance and could be including neighborhoods less likely to be considered disproportionately burdened by traffic-related air pollution. This large distance could be minimizing localized effects and may make it difficult to identify disproportionate impacts in densely populated urban areas. A US Centers for Disease Control and Prevention study based on the 2010 Census found that Latinos, non-whites, foreign born and people who speak a language other than English at home were most likely to live within 150 meters of a major highway (Boehmer et al., 2013). Future analyses should consider distances of 100 to 300 meters and more local data. Refined dispersion modeling at the individual census block level, while adjusting for roadway length and wind direction, was more strongly correlated with modeled roadway pollutant concentrations (Rowangould et al., 2019).

References

Anderson HR, et. al., *Long-term exposure to air pollution and the incidence of asthma: Meta-analysis of cohort studies. Air Quality*. Atmosphere & Health. 2013. 1(6):47-56.

Baumann, L, et al. *Effects of distance from a heavily transited avenue on asthma and atopy in a peri-urban shanty-town in Lima, Peru*. Journal of Allergy Clinical Immunology. April 2012. 127(4):875-82.

Boehmer, Tegan K., et al. *Residential Proximity to Major Highways - United States, 2010*. Centers for Disease Control and Prevention, Morbidity and Mortality Weekly Report, Supplement. November 2013 62(03).

Clifford A, et al. *Exposure to air pollution and cognitive functioning across the life course--a systematic literature review*. Environmental Research. May 2016. 147:383-398.

Health Effects Institute (HEI). *Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects.* Special Report 17, 2010.

Pedersen M., et al. *Ambient air pollution and pregnancy-induced hypertensive disorders: A systematic review and meta-analysis*. Hypertension. September 2014. 64(3):494-500.

Power MC, et al. *Exposure to air pollution as a potential contributor to cognitive function, cognitive decline, brain imaging, and dementia*: *A systematic review of epidemiologic research*. Neurotoxicology. September 2016. 56:235-253.

Rowangould, D., et al. *Validating and Refining EPA's Traffic Exposure Screening Measure*. International Journal of Environmental Research and Public Health. January 2019, 16(1) 3.

Stieb DM, et al. *Ambient air pollution, birth weight and preterm birth: A systematic review and meta-analysis.* Environmental Research. August 2012. 117:100-111.

Thurston G.D. et al. *Outdoor Air Pollution and New Onset Airway Disease. An Official American Thoracic Society Workshop Report*. Annals American Thoracic Society. April 2020. 17(4):387-398.
Tzivian L, et al. *Effect of long-term outdoor air pollution and noise on cognitive and psychological functions in adults*. International Journal of Hygiene and Environmental Health. January 2015. 218(1)1-11.
US Environmental Protection Agency (EPA). EJ Screen Technical Documentation. September 2019. Online: https://www.epa.gov/sites/default/files/2021-04/documents/ejscreen_technical_document.pdf. Accessed 1/24/2022.
US Environmental Protection Agency (USEPA). EJScreen Traffic Proximity. Online: https://www.epa.gov/ejscreen/download-ejscreen-data. Accessed March 2020.

Land Use and Facility Siting Associated with Historical Discrimination or Disinvestment

Industrial, Mining, and Manufacturing Land Use

Metric Definition: Percent of census tract land area that is designated as a manufacturing tax lot (for New York City only) or parcel (for the rest of New York State) in tax records. The following land uses are included:

- Light, heavy, and high-tech manufacturing and industrial processing
- Warehouses and factories
- Mining and quarrying
- Lumber yards
- Petroleum production and gas or oil fuel storage (not for a utility)
- Water storage

The designation generally excludes vacant land and junk yards in industrial areas

Data Source: Department of City Planning Primary Land Use Tax Lot Output (PLUTO) lots (for New York City only) and New York State Homes and Community Renewal (HCR) tax parcels (for the rest of New York State) [2021].
New York City data: https://data.cityofnewyork.us/City-Government/Primary-Land-Use-Tax-Lot-Output-PLUTO-/64uk-42ks
NYS HCR data received through direct communication; available from HCR upon request.
NYS property
class documentation: https://www.tax.ny.gov/research/property/assess/manuals/prclas.htm#industrial
Statewide building footprint data: https://gisservices.its.ny.gov/arcgis/rest/services/
NYS statewide parcel map data: http://gis.ny.gov/gisdata/inventories/details.cfm?DSID=1300
Calculation Method: We classified each tax class into categories of industrial and manufacturing or non-industrial and manufacturing. We totaled the area of the tax lots (for New York City only) or parcels (for the rest of New York State) that were manufacturing land and divided by the total land area of the census tract.
Rationale for Inclusion: These sites are included to represent the possible historical discrimination when siting industrial facilities in or near disadvantaged communities. Systemic low land values may have attracted the sites, and further decreased land values. Siting may represent historical discrimination and there is an increased risk of air and water contamination. While there are regulations for the operations of industrial facilities, poorly regulated facilities can be a blight for communities. Industrial areas are also associated with high truck traffic, which causes air and noise pollution and is problematic for adjacent residents. Specific to manufacturing areas, 'large- and small-scale industrial and manufacturing activity' is associated with the release of chemicals into the environment, with effects that can range from nonexistent to acute or toxic. Chemical manufacturing operations and coal combustion are associated with increased mercury emissions. Industrial processes are associated with increased carbon monoxide emissions. Metal industrial processing (such as smelters) is associated with increased lead and sulfur dioxide emissions. Chemical manufacturing facilities, refineries, and factories are associated with increased VOCs.
Potential Limitations: This data relies on the accuracy of tax records and their granular categories. Because different sources were used for New York State and New York City, which may have slightly different classification practices, there may be a systematic difference in results across the state. However, since the DAC scoring approach considers relative combined scores for NYC tracts separately from Rest of State tracts, this potential inconsistency is addressed through final scoring. Some clean and quiet facilities may be beneficial, especially in terms of job

creation. Multiple CJWG members expressed that not all industrial areas (public utility, manufacturing, or transportation) represent exposures, risks, or threats. DEC noted that while zoning is an important tool municipalities use, there does not need to be an implication that all industrial zones are bad and that this needed further discussion. Additionally, one stakeholder noted that this indicator should also capture abandoned manufacturing zones and brownfields. This indicator does not capture historical land uses, which could indicate the lingering contamination of, for example, old fuel tanks. Other environmental exposure or burden indicators (e.g., proximity to remediation sides, groundwater threats or chemical waste sites) may capture some of the burden from historical uses.

Considerations for Future Modifications:

In the future an alternative metric could look at citations for regulated facilities, which would indicate the non-compliance of facilities to regulations. This alternative metric would depend on the breadth of the citation reporting system and not include the overall industrial land concept of discrimination in siting and land value. Looking instead at major truck routes to represent the increased truck traffic in manufacturing areas was suggested during a CJWG meeting.

References:

Report on the Environment (ROE) | US EPA
Report on the Environment (ROE) | US EPA NOx
Report on the Environment (ROE) | US EPA $PM_{2.5}$ emissions
Report on the Environment (ROE) | US EPA Sulfur dioxide
Report on the Environment (ROE) | US EPA Blood mercury level
Report on the Environment (ROE) | US EPA Carbon monoxide
Report on the Environment (ROE) | US EPA Lead
Report on the Environment (ROE) | US EPA VOCs

Agricultural Land Use

Metric Definition: Percent of census tract land area that is covered by agricultural land, classified as hay/pasture or cultivated crop area.

Data Source: USGS National Land Cover Database (NLCD) [2016] (30m raster geospatial data)

Calculation Method: NLCD land cover categories and class values were reclassified as either agricultural or non-agricultural land covers. Then the re-classified NLCD land cover dataset (a raster GIS file) was overlaid with census tracts to find the percent of each tract comprised of each class. Within each census tract the percent agricultural land was calculated as the sum of both agricultural land classes divided by the sum of all non-water land classes (i.e., excluded open water). Agricultural land cover classes include hay/pasture and cultivated crop area.

Rationale for Inclusion: The indicator represents potential risks to agriculture productivity and rural and migrant population due to climate change. Tracts with a higher percentage of agricultural land may be at greater economic risk from droughts or extreme weather, including land productivity and workforce impacts (including resident or migrant population). A lack of diverse foliage causes land to be susceptible to the spread of invasive species, and there are negative effects on quality of water from agricultural runoff or pesticide use. Migrant labor found in agricultural areas is a historically underserved population. These workers also have high exposure to organic and inorganic dust due to loss of native habitats and exposure to chemicals. This indicator is also one of several that describes threats to census tracts from future heat vulnerability by mapping areas with high potential for added heat stress. Agricultural land use is a driver of heat vulnerability and has associated health risks including aggravated asthma and heat related hospitalizations, especially for the workforce population.

Potential Limitations: The indicator's reclassification of land area does not consider open water in either the numerator or denominator. Therefore, this indicator does not include any potential protective effect that open water may have on heat vulnerability.

Future Improvements: Monitor if/when new NLCD data is available.

References:

envhper00313-0060.pdf (nih.gov) (sited by EPA in ROE)
USDA ERS - Major Land Uses
Land Use | EPA's Report on the Environment (ROE) | US EPA

Proximity to Remediation Sites

Metric Definition: Count of remediation sites within a census tract.
Data Source: NYSDEC remediation sites as of July 26, 2010 (NYSDEC, 2010).
Calculation Method: Number of remediation sites (both point and area locations) within each census tract. Census tracts without a point location or with less than 1% of tract area covered by remediation site area, are given a value of zero. Descriptions of NYSDEC's Brownfield Cleanup and State's Superfund Programs available online (NYSDEC 2022).
Rationale for Inclusion: Some remediation sites may carry risks to nearby residents through the movement of hazardous substances through volatilization, groundwater plume migration, or windblown dust. A study of pregnant women living near Superfund sites in New York state showed an increased probability of having a low-birth weight child (Baibergenova et al., 2003). A later study of cities in New York saw an association between prevalence of liver disease and the number of Superfund sites per 100 square miles (Ala et al., 2006). More recently, it was found that Superfund sites contribute to increased rates of elevated blood lead levels in children (Klemick et al., 2020). The sites included represent those which have been determined to pose a risk to public health or environment and are going or have undergone cleanup under the oversight by NYSDEC. Some sites may have undergone remediation and no longer pose a public health threat but may represent historical discrimination while others are undergoing remediation.
Potential Limitations and Future Improvements: Proximity alone may not represent any actual risk or even exposure. The metric does not consider pollutant dispersion or offsite migration, toxicity of contaminants, and magnitude of emissions. An evaluation on the types of contaminants remediated or the amounts remediated was not done.
References:
Ala, A, et al. *Increased prevalence of primary biliary cirrhosis near Superfund toxic waste sites*. Hepatology. March 2006. 43(3):525-31.
Baibergenova A, et al. *Low birth weight and residential proximity to PCB-contaminated waste sites*. Environmental Health Perspective. August 2003. 111(10):1352-7
Klemick H, Mason H, Sullivan K. *Superfund cleanups and children's lead exposure.* Journal of Environmental Economics and Management. March 2020. 100:102289.
NYS Department of Environmental Conservation (NYSDEC). 2010. Environmental Remediation Sites - New York State (NYSDEC). For the data used https://gis.ny.gov/gisdata/inventories/details.cfm?DSID=1097 and details on DEC's program https://www.dec.ny.gov/chemical/8450.html. Accessed March 2020.
NYS Department of Environmental Conservation (NYSDEC). 2022. Brownfield and State Superfund Programs online at https://www.dec.ny.gov/chemical/84286.html. Accessed January 19, 2022.

Proximity to Risk Management Plan Sites

Metric Definition: Count of facilities within 5 km, divided by distance (USEPA 2019).
Data Source: USEPA EJScreen's Risk Management Plan (RMP) (USEPA 2022) sites data, downloaded from file created May 2019 (USEPA 2020).
Calculation Method: USEPA calculated the count of facilities within a 5 km distance from the of a census block centroid. A proximity score was calculated which gave more weight to nearer distances by using an inversion formula (1/distance). If there was no facility within 5 km of a block centroid, 1/distance was used, with distance in km to the single nearest facility. A weighted average of the block observations, weighted by the proportion of the block group population that was in the block, was done to calculate the average proximity to a site of a block group. The block group-level results were aggregated to the census tract-level by weighting the proportion of the census tract population that was in the block group to provide an average proximity to a site within a census tract.
Rationale for Inclusion: RMP facilities are those that are required by the Clean Air Act section 112(r) to file risk management plans. The regulations established a list of 72 substances because of their high acute toxicity and 60 because of their flammable or explosive potential, along with thresholds quantities for each substance. The primary concerns with RMP facilities are the accidental release of substances and fires or explosions. The sudden release of relatively large quantities of acutely toxic substances can cause serious health effects. Additionally, as with many types of industrial facilities, there may be routine releases to the air and water of the residuals after pollution control devices remove what is generally a large fraction of the waste stream. Thus, people may be exposed to some substances directly through inhalation or indirectly through water routes or via ingestion of food.

Potential Limitations and Future Improvements: Proximity alone may not represent any actual health risk or even exposure. This metric does not include smaller facilities with regulated substances below the established threshold. RMP facilities are diverse in their size, structure activities and the type of regulated substance.

References:

US Environmental Protection Agency (USEPA), EJScreen: Technical Documentation. September 2019. Obtained online: https://www.epa.gov/sites/default/files/2021-04/documents/ejscreen_technical_document.pdf. Accessed January 2022.

US Environmental Protection Agency (USEPA), EJScreen: Environmental Justice Screening and Mapping Tool. Data obtained online at: https://www.epa.gov/ejscreen/download-ejscreen-data. Accessed March 2020.

US Environmental Protection Agency (USEPA), Risk Management Plan (RMP) Rule Overview. Online at: https://www.epa.gov/rmp/risk-management-plan-rmp-rule-overview. Accessed January 2022.

Proximity to Major Oil Storage Facilities

Metric Definition: Percentage of census land area within 500 meters of at least one Major Oil Storage Facilities (MOSF), including storage terminals at airports, military sites, and manufacturing facilities.

Data Source: NYSDEC major oil storage facilities as of July 20, 2010 (NYSDEC, 2010).

Calculation Method: A 500-meter buffer around each MOSF was created and the buffer areas were overlaid on census tracts. Using the intersection areas as areas of influence, the percent of influence for each census tract was developed. Overlapping areas of influence were combined which could provide some tracts with an area of influence greater than 100%. Tracts without intersection areas were assigned 0%.

Rationale for Inclusion: NYSDEC's MOSF program applies to facilities that store 400,000 gallons or more of petroleum products in aboveground and underground storage tanks. These types of facilities process large quantities of petroleum products which can result in air releases of large quantities of volatile organic compounds some of which are hazardous air pollutants (e.g., benzene, toluene, and xylene). Additional community burdens include noise and emissions from truck traffic, rail, and marine transport. Many MOSF are in Ports which are often in proximity to environmental justice communities.

Potential Limitations and Future Improvements: Proximity alone may not represent any actual risk or even exposure. An evaluation of the type of petroleum product stored was not done. Some stored products are more volatile and result in larger air releases.

References:

NY State Department of Environmental Conservation (NYSDEC). 2010. NYSDEC Bulk Storage Sites in New York State. Obtained from the NYS Geographic Information System Clearinghouse. Available online at: https://gis.ny.gov/gisdata/inventories/details.cfm?DSID=1253

Proximity to Power Generation Facilities

Metric Definition: Percentage of tract land area within 1 mile of at least one power generation facilities burning fossil fuel, including peaker units.

Data Source: Fossil-fuel power generation facilities from NYSDEC's 2019 emissions inventory (NYSDEC 2019) and USEPA's Emissions & Generation Resource Integrated Database (eGRID) for facilities operating within 1-mile of New York's borders (USEPA 2019).

Calculation Method: A 1-mile buffer around each power plant was created and the buffer areas were overlaid on census tracts. Using the intersection areas as areas of influence, the percent of influence for each census tract was developed. Overlapping areas of influence were combined which could provide some tracts with an area of influence greater than 100%. Tracts without intersection areas were assigned 0%.

Rationale for Inclusion: Studies have demonstrated health outcomes for residents near fossil-fuel fired power plants. Researchers at the University at Albany's School of Public Health studied the proximity of New York State residents to electric generating facilities (using coal, oil, natural gas, landfill gas, and/or solid waste) (Lui, 2012). Researchers found statistically significant increase in acute respiratory infection, hospitalization for asthma and chronic obstructive pulmonary disease among individuals greater than 10 years of age living in a ZIP code containing a fuel-fired power plant. Another study (Ha, 2015) looked at birth outcomes and found an association with preterm delivery and very preterm delivery for pregnant women living in proximity to fossil-fuel power plants.

Potential Limitations and Future Improvements: Proximity alone may not represent any actual risk or even exposure. The approach applied does not consider dispersion and toxicity of pollutants, and magnitude of emissions.

The approach does not evaluate size of the facility. Metric is based on counts of overlap between tract and a buffer around facility, but not degree of overlap.

References:

Ha, Sandie, et al. *Associations between Residential Proximity to Power Plants and Adverse Birth Outcomes.* American Journal of Epidemiology. August 2015. 182(3). 215-224.

Liu, Xiaopng, et al. *Association between Residential Proximity to Fuel-Fired Power Plants and Hospitalization Rate for Respiratory Diseases.* Environmental Health Perspectives. June 2012. 120(6):807-810.

NYS Department of Environmental Conservation (NYSDEC). Data compiled on June 14, 2021. It included facility names, amount of electricity generated, and locations of 79 New York fossil-fuel powered electric generating facilities operating in 2019.

US Environmental Protection Agency (USEPA), Emissions & Generation Resource Integrated Database (eGRID) (2019) available online at: https://www.epa.gov/egrid/download-data. Accessed June 16, 2021.

Proximity to Active Landfills

Metric Definition: Percent overlap of an active landfill's estimated area of influence (500 meters) within a census tract.

Data Source: Locations of active landfills operating in 2021, obtained from NYSDEC's Division of Materials Management (NYSDEC 2021).

Calculation Method: A 500-meter buffer for a single point location in the landfill was created and the buffer areas were overlaid on census tracts. Using the intersection areas as areas of influence, the percent of influence for each census tract was developed (i.e., percent census tract falling within the buffer). Overlapping areas of influence were combined which could provide some tracts with an area of influence greater than 100%. Tracts without intersection areas were assigned 0%.

Rationale for Inclusion: Landfills are known to produce a mixture of odorant and irritant air pollutants and leachate released from improperly constructed landfills could impact surface and ground waters. The environmental movement began when Dr. Robert Bullard and his students researched the locations of Houston's five city-owned landfills and found they were all in Black neighborhoods (Ahmed, 2021). Other studies have supported this conclusion finding an unequal distribution of waste management facilities, but the authors found mixed results as to whether waste-related exposures cause health effects (Martuzzi, et., al., 2010). The authors concluded that social determinants of health, played a crucial role in the outcome of health effects by those living near waste treatment facilities. Another study concluded that odors and presence of waste may affect the health and quality of life (Heaney, et. al., 2011). A panel studying acute respiratory outcomes in the community surrounding Fresh Kills Municipal Landfill in Staten Island (NY) concluded that the perception of odors is associated with worsening of respiratory symptoms of some people in the study group (ATSDR, 2000).

Potential Limitations and Future Improvements: Proximity alone may not represent any actual risk or even exposure. The approach applied does not consider dispersion and toxicity of pollutants, and magnitude of emissions. Metric is based on counts of overlap between tract and a buffer around facility, but not degree of overlap.

References:

Ahmed, Amal, *Civil Rights: Robert Bullard isn't Done yet.* 2021. Texas Observer. May 3, 2021. Online. https://www.texasobserver.org/robert-bullard-isnt-done-yet/, accessed January 18, 2022.

ATSDR. *A Panel Study of Acute Respiratory Outcomes, Staten Island, New York*. Atlanta, GA: Agency for Toxic Substances and Disease Registry, 2000

Heaney, C, et al. *Relation between malodor, ambient hydrogen sulfide, and health in a community bordering a landfill.* Environmental Research. August 2011. 111(6): 847-852.

Martuzzi, M., et al. *Inequalities, inequities, environmental justice in waste management and health.* European Journal of Public Health. February 2010. 20(1). 21-26.

New York State Department of Environmental Conservation compiled data on June 3, 2021. All active 2021 landfills operating in New York State.

Proximity to Municipal Waste Combustors

Metric Definition: Percent of tract area within a 500-meter buffer of a municipal waste combustor

Data Source: Locations of active municipal waste combustors operating in 2021, obtained from NYSDEC's Division of Materials Management (NYSDEC 2021).

Calculation Method: A 500-meter buffer for municipal waste combustor was created and the buffer areas were overlaid on census tracts. Using the intersection areas as areas of influence, the percent of influence for each census tract was developed (i.e., percent census tract falling within the buffer). Tracts without intersection areas were assigned 0%.

Rationale for Inclusion: Potential community burden including potential for hazardous air pollutant (HAP) emissions, noise due to the transportation of waste for incineration, or other community concerns. Some studies document an unequal distribution of waste management facilities in environmental justice communities (Martuzzi, et., al., 2010). Facilities in New York are well-controlled requiring strict emission controls and routine emission testing.

Potential Limitations and Future Improvements: Proximity alone may not represent any actual risk or even exposure. The approach applied does not consider dispersion and toxicity of pollutants, and magnitude of emissions. Metric is based on counts of overlap between tract and a buffer around facility.

References:

Martuzzi, M., et al. *Inequalities, inequities, environmental justice in waste management and health.* European Journal of Public Health. February 2010. 20(1). 21-26.

New York State Department of Environmental Conservation compiled data on June 3, 2021. All active 2021 municipal waste combustors operating in New York State.

Proximity to Scrap Metal Processing and Vehicle Dismantlers

Metric Definition: Frequency of scrap metal processing and vehicle dismantler facilities in a census tract.

Data Source: Locations of active vehicle dismantlers and scrap metal processing facilities operating in 2021, obtained from NYSDEC's Division of Materials Management (NYSDEC 2021).

Calculation Method: The number of facilities within each census tract were counted to obtain the frequency by census tract.

Rationale for Inclusion: Community complaints of fires, smoke, dust, noise, and odors from scrap metal processing facilities are common. A study in four environmental justice communities in the Houston, Texas area found elevated iron, manganese, chromium, nickel, lead, and arsenic metals downwind of scrap metal facilities. Results included elevated metals above acceptable human health risk levels (Han, 2020). Spatial analysis of air pollution in Winnipeg, Canada, found higher concentrations of metals closer to a scrap metal shredder (Folarin and Thompson, 2020). USEPA has recently found many violations of the Clean Air Act outside scrap metal processing facilities (USEPA, 2021).

Potential Limitations and Future Improvements: Proximity alone may not represent any actual risk or even exposure. The approach applied does not consider dispersion and toxicity of pollutants, and magnitude of emissions. The metric does not consider the size of the facility, or the volume of vehicles or scrap metal processed on an annual basis.

References:

Folarin, S., Thompson, S. *Spatial Analysis of Heavy Metal Emissions in Residential, Commercial and Industrial Areas Adjacent to a Scrap Metal Shredder in Winnipeg, Canada*. Journal of Geoscience and Environment Protection. May 2020. 8:359-386.

Han, I., et al., *Evaluation of metal aerosols in four communities adjacent to metal recyclers in Houston, Texas, USA*. Journal of the Air & Waste Management Association. May 2020. 70(5) 568-579.

New York State Department of Environmental Conservation (NYSDEC) compiled data on June 23, 2021. All active 2021 vehicle dismantler facilities and scrap metal processors operating in New York State.

US Environmental Protection Agency (USEPA) July 2021. Enforcement Alert: *Violations at Metal Recycling Facilities cause Excess Emission in Nearby Communities.* Available online at: https://www.epa.gov/system/files/documents/2021-07/metalshredder-enfalert.pdf. Accessed January 19, 2022.

Housing Vacancy Rates

Metric Definition: Vacant housing units as a percentage of housing units

Data Source: 2019 American Community Survey (ACS) 5-year table DP04 – Selected Housing Characteristics

Calculation Method: Percentage data available from the census at the census tract level was used.

Rationale for Inclusion: Housing vacancy rates represent disinvestment from a community. Housing vacancy rates can be driven up by a confluence of factors including housing affordability, foreclosures, outmigration,

increasing rates of crime, and/or declining property values. Vacant properties are linked to 'increased risk to public health and welfare, and increased costs for municipal governments' (HUD).

Potential Limitations and Future Improvements: Stakeholders requested migration indicators for inclusion in the DAC criteria but we were unable to know the starting place of a migrant population with available data. Meaningful migration data is available at county-level. A migration indicator would be a more direct measure of community investment over time than housing vacancy rates. The time frame would have to be considered to represent either short-term changes in population or historical fluctuation. While possible to capture net migration by census tract, it is difficult to assess whether a net decrease or increase is a disadvantage. In-migration could represent disadvantage due to overcrowding, threats from other areas (with higher climate risk) or displacement of low-income residents from rising rents in low-property value areas. Outmigration could represent disadvantage due to community disinvestment, threats of climate risks, and population displacement.

References:

https://www.huduser.gov/portal/periodicals/em/winter14/highlight1.html
https://ncrc.org/gentrification/

Climate Change Risks

Flooding in coastal and tidally influenced areas (projected)

Metric Definition: Percentage of census tracts within an "Extreme" or "High" flood risk area for coastal and tidally influenced areas including Lake Ontario, Hudson River, and ocean shorelines.

Data Source: New York State Department of State (NYSDOS) Coastal Risk Areas

Calculation Method: DOS models risk for three coastal sub-regions in New York State: Lake Ontario, Hudson River, and ocean shoreline. Topology was examined for overlapping areas for each data set separately and corrected (sliver areas). Data sets were examined for geometric errors and corrected as needed using "Repair Geometry" function in ArcGIS Pro (v. 2.6.0).

Our goal was to estimate flood risk for a "middle of the road" climate scenario. For the coastal areas, these include flood or erosion risk from shallow water flooding areas, areas prone to erosion, sea level rise (SLR), FEMA flood zones (i.e., floodplains - V zone, 100, and 500 year), and Category 3 Hurricane from Sea Lake and Overland Surges from Hurricanes - projected out to year 2100. Of note, a 3-foot SLR (above 2000-2004 average) was incorporated into this analysis (above MHHW [1983-2001 NOAA datum]).

Three levels of risks were identified: (1) Extreme – FEMA V, shallow water flooding areas + 3-feet of SLR and areas prone to erosion, (2) High – 100-year floodplain zone + 3' SLR, and (3) Moderate – 500-year floodplain zone + 3' SLR + Category 3 SLOSH storm. To approximate a moderate risk, we included only the Extreme and High flood risk areas in this analysis and grouped them into a single risk category to simplify for inclusion into an overall flood/erosion index. Census tracts were processed using the NYSDOS Risk Area model, and the percent of the tract falling in the different risk zones was calculated to attain a relative ranking across census tracts.

Rationale for Inclusion: Combines federal flooding information sources to represent total area with risk of infrastructure and land damage. Projections account for a moderate rate of level rise through 2100. Represents a community's vulnerability to flooding damage from an increase in extreme or moderate flooding events of which may be exacerbated by the impacts of climate change.

Potential Limitations and Future Improvements: Rates of future sea level rise will largely depend on global levels of GHG emissions. Pursuant to the Community Risk and Resiliency Act, DEC will update its sea level rise projections at least every five years, with the next update due in 2022. The DOS Coastal Risk Areas should be updated to reflect DEC's updated sea level rise projections. Future indicator updates could use updated coastal risk models to include updated SLR projections expected in 2022.

References:

http://opdgig.dos.ny.gov/#/storyTemplate/10/1/1

Flooding in inland areas (projected)

Metric Definition: The data represent the projected annual return interval (RI) of flow relative to the historic 100-yr event flows for modeling units (Habitat Response Units - HRU) as projected under a climate change (CC) scenario at a future point in time. For example, a value of 70 means the 100-yr event is projected to occur every 70 years under that CC scenario/time period.

Data Source: FEMA Digital Flood Insurance Rate Map (DFIRM) (https://msc.fema.gov/portal/home; released on May 06, 2021), National Center for Atmospheric Research (NCAR), US EPA's Climate Impacts Risk Assessment (CIRA)

Calculation Method: Analysis of inland flood risk utilized data generated by Wobus et al. 2017[6], which projected annual return intervals (RI) of flows relative to the historic 100-year event flows for modeling units (Habitat Response Units - HRU) as projected under a climate change scenario at a future point in time. For example, a value of 70 means the current 100-year event is projected to occur every 70 years under that climate change scenario and time period. The Technical Team overlaid the current FEMA 100-yr floodplain GIS layer with census tracts and the Wobus projections of future RIs. Projected RI values were area-weighted where floodplains and tracts crossed into adjacent HRUs. The final RI values were then converted into the annual probability of exceeding the 100-year event in the year 2090 (e.g., 1 = 1% chance of exceeding the 100-year event in any year). The exceedance probability was area-weighted by the proportion of the census tract falling within the floodplain to provide a relative flood risk index for the census tract.

Note: Census tracts that do not include a mapped FEMA floodplain were not included in this analysis. Additional note: The Technical Team used a "middle of the road" emission scenario (Representative Concentration Pathway - RCP 4.5) for year 2090 to align with a 3-foot SLR scenario as noted in the ClimAid 2014 Update (Horton et al., 2014).

Rationale for Inclusion: Represents potential economic damage from flooding. Projections to 2090 account for climate change scenario (middle of the road emissions scenario). Represents a community's vulnerability to flooding damage from an increase in extreme or moderate flooding events of which may be exacerbated by the impacts of climate change.

Potential Limitations and Future Improvements:

References:

Federal Emergency Management Agency (FEMA), 2021. National Flood Hazard Layer (NFHL), Version 1.1.1.0. Digital vector data. Washington D.C.

Horton, R., D. Bader, C. Rosenzweig, A. DeGaetano, and W.Solecki. 2014. Climate Change in New York State: Updating the 2011 ClimAID Climate Risk Information. New York State Energy Research and Development Authority (NYSERDA), Albany, New York.

Hudson River technical documentation.

Available: Hudson_River_Flood_Impact_Decision_Support_Tool_Technical_Report.pdf (columbia.edu)

NYS Risk assessment mapping. Available: Risk_Assessment_Area_Mapping.pdf (ny.gov)

van Vuuren, D. P., J. Edmonds, M. Kainuma, K. Riahi, A. Thomsom, K. Hibbard, G. Hurtt, T. Kram, V. Krey, J. Lamaraque, T. Masui, M. Meinshausen, N. Nakicenovic, S. Smith, and S. Rose. 2011. The representative concentration pathways: an overview. *Climatic Change.* 109:5-31; DOI 10.1007/s10584-011-0148-z. Available: https://psl.noaa.gov/ipcc/cmip5/rcp.pdf

U.S. Department of Commerce, U.S. Census Bureau, Geography Division (Originator). 2019. TIGER/Line Shapefile, 2019, state, New York, Current Census Tract State-based.

Wobus, C., E. Gutmann, R. Jones, M. Rissing, N. Mizukami, M. Lorie, H. Mahoney, A. Wood, D. Mills, and J. Martinich. 2017. Climate Change Impacts on 100 Year Flood Risk and Asset Damages within Mapped Floodplains of the Contiguous United States. *Nat. Hazards*

Projected Days Above 90 degrees Fahrenheit

Metric Definition: Average annual number of days with maximum temperature above 90°F and 95°F for both baseline (1980-2010) and future (2036-2065) time periods.

Data Source: https://www.nyclimatescience.org/highlights/data_products

Calculation Method: Overlaid the census tracts with average annual number of days with maximum temperature above 90°F and 95°F for baseline and future scenarios. The baseline used 30 years of data centered on 1995 (years 1980-2010) and future used 30 years centered on 2050 (years 2036-2065).

Both climate data sets were obtained from the Climate Data Grapher developed by the Northeast Regional Climate Center and available on the New York Climate Change Science Clearinghouse (NYCCSC)

[6] Wobus, C., Gutmann, E., Jones, R., Rissing, M., Mizukami, N., Lorie, M., Mahoney, H., Wood, A. W., Mills, D., and Martinich, J.: Climate change impacts on flood risk and asset damages within mapped 100-year floodplains of the contiguous United States, Nat. Hazards Earth Syst. Sci., 17, 2199–2211, https://doi.org/10.5194/nhess-17-2199-2017, 2017.

(https://www.nyclimatescience.org/highlights/data_products) as tabular data (in "*.csv" files) and summarized by USGS basins (at the Hydrologic Unit Code 8 [HUC8] level). Note that when using the Climate Data Grapher Interactive Chart, the values displayed for selected parameters do not match the tabular data being downloaded from the same site. This analysis was based on the downloaded datasets.
Baseline data were derived from the gridded data at a resolution of 1/16th degree described by Livneh (2015) and based on observed weather station data and statistically interpolated using the parameter-elevation regressions on independent slopes (PRISM) model (Daly et al., 1994). The projected data are derived from an average of 32 General Circulation Model (GCM) projections from the Climate Model Intercomparison Project Phase 5 (CMIP5) and downscaled to a spatial resolution of 1/16 degree (approximately 6 km x 6 km) using the Localized Constructed Analog (LOCA) method (Pierce et al., 2014). In order to link census tracts to climate model results at the HUC8 level, we obtained USGS HUC8 GIS layer released in 2017 (USGS, 2017), which matched to the HUC8 identifiers and basin names listed by the NYCCSC datasets. We overlaid the census tracts and USGS HUC8 GIS layers and calculated their intersection areas and area weights (percent) relative to the tract areas. We used area weights to estimate weighted mean numbers of days with maximum temperature above 90°F and 95°F for each time period. For census tracts without model results – due to a location outside the model domain or with missing model results - we assigned a value of "-999."
Rationale for Inclusion: Contributor to ozone formation. Driver of heat vulnerability and its associated health risks including aggravated asthma and heat related hospitalizations. Risk to agriculture.
Potential Limitations and Future Improvements: Ideally this metric would be heat waves or consecutive hot days above 90 degrees, but this was not possible in the time frame of the evaluation. The NYS DOH does not have a reliable indicator for heat-related illnesses or deaths due to infrequency impacting data reliability. However, heat vulnerability is a factor of other variables such as projected 90F days, vehicle traffic (road) density, and vegetative cover. Sociodemographic and health indicators (including race, ethnicity, Percent >65 and Percent with disabilities), which are included in the selected indicators, are also characteristics/conditions that are associated with heat vulnerability.
References:
https://www.georgetownclimate.org/files/report/Community-Informed-Heat-Relief-2021.pdf
New York City Department of Health. Heat Vulnerability Index. https://a816-dohbesp.nyc.gov/IndicatorPublic/HeatHub/hvi.html
New York State Department of Health. Heat Vulnerability Index for New York State. https://www.health.ny.gov/environmental/weather/vulnerability_index/
Daly, C., R. P. Neilson, and D. L. Phillips, 1994: A statistical–topographic model for mapping climatological precipitation over mountainous terrain. *J. Appl. Meteor.*, 33, 140–158.
Livneh, B., T.J. Bohn, D.W. Pierce, F. Munoz-Arriola, B. Nijssen, R. Vose, D.R. Cayan, and L. Brekke, 2015: A spatially comprehensive, hydrometeorological data set for Mexico, the U.S., and Southern Canada 1950–2013. *Sci. Data 2*, 150042. Doi:10.1038/sdata.2015.42.
Pierce, D. W., D. R. Cayan, and B. L. Thrasher, 2014: Statistical downscaling using localized constructed analogs (LOCA), *Journal of Hydrometeorology*, 15(6), 2558-2585.
U.S. Department of Commerce, U.S. Census Bureau, Geography Division (Originator). 2019. TIGER/Line Shapefile, 2019, state, New York, Current Census Tract State-based.
U.S. Geological Survey (USGS). 2015. National Watershed Boundary Dataset (WBD). Vector Digital Data Set.

Low Vegetative Cover

Metric Definition: Percent of census tract land area that is highly developed or not covered by vegetation.
Data Source: USGS National Land Cover Database (NLCD) [2016]
Calculation Method: NLCD land cover categories and class values were reclassified as either vegetated or non-vegetated land covers. The re-classified NLCD land cover dataset was then overlaid with census tracts to find the percent of each tract comprised of each class. Within each census tract the percent vegetated land was calculated as the sum of all vegetated land classes divided by the sum of all non-water land classes (i.e., excluded open water). Land cover classes were distinguished as follows:

- Low- or non- vegetated
    - Developed, Medium Intensity
    - Developed, High Intensity

    - Barren Land
    - Other unclassified areas
- Vegetated
    - Developed, Open Space
    - Developed, Low Intensity
    - Deciduous Forest
    - Evergreen Forest
    - Mixed Forest
    - Shrub/Scrub
    - Herbaceous
    - Hay/Pasture
    - Cultivated Crops
    - Woody Wetlands
    - Emergent Herbaceous Wetlands

Rationale for Inclusion: Low vegetative land cover is an indicator of urban areas, where dark surfaces like pavement absorb heat, infrastructure prevents airflow, more vehicles emit heat, and natural cooling processes are reduced. The health risks adversely impact vulnerable populations, such as "those who work outside, older adults, children, people of color, lower-income families, and people experiencing homelessness." The health risks associated with low vegetative land cover include aggravated asthma and heat related hospitalizations.
This indicator is one of several that describes threats to census tracts from future heat vulnerability by mapping areas with high potential for added heat stress. Low vegetative land cover is a driver of heat vulnerability that several heat indices include as a component, typically represented either as vegetative cover or green space, or developed land area instead.
Potential Limitations: The indicator's reclassification of land area does not consider open water in either the numerator or denominator. Therefore, this indicator does not include any potential protective effect that open water may have on heat vulnerability.
Future Improvements: Monitor if/when new NLCD data is available.
References:
https://www.georgetownclimate.org/files/report/Community-Informed-Heat-Relief-2021.pdf
New York City Department of Health. Heat Vulnerability Index. https://a816-dohbesp.nyc.gov/IndicatorPublic/HeatHub/hvi.html
New York State Department of Health. Heat Vulnerability Index for New York State. https://www.health.ny.gov/environmental/weather/vulnerability_index/

Driving Time to Hospitals or Urgent/Critical Care

Metric Definition: Average travel times (minutes) and distances (miles) between New York Census Tracts and the 3 nearest healthcare facility within New York or neighboring states
Data Source: State hospitals: "Locations of Article 28, Article 36, and Article 40 health care facilities and programs from the Health Facilities Information System (HFIS)." Updated weekly. Vector Digital Data Set (Point). NY State Department of Health. Accessed: https://health.data.ny.gov/Health/Health-Facility-Map/875v-tpc8 (6/11/2021)
Federal hospitals: "Hospitals". Publication date: 6/30/2020. Vector Digital Data Set (Point). Homeland Infrastructure Foundation-Level Data (HIFLD) database. (https://gii.dhs.gov/HIFLD) Credits: Oak Ridge National Laboratory (ORNL); National Geospatial-Intelligence Agency (NGA) Homeland Security Infrastructure Program (HSIP) Team. Accessed: https://hifld-geoplatform.opendata.arcgis.com/datasets/hospitals/explore?location=43.179486%2C-73.245981%2C7.00 (6/11/2021)
Calculation Method: Healthcare facilities were obtained from a Federal (406 facilities) and NY state (1,452 facilities) sources (see input data sources). Tract points were the origins and hospitals were the destinations. Locations were snapped to the network up to a distance of 7.5 km. For each tract, the three closest hospitals by travel time was found and time (minutes) and distances (miles) was reported. Road travel time and distances were calculated using an Origin-Destination Cost Matrix using ESRI ArcMap Network Analyst and Tele Atlas StreetMap Premium v. 7.2.

Rationale for Inclusion: This metric was used as an indicator of access to healthcare and of a community's vulnerability in the event of an extreme hazardous climate event. Local access to healthcare is a social determinant of health. This metric captures burden of long distances/drive times in more rural areas. A longer driving time to a hospital or urgent/critical care facility may result in an increased risk of severe morbidity or mortality.
Potential Limitations: Area level measures of driving distance may not capture individual burden of time spent in transit. Since we do not have complete information for facilities in other states, the burden may not be captured accurately in areas that are on a border with other states. Different health conditions may have specialized health care needs that may not be captured by the general health care facilities captured by this measure.
Future Improvements:

6.3 Population Characteristics and Health Vulnerabilities Indicators

The Technical Team generated all indicator data below using the calculation methods described below to generate "raw" value, and then we calculated the percentile rank of each indicator using the approach described in Section 5.

FACTOR #1: INCOME, EDUCATION AND EMPLOYMENT

Population earning less than 80% of Area Median Income

Metric Definition: Percentage of census tract population earning less than 80% of Area Median Income
Data Source: Housing and Urban Development 2020 (from 2011-2015 ACS Census data and the Income Limits for Metropolitan Areas and for Non Metropolitan Counties)
Calculation Method: HUD develops median family incomes for each metropolitan area, parts of some metropolitan areas, and each nonmetropolitan county. HUD normalizes the data 'by family size and for areas with unusually high or low family income or housing-cost-to-income relationships.' As per HUD, 'The data necessary to determine an LMI [AMI] percentage for an area is not published in the publicly-available ACS data tables. Therefore, the Bureau of Census matches family size, income, and the income limits in a special tabulation to produce the estimates.' We used HUD's final data set of percentage of population earning less than 80% AMI by census tract.
Rationale for Inclusion: Population earning less than 80% AMI was included to capture more general poverty across communities as compared to the extreme poverty threshold (Poverty rate indicator) also included based on the federal poverty level. Stakeholders prefer this localized income metric that is used as a common income-based eligibility threshold for NYS affordable housing and low-to-moderate income energy assistance programs. For example, NYS Homes and Community Renewal uses incomes at or below 50% of AMI when determining eligibility for its State of NY Mortgage Agency program. Section 8 Housing Assistance Payments generally set their limits based on 50% AMI. The Community Development Block Grant program threshold of moderate income relies on Section 8 "lower income" limits, which are generally tied to 80% of area median income.

Low-income communities have historically been associated with increased exposure to environmental pollutants, negative health outcomes, and chronic stress, and are more seriously impacted by hazardous climate events. According to the US Department of Health and Human Services, poverty is a social determinant of health and 'people living in poverty are more likely to die from preventable diseases.'
Potential Limitations and Future Improvements: This indicator does not capture extreme poverty, and so the indicator based on federal poverty level is included as well.
References:
https://hudgis-hud.opendata.arcgis.com/datasets/HUD::low-to-moderate-income-population-by-tract/about
https://www.hudexchange.info/programs/acs-low-mod-summary-data/
https://www.huduser.gov/portal/datasets/il//il21/IncomeLimitsMethodology-FY21.pdf
https://hcr.ny.gov/income-limits
https://oehha.ca.gov/media/downloads/calenviroscreen/report/calenviroscreen40reportf2021.pdf
https://health.gov/healthypeople/objectives-and-data/browse-objectives/economic-stability
https://health.gov/healthypeople/objectives-and-data/browse-objectives/economic-stability/reduce-proportion-people-living-poverty-sdoh-01

Poverty rate (Below 100% Federal Poverty Level)

Metric Definition: Percentage of the population earning income less than 100% of the federal poverty level
Data Source: 2019 American Community Survey (ACS) 5-year table C17002 – Ratio of Income to Poverty Level in the Past 12 Months
Calculation Method: We summed the estimates of the population in each tract that were under 50% of the federal poverty level and between 50 and 99% of the federal poverty level. Then we divided that total by the total population in the census tract
Rationale for Inclusion: Low-income communities have historically been associated with increased exposure from environmental pollutants, negative health outcomes, and are more seriously impacted by hazardous climate events. Below 100% Federal Poverty Level was included to capture more deeply entrenched poverty as compared to 80% AMI. Family poverty rate is an indicator of economic stability, which is a social determinant of health. This census table uses a lookup table to normalize the poverty threshold (income) by family size and composition. Because this indicator does not normalize the poverty threshold by any area or geography, the federal poverty level is effectively a lower income threshold in New York State than the area median income indicators we have included (less than 80% of area median income). The lower federal poverty level metric therefore captures more burdensome living conditions and burdens of higher poverty.
Potential Limitations and Future Improvements: This census table does not normalize the poverty threshold by any area or geography, which, while indicated above, is beneficial in the sense that we can capture burdens of higher poverty, with this metric we are not able to capture families who are relatively burdened in higher income areas. This federal poverty level metric combined with an area median income metric captures both absolute and relative burden. In the future, the Technical Team may be able to develop one indicator that represents overall income burden.
References:
CalEnviroScreen https://oehha.ca.gov/media/downloads/calenviroscreen/report/calenviroscreen40reportf2021.pdf

Single Parent Households

Metric Definition: Percentage of households with single parent and children below age 18.
Data Source: 2019 American Community Survey 5-year Table – DP02
Calculation Method: We totaled the number of households with a single male head of household with their own children under the age of 18 and the number of households with a single female head of household with their own children under the age of 18. We divided this total by the overall number of households in the census tract.
Rationale for Inclusion: May be associated with households with lower income and childhood poverty, or households that are more susceptibility to power outages and emergency situations due to extreme weather events. Moreover, single-mother households may be correlated to living in communities with high concentrations of air pollution (Liam and Hawkins).
Potential Limitations and Future Improvements: None discussed.
References:
Downey, Liam, and Brian Hawkins. "Single-Mother Families and Air Pollution: A National Study." *Social Science Quarterly* 89, no. 2 (2008): 523–36. http://www.jstor.org/stable/42956327.

Adults without a Bachelor's Degree

Metric Definition: Percentage of population over age 25 without a bachelor's or professional school degree.
Data Source: 2019 American Community Survey 5-year – Table B15003 – Educational Attainment for the Population 25 Years and Over
Calculation Method: We totaled the census estimates for educational attainment for the following population categories, which are estimated for the population 25 years and older:

- No schooling
- Nursery school
- Kindergarten through 11th grade
- 12th grade without a diploma
- High school diploma, GED or alternative credential
- Some college without a degree

- Associates degree

We divided this total by the total population 25 years and older.

Rationale for Inclusion: Education is a social determinant of health and represents one's long-term health and lifespan. Moreover, this indicator represents systemic educational disadvantage which may be associated with long-term income potential and other socio-economic factors. Communities suffering systemic socio-economic disadvantaged are more adversely impacted by climate change and have a more difficult time managing a hazardous climate event.

Potential Limitations and Future Improvements:

References:

Unemployment Rate

Metric Definition: Unemployed as percentage in the labor force.

Data Source: 2019 American Community Survey 5-year Table – B23025

Calculation Method: We divided the estimate for the total population that is unemployed in the labor force by the total population in the labor force.

Rationale for Inclusion: The unemployment rate is a strong indicator of stable housing, health conditions, and resilience to disasters. The unemployment rate can be substantially increased by environmental hazards and ecosystem degradation. Extreme temperatures and other climate disaster events can also reduce labor productivity and career longevity.

Potential Limitations and Future Improvements:

References:

NOAA: https://www.fisheries.noaa.gov/national/socioeconomics/social-indicators-coastal-communities
EPA: https://www.epa.gov/climate-indicators/understanding-connections-between-climate-change-and-human-health
International Labor Organization: https://tinyurl.com/2uku6s88
Washington State: https://deohs.washington.edu/washington-environmental-health-disparities-map-project

FACTOR #2: RACE, ETHNICITY, AND LANGUAGE

Black or African American Population

Metric Definition: Percentage of population who is Black or African American alone or in combination with one or more other races

Data Source: 2019 American Community Survey 5-year Tables – B02009 and B01003

Calculation Method: We divided the estimate for the population of Blacks or African Americans alone or in combination with one or more other races by the total population of the census tract.

Rationale for Inclusion: Represents legacies of historical discrimination on the basis of race and ethnicity. People of Color are more likely to live in areas with higher environmental burdens and experience the negative health consequences of several environmental factors. Moreover, minority populations are more likely to live in climate vulnerable communities that bare the harshest impacts from climate change (EPA, 2021). Out of all racial demographic populations, Black or African Americans are exposed to more PM 2.5 pollution on average, which is the largest environmental health risk factor in the US. Black or African American households also have the lowest mean and median net wealth.

Potential Limitations and Future Improvements: None discussed.

References:

https://www.epa.gov/system/files/documents/2021-09/climate-vulnerability_september-2021_508.pdf
https://www.georgetownclimate.org/files/report/Community-Informed-Heat-Relief-2021.pdf [see file for further sources to cite]
New York City Department of Health. Heat Vulnerability Index. https://a816-dohbesp.nyc.gov/IndicatorPublic/HeatHub/hvi.html
New York State Department of Health. Heat Vulnerability Index for New York State. https://www.health.ny.gov/environmental/weather/vulnerability_index/
Wealth: https://tinyurl.com/29zbdust

Air pollution exposure:1 https://www.science.org/doi/10.1126/sciadv.abf4491#F2
Air pollution exposure 2 : https://www.pnas.org/content/116/13/6001

Hispanic and Latino Population

Metric Definition: Percentage of Hispanic or Latino/a Origin
Data Source: 2019 American Community Survey 5-year Table – B03003
Calculation Method: We divided the estimate for the Hispanic or Latino origin population by the total population of the census tract.
Rationale for Inclusion: Represents legacies of historical discrimination on the basis of race and ethnicity. Minority populations are more likely to live in areas with higher environmental burdens and experience the negative health consequences of several environmental factors. Moreover, minority populations are more likely to live in climate vulnerable communities that bare the harshest impacts from climate change (EPA, 2021). The Hispanic/Latino population also speaks English at a lower propensity, which impedes the ability to manage climate related health risks. Of all racial demographic populations, Hispanics/Latinos bear the most disproportionate burden of PM 2.5 pollution, which is the largest environmental health risk factor in the US. Hispanic/Latino households also have the second lowest mean and median net worth in the US.
Potential Limitations and Future Improvements:
References:
Language issues: https://minorityhealth.hhs.gov/omh/browse.aspx?lvl=3&lvlid=64
Language as a vulnerability: https://health2016.globalchange.gov/populations-concern
Wealth: https://tinyurl.com/29zbdust
Air pollution exposure 1: https://www.science.org/doi/10.1126/sciadv.abf4491#F2
Air pollution exposure 2: https://www.pnas.org/content/116/13/6001

Asian and Asian American Population

Metric Definition: Percentage of population who is Asian alone or in combination with one or more other races
Data Source: 2019 American Community Survey 5-year – Tables B02011 and B01003
Calculation Method: We divided the estimate for the population of Asians alone or in combination with one or more other races by the total population of the census tract.
Rationale for Inclusion: Represents legacies of historical discrimination on the basis of race and ethnicity. Minority populations are more likely to live in areas with higher environmental burdens and experience the negative health consequences of several environmental factors. Moreover, minority populations are more likely to live in climate vulnerable communities that bare the harshest impacts from climate change (EPA, 2021). Asians or Asian Americans also speak English at a lower propensity, which impedes the ability of the population to manage climate related health risks. In addition, out of all racial demographic populations, Asians are the second most exposed to PM 2.5 pollution on average, which is the largest environmental health risk factor in the US.
Potential Limitations and Future Improvements:
References:
Language issues: https://www.pewresearch.org/social-trends/chart/english-proficiency-of-chinese-population-in-the-u-s/
Language as a vulnerability: https://health2016.globalchange.gov/populations-concern
Air pollution exposure : https://www.science.org/doi/10.1126/sciadv.abf4491#

Native American or Indigenous Population

Metric Definition: Percent of tract population who is American Indian, Alaska Native, Native Hawaiian or other Pacific Islander alone or in combination with one or more other races
Data Source: 2019 American Community Survey 5-year – Tables B02010, B02012, and B01003
Calculation Method: The Technical Team totaled the estimates for the population of American Indians and Alaska Natives alone or in combination with one or more other races and Native Hawaiians and other Pacific Islanders alone or in combination with one or more other races. We then divided the sum by the total population of the census tract.
Rationale for Inclusion: Represents legacies of historical discrimination based on race and ethnicity. Minority populations are more likely to live in areas with higher environmental burdens and experience the negative health

consequences of several environmental factors. Moreover, minority populations are more likely to live in climate vulnerable communities that bare the harshest impacts from climate change (EPA, 2021). Specifically, Indigenous populations have, and are, the target of colonial and neocolonial practices amounting to genocide and ethnocide (Mohatt et al., 2014; Woolford, 2015). Indigenous populations are considered separately than Indigenous territories (reservations or Nation-owned land), which are included through consultation with New York State recognized Indigenous Nations according to DEC Commissioner's Policy 42, "Contact, Cooperation, and Consultation with Indian Nations" (Witt and Hartley, 2019).

Potential Limitations and Future Improvements:

References:

Historical trauma: Mohatt, Nathaniel Vincent, Azure B. Thompson, Nghi D. Thai, and Jacob Kraemer Tebes. 2014. "Historical Trauma as Public Narrative: A Conceptual Review of How History Impacts Present-Day Health." Social Science & Medicine 106:128-136. https://doi.org/10.1016/j.socscimed.2014.01.043
Boarding schools: Woolford, Andrew. 2015. This Benevolent Experiment: Indigenous Boarding Schools, Genocide, and Redress in Canada and the United States. Lincoln, Nebreska: Univesity of Nebreska Press. https://www.nebraskapress.unl.edu/nebraska/9780803276727/
Consultation: Witt, David E., and Bonney Hartley. 2019. "Recognizing Multiple Sovereignties: A Starting Point for Native American Cultural Resource Consultation." Journal of Community Archaeology & Heritage 7 (1):3-16. https://www.tandfonline.com/doi/full/10.1080/20518196.2019.1654673
Commissioner's Policy 42: https://www.dec.ny.gov/docs/permits_ej_operations_pdf/cp42.pdf

Limited English Proficiency

Metric Definition: Percentage of households that are limited English speaking households.

Data Source: 2019 American Community Survey 5-year Table -C16002

Calculation Method: We totaled the estimates for the number of households that are limited English speaking households (speaking Spanish, Asian and Pacific Island languages, other Indo European languages, or other languages). We then divided the sum by the total number of households in the census tract.

Rationale for Inclusion: In New York approximately 30.5% of individuals aged 5 an up speak a language other than English at home (ACS 2015-2019). Language affects ability to seek and access energy solutions, medical care and social services. This indicator also serves to identify groups of people excluded from race and ethnicity indicators due to insufficient resolution.

Potential Limitations and Future Improvements:

References:

Historical Redlining

Metric Definition: Historic (1930) redlining 'score' from 1-4 where 4 is most likely to be a redlined area

Data Source: National Community Reinvestment Coalition (NCRC) 2021

Calculation Method: The NCRC digitized the mortgage security risk maps of the Home Owners' Loan Corporation (HOLC) from the 1930s. The 'NCRC assigned a numerical value to each HOLC risk category as follows: 1 for "A" grade, 2 for "B" grade, 3 for "C" grade, and 4 for "D" grade. We calculated a historic redlining score from the summed proportion of HOLC residential security grades multiplied by a weighting factor based on area within each census tract.' For the purposes of this metric, if the percentage of the tract area that had an assigned score was zero, the data point was removed. The NCRC did not give final scores for census tracts that had less than 20% area covered by a score. We manually calculated the score for these low coverage census tracts to include them in this metric by summing the weighted A-E scores NCRC provided for each tract.

Rationale for Inclusion: Starting in the 1930s, mortgage lenders rated neighborhoods for lending risk, giving lower scores to areas with Black and lower-income residents. 'Redlining imposed barriers to the flow of capital in many low-income neighborhoods and in Black and other minority communities, creating the circumstances for long-term racial segregation' (NCRC Redlining and Neighborhood Health). Significant literature shows persistent effects of this discrimination on segregation, neighborhood investment, inequality, vegetative cover, air quality, and air temperature. Nationally, temperatures of historically redlined areas can be 7 degrees Celsius higher than neighboring non-redlined areas. There are also positive relationships between redlined neighborhoods and lower life expectancy, as well as higher risk for asthma, COPD, diabetes, and other health issues.

Potential Limitations and Future Improvements: There are missing values for areas without scoring coverage, mostly outside of metropolitan areas.

References:

https://ncrc.org/redlining/
https://ncrc.org/holc-health/
Meier, Helen C.S., and Mitchell, Bruce C. Historic Redlining Scores for 2010 and 2020 US Census Tracts. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2021-05-26. https://doi.org/10.3886/E141121V1
Hoffman, Jeremy S., Vivek Shandas, and Nicholas Pendleton. 2020. "The Effects of Historical Housing Policies on Resident Exposure to Intra-Urban Heat: A Study of 108 US Urban Areas" Climate 8, no. 1: 12. https://doi.org/10.3390/cli8010012

FACTOR #3: HEALTH OUTCOMES AND HEALTHCARE

Asthma Emergency Department Visits

Metric Definition: Age-adjusted annual average rate of emergency department (ED) visits for asthma per 10,000 people

Data Source: Statewide Planning and Research Cooperative System (SPARCS), a comprehensive database of hospital and emergency department admissions throughout NYS; NYSDOH Center for Environmental Health, Bureau of Environmental and Occupational Epidemiology and Center for Community Health, Asthma Program

Calculation Method: Total number of cases from 2008 to 2012 in each of four age categories (0-4, 5-14, 15-64, 65 and above). Cases were geocoded and assigned to census tracts or census tract aggregations (i.e., aggregated areas), or imputed if they could not be geocoded. NYS has created aggregated areas that are a combination of 1) individual census tracts, 2) aggregations of census tracts, and 3) NYC Neighborhood Tabulation Areas, which are pre-existing, census tract-based geographies created by the NYC Department of City Planning. Each of these age groups was divided by the 2010 population estimate from the Decennial Census for that age group in that aggregated area and weighted using the NYS population age distribution for 2008-2012. These weighted age-specific rates were summed, then divided by 5, to calculate the annual average age-adjusted rate. For aggregated areas that include multiple census tracts, each census tract in the aggregated area was assigned the same overall age-adjusted annual average rate.

Rationale for Inclusion: Asthma is a multifactorial disease, for which incidence or exacerbation has been linked with environmental and occupational exposures. Also, prevalence and management of asthma is associated with socioeconomic status and healthcare access. Outdoor and indoor air pollution can affect asthma (*e.g.*, ozone and particulate matter) and increase visits to emergency departments. Heat stress has also been shown to be associated with complications of lung disease such as asthma. The seasonality and severity of asthma is affected by the growth patterns of pollen producing vegetation species which can act synergistically with air pollutants.[7] According to NYSDOH's asthma dashboard, the age-adjusted asthma ED visits were 75 per 10,000 in 2018, a significant improvement from previous time periods (i.e. 2016 and 2017). NYSDOH demonstrated that targeted at-home interventions that improve trigger avoidance is successful in reducing asthma morbidity.[8] There was a high correlation between emergency department visits and hospitalizations. We chose to use emergency department visits only to mitigate the possibility of double counting patients.

Potential Limitations and Future Improvements: These data require aggregation over time and space for rate stability and confidentiality. About 10% of the aggregated areas do not have values because the rate was not calculated (area contains over 50% population in group quarters or fewer than 11 cases), the rate was not stable (the area contains between 11 and 20 cases), or the rate was not applicable (area has no or very unreliable

[7] Poole JA et al. *Impact of weather and climate change with indoor and outdoor air quality in asthma: A Work Group Report of the AAAAI Environmental Exposure and Respiratory Health Committee,* Journal of Allergy and Clinical Immunology, Volume 143, Issue 5,2019, pp 1702-1710, https://doi.org/10.1016/j.jaci.2019.02.018.

[8] Reddy, AL., et al. 2017. *The New York State Healthy Neighborhoods Program: Findings from an Evaluation of a Large-Scale, Multisite, State-Funded Healthy Homes Program. Journal of Public Health Management and Practice: March/April 2017, Vol. 23, Issue 2, pp. 210-218.*

populations). NYS residents seeking care in other states may not be counted. This may especially impact aggregated areas that border another state.

References:

https://www.health.ny.gov/diseases/asthma/
https://www.health.ny.gov/statistics/ny_asthma/index.htm
https://www.epa.gov/asthma
https://www.cdc.gov/climateandhealth/effects/air_pollution.htm
https://www.cdc.gov/climateandhealth/effects/allergen.htm

COPD Emergency Department Visits

Metric Definition: Age-adjusted annual average rate of emergency department visits for chronic obstructive pulmonary disorder (COPD) per 10,000 people

Data Source: Statewide Planning and Research Cooperative System (SPARCS), a comprehensive database of hospital and emergency department admissions throughout NYS; NYSDOH Center for Environmental Health, Bureau of Environmental and Occupational Epidemiology

Calculation Method: Total number of cases from 2008 to 2012 in each of three age categories (0-34, 35-64, 65 and above). Cases were geocoded and assigned to census tracts or census tract aggregations (i.e., aggregated areas), or imputed if they could not be geocoded. NYS has created aggregated areas that are a combination of 1) individual census tracts, 2) aggregations of census tracts, and 3) NYC Neighborhood Tabulation Areas, which are pre-existing, census tract-based geographies created by the NYC Department of City Planning. Each of these age groups was divided by the 2010 population estimate from the Decennial Census for that age group in that aggregated area and weighted using the NYS population age distribution for 2008-2012. These age-specific rates were summed, then divided by 5 to calculate the annual average age-adjusted rate. For aggregated areas that include multiple census tracts, each census tract in the aggregated area was assigned the same overall age-adjusted annual average rate.

Rationale for Inclusion: COPD refers to a group of severe lung diseases that includes chronic bronchitis and emphysema. Although there is insufficient information to determine a causal relationship, outdoor air pollution, as well as tobacco, biomass smoke, and occupational exposures are considered environmental factors contributing to the development and progression of COPD. A study of long-term US health disparities found significant racial/ethnic, socioeconomic, and geographic factors affecting morbidity and mortality with leading chronic diseases, including COPD.[9] People who have COPD may be more vulnerable to the impacts of heat.[10] There was a high correlation between emergency department visits and hospitalizations. We chose to use emergency department visits only to mitigate the possibility of double counting patients.

Potential Limitations and Future Improvements: Health data require aggregation over time and space for rate stability and confidentiality. About 10% of the aggregated areas do not have values because the rate was not calculated (area contains over 50% population in group quarters or fewer than 11 cases), the rate was not stable (the area contains between 11 and 20 cases), or the rate was not applicable (area has no or very unreliable populations). NYS residents seeking care in other states may not be counted and outcomes are influenced by access to healthcare. This may especially impact aggregated areas that border another state.

References:

https://www.health.ny.gov/diseases/chronic/copd/fact_sheet.htm
https://www.lung.org/clean-air/climate-change/who-is-at-risk-climate
https://jamanetwork.com/journals/jama/fullarticle/2747669

Myocardial Infarction Hospitalizations

Metric Definition: Age-adjusted annual average rate of hospitalizations for myocardial infarction (or heart attack) per 10,000 people

Data Source: Statewide Planning and Research Cooperative System (SPARCS), a comprehensive database of hospital and emergency department admissions throughout NYS; NYSDOH Center for Environmental Health, Bureau of Environmental and Occupational Epidemiology and Center for Community Health, Asthma Program.

---

[9] Singh G.K. *et al*. 2017. *Social Determinants of Health in the United States: Addressing Major Health Inequality Trends for the Nation, 1935-2016*. Int J MCH AIDS. 2017;6(2):139-164.

[10] Nadia N. Hansel, Meredith C. McCormack & Victor Kim (2016) *The Effects of Air Pollution and Temperature on COPD*, COPD: Journal of Chronic Obstructive Pulmonary Disease, 13:3, 372-379, DOI: 10.3109/15412555.2015.1089846

Calculation Method: Total number of cases from 2008 to 2012 in each of two age categories (35-64, 65 and above). Cases were geocoded and assigned to census tracts or census tract aggregations (i.e., aggregated areas), or imputed if they could not be geocoded. NYS has created aggregated areas that are a combination of 1) individual census tracts, 2) aggregations of census tracts, and 3) NYC Neighborhood Tabulation Areas, which are pre-existing, census tract-based geographies created by the NYC Department of City Planning. Each of these age groups was divided by the 2010 population estimate from the Decennial Census for that age group in that aggregated area and weighted using the NYS population age distribution for 2008-2012. These age-specific rates were summed, then divided by 5 to calculate the annual average age-adjusted rate. For aggregated areas that include multiple census tracts, each census tract in the aggregated area was assigned the same overall age-adjusted annual average rate.
Rationale for Inclusion: Myocardial Infarction (MI) or "heart attack," is caused by coronary artery disease. MI hospitalization data was at the sub-county level. There are several risk factors for MI, including family history, high blood pressure and cholesterol, diabetes and smoking. Numerous scientific studies have linked cardiopulmonary diseases, including MI, to exposure to fine particulate matter (PM). According to the USEPA, the evidence for associations between fine PM exposure and cardiovascular morbidity has grown, while the results from studies are not entirely consistent, epidemiological studies report positive associations with ischemic heart disease and MI.[11] Although more clarity is needed on the role of extreme heat in causing CVD or MI, people who experience a MI may subsequently be more vulnerable to the impacts of heat.[12] Additionally, there may be cardiac health co-benefits associated with reducing greenhouse gases and other combustion pollutants, and increasing active transportation.
Potential Limitations and Future Improvements: Health data require aggregation over time and space for rate stability and confidentiality. About 10% of the aggregated areas do not have values because the rate was not calculated (area contains over 50% population in group quarters or fewer than 11 cases), the rate was not stable (the area contains between 11 and 20 cases), or the rate was not applicable (area has no or very unreliable populations). NYS residents seeking care in other states may not be counted. This may especially impact aggregated areas that border another state.
References:
https://www.health.ny.gov/diseases/cardiovascular/heart_disease/
https://www.epa.gov/naaqs
https://www.cdc.gov/climateandhealth/docs/HeatCardiovasculoarHealth-508.pdf
https://www.karger.com/Article/Pdf/398787
https://www.sciencedirect.com/science/article/pii/S0160412020318651?via%3Dihub

Premature Deaths

Metric Definition: Percent of deaths that occur among people under age 65
Data Source: Mortality Vital Statistics Data, New York State Bureau of Vital Records; NYSDOH Center for Environmental Health, Bureau of Environmental and Occupational Epidemiology
Calculation Method: Total number of deaths from all causes from 2015 to 2019 in each of two age categories (0-64, all deaths with known ages). Deaths were geocoded and assigned to census tracts or census tract aggregations (i.e., aggregated areas), or imputed if they could not be geocoded. NYS has created aggregated areas that are a combination of 1) individual census tracts, 2) aggregations of census tracts, and 3) NYC Neighborhood Tabulation Areas, which are pre-existing, census tract-based geographies created by the NYC Department of City Planning. The number of deaths aged 0-64 years was divided by the total number of deaths for whom age was known within each aggregated area. For aggregated areas that include multiple census tracts, each census tract in the aggregated area was assigned the same value.
Rationale for Inclusion: Preventive interventions around certain factors related to premature death could lead to improvement on this indicator. Could also be indicator that reflect historical policy decisions. USEPA's primary National Ambient Air Quality Standard for PM is based on premature mortality. A recent study of US county-level mortality rates associated with non-communicable disease identified a widening gap between mortality rates

[11] USEPA, 2020. Review of the National Ambient Air Quality Standards for Particulate Matter. 40 CFR Part 50: Vol. 85, No. 244, pp. 82684-82748. December 18, 2020.
[12] Peters, A., Schneider, A. Cardiovascular risks of climate change. *Nat Rev Cardiol* 18, 1–2 (2021). https://doi.org/10.1038/s41569-020-00473-5

in high- and low- income counties.[13] Sound public health policies and practices can help reduce premature mortality associated with chronic disease.[14]

Potential Limitations and Future Improvements: Mortality data require aggregation over time and space for rate stability and confidentiality. About 10% of the aggregated areas do not have values because the rate was not calculated (area contains over 50% population in group quarters or fewer than 11 cases), the rate was not stable (the area contains between 11 and 20 cases), or the rate was not applicable (area has no or very unreliable populations). NYS residents who died in other states may not be counted.

References:

https://www.who.int/bulletin/volumes/98/6/20-254110.pdf

https://www.cdc.gov/climateandhealth/effects/air_pollution.htm

Low birth weight births

Metric Definition: Percent of births with birth weight below 2500 grams

Data Source: Live Births Vital Statistics Data, New York State Bureau of Vital Records; NYSDOH Center for Environmental Health, Bureau of Environmental and Occupational Epidemiology

Calculation Method: Total number of births from 2014 to 2018 in each of two categories (births under 2500 grams, all births with known birth weight). Births were geocoded and assigned to census tracts or census tract aggregations (i.e., aggregated areas), or imputed if they could not be geocoded. NYS has created aggregated areas which are a combination of 1) individual census tracts, 2) aggregations of census tracts, and 3) in NYC Neighborhood Tabulation Areas, which are pre-existing, census tract-based geographies created by NYC agencies. The number of infants born with birth weight below 2500 grams was divided by the total number of infants for whom birth weight was known within each aggregated area. For aggregated areas that include multiple census tracts, each census tract in the aggregated area was assigned the same value.

Rationale for Inclusion: Low birth weight (LBW) is a result of pre-term birth, intrauterine growth restrictions or both. This indicator broadly represents maternal health, which is a factor of environmental, social, and structural factors and policies. Studies have shown that low birth weight may predict future morbidity and mortality. Smoking is thought to be one of the most preventable causes of low birth weight in the US. Some studies have found associations between temperature extremes, particulate matter, ozone and low birth weight births, although further research is necessary to confirm that relationship.[15]

Potential Limitations and Future Improvements: Low birth weight may result from a number of factors. Birth data require aggregation over time and space for rate stability and confidentiality. About 10% of the aggregated areas do not have values because the rate was not calculated (area contains over 50% population in group quarters or fewer than 11 cases), the rate was not stable (the area contains between 11 and 20 cases), or the rate was not applicable (area has no or very unreliable populations). NYS residents who were born in other states may not be counted.

References:

https://www.sciencedirect.com/science/article/abs/pii/S0013935116307332?via%3Dihub

https://www.sciencedirect.com/science/article/pii/S0160412021002130?via%3Dihub

https://www.sciencedirect.com/science/article/pii/S0160412021002130?via%3Dihub

Population with a disability

Metric Definition: Percentage of tract population with at least one of 6 reported disability types: hearing difficulty, vision difficulty, cognitive difficulty, ambulatory difficulty, self-care difficulty, and independent living difficulty.

Data Source: 2019 American Community Survey (ACD) 5-year table B18101 – Sex by Age by Disability Status

Calculation Method: We calculated the total population with a disability (males and females in all age categories) and divided by the total population.

---

[13] Song S, *et al*. 2020. *Factors Associated with County-Level Variation in Premature Mortality Due to Noncommunicable Chronic Disease in the United States, 1999-2017*. JAMA Netw Open. 2020;3(2):1-13.

[14] Bauer, U.E., et al. 2014. Prevention of chronic disease in the 21st century: elimination of the leading preventable causes of premature death and disability in the USA. The Lancet. Vol. 384, Issue 9937, pp. 45-52.

[15] Bekkar B, Pacheco S, Basu R, DeNicola N. *Association of Air Pollution and Heat Exposure With Preterm Birth, Low Birth Weight, and Stillbirth in the US: A Systematic Review*. *JAMA Netw Open.* 2020;3(6):e208243. doi:10.1001/jamanetworkopen.2020.8243

Rationale for Inclusion: Potentially vulnerable populations were added due to the extra risk posed by climate change or other environmental burdens on these groups. Vulnerable populations have a more difficult time enduring and responding to climate change while also being disproportionally impacted than other communities. This indicator represents communities' susceptibility to power outages and emergency situations due to extreme weather events as well as heat vulnerability.

Potential Limitations and Future Improvements: None discussed.

References:

https://www.georgetownclimate.org/files/report/Community-Informed-Heat-Relief-2021.pdf
New York City Department of Health. Heat Vulnerability Index. https://a816-dohbesp.nyc.gov/IndicatorPublic/HeatHub/hvi.html
New York State Department of Health. Heat Vulnerability Index for New York State. https://www.health.ny.gov/environmental/weather/vulnerability_index/

Population over age 65

Metric Definition: Percentage of the total tract population that is 65 years of age or older

Data Source: 2019 American Community Survey (ACS) 5-year table S0101 – Age and Sex

Calculation Method: We divided the population in the census tract that is at least age 65 by the total population in the tract.

Rationale for Inclusion: Potentially vulnerable populations were added due to the extra risk posed by climate change or other environmental burdens on these groups. Vulnerable populations have a more difficult time enduring and responding to climate change while also being disproportionally impacted than other communities. This indicator represents a communities' susceptibility to power outages and emergency situations due to extreme weather events as well as heat vulnerability. The proportion of the population that is 65 years of age or older is used as a vulnerability indicator to represent the older population's susceptibility to health events during power outages and other emergency situations caused by extreme weather events. This metric is also an indicator of heat vulnerability. According to the EPA, "since 1999, people aged 65+ have been several times more likely to die from heat-related cardiovascular disease than the general population." We do not have an indicator for heat-related illnesses or deaths due to infrequency impacting data reliability, but heat vulnerability is a factor of other variables such as projected 90F days, vehicle traffic (road) density, and vegetative cover. Other sociodemographic and health indicators that are associated with heat vulnerability include race, ethnicity, and population with disabilities), which are included in the selected indicators, are also characteristics/conditions.

Potential Limitations and Future Improvements: Because this indicator is a proxy for the concepts of power outages, emergency situations, and heat vulnerability, future improvements may include those direct indicators if data is available.

References:

https://www.georgetownclimate.org/files/report/Community-Informed-Heat-Relief-2021.pdf [see file for further sources to cite]
New York City Department of Health. Heat Vulnerability Index. https://a816-dohbesp.nyc.gov/IndicatorPublic/HeatHub/hvi.html
New York State Department of Health. Heat Vulnerability Index for New York State. https://www.health.ny.gov/environmental/weather/vulnerability_index/

Percentage Without Health Insurance

Metric Definition: Percentage of the population without health insurance.

Data Source: 2019 American Community Survey 5-year - Table B27001 Health Insurance Coverage Status by Sex by Age

Calculation Method: We calculated the total population without health insurance (males and females in all age categories) and divided by the total population.

Rationale for Inclusion: Represents access to screening, ability to manage conditions, affordable care. May indicate structural and socioeconomic disadvantage.

Potential Limitations and Future Improvements:

References:

Housing and Energy

Rented Housing Units

Metric Definition: Percentage of renter occupied housing units.
Data Source: 2019 American Community Survey 5-year - Table B25003 Tenure
Calculation Method: We divided the estimate of total renter occupied housing units by the total number of housing units.
Rationale for Inclusion: As a group, renters have lower incomes and are less resilient to climate impacts. Whereas homeowners may receive insurance payments and affordable loans after a climate disaster, renters must often relocate to more expensive housing. They also receive less information on the condition of their properties they rent, including on flood risk. After disasters, renters often have less input on any necessary repairs to their units, making it more likely for them to endure living in substandard housing.

Potential Limitations and Future Improvements:
References: Yale Climate Connections, Initiative of the Yale School of the Environment: https://yaleclimateconnections.org/about-us/

Rental Housing Cost Burden

Metric Definition: Rental housing costs as a percentage of household income
Data Source: US Census (2015-2019 ACS) table B25070 -- Gross Rent as a Percentage of Household Income in the Past 12 Months
Calculation Method: The Technical Team added all of the census categories for population spending 30% or more of their household income on rent (i.e., category for 30-34.9% of income, plus 35-39.9% of income, etc.) and divided by the total population of renter-occupied housing units.
Rationale for Inclusion: Renters who spend an above average share of their income on rent face additional burdens from climate change. Their relatively high housing costs limit their ability to save for emergencies. After disasters, they are less likely to receive public assistance to cover significant damage to any material goods they own. These renters are also most likely to experience homelessness as climate disasters reduce the supply of affordable housing. Renters with high rent burden are also more likely to postpone medical services, which increases vulnerability to chronic health problems, stress, and poor educational outcomes for children (CalEnviroScreen).
Potential Limitations and Future Improvements: The population included in this metric is only renters. This metric could be expanded in the future to include high housing costs for mortgage owners.
References:
Yale Climate Connections, Initiative of the Yale School of the Environment: https://yaleclimateconnections.org/2021/05/climate-change-increases-renters-risks/
CalEnviroScreen https://oehha.ca.gov/media/downloads/calenviroscreen/report/calenviroscreen40reportf2021.pdf

Energy Affordability

Metric Definition: Average energy costs as percentage of income
Data Source: DOE Low-Income Energy Affordability Data (LEAD) Tool (U.S. Census Bureau's American Community Survey 2018 Public Use Microdata Samples)
Calculation Method: DOE used census energy expenditure data, housing unit type data, household income data, and number of people in the household, to model the average energy burden by tract.
Rationale for Inclusion: Energy affordability or energy burden is an indicator that is highly actionable and addressable by the Climate Act. The NY REV Energy Affordability Policy intends to limit energy costs to no more than 6% of income as per the 2016 order from the PSC, which plans for bill assistance, energy efficiency, and access to clean energy resources to decrease low-income energy costs.
High energy burden leads to stress, depression, hot or cold home temperatures, and associated health risks including asthma. This metric is also a proxy for type and age of home, which could impact how expensive it is to heat or cool due to materials or inefficiencies.
Potential Limitations and Future Improvements: The US DOE's estimation approach does have some margin of error that they are looking to improve upon by using more measured values in future iterations.

References:
https://www.energy.gov/eere/slsc/maps/lead-tool
Ma, Ookie, Krystal Laymon, Megan Day, Ricardo Oliveira, Jon Weers, and Aaron Vimont. 2019. Low-Income Energy Affordability Data (LEAD) Tool Methodology. Golden, CO: National Renewable Energy Laboratory. NREL/TP-6A20-74249. https://www.nrel.gov/docs/fy19osti/74249.pdf.
https://www1.nyc.gov/assets/sustainability/downloads/pdf/publications/EnergyCost.pdf
2021 ORDER ADOPTING ENERGY AFFORDABILITY POLICY MODIFICATIONS AND DIRECTING UTILITY FILINGS:
https://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={1CFD4CE2-AB87-4A8C-B56B-F123366B1520}
2021 STAFF REPORT ON NEW YORK STATE'S ENERGY AFFORDIBILIY POLICY
https://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId={C3F867FC-27B0-49FB-AD29-7EED80C8F69E}

Manufactured and Mobile Homes

Metric Definition: Percentage of housing units that are manufactured or mobile homes.
Data Source: US Census (2015-2019 ACS) table B25024 – Units in Structure
Calculation Method: We divided the estimate for the number of mobile homes by the total number of housing units.
Rationale for Inclusion:
The occupants of Manufactured and Mobile Homes endure several risks that are exacerbated by climate change. Zoning and land use policies have placed these homes in areas that are more prone to flooding during intense precipitation events. Moisture accumulation inside these homes can also create health risks from mold, mildew, and dust mites. Many of these homes can be poorly insulated, resulting in higher energy costs and insufficient protection during extremely cold or hot outdoor temperatures.
Potential Limitations and Future Improvements:
References:
Mold/Mildew: USHHS and USHUD report: 'Safety and Health in Manufactured structures: https://tinyurl.com/4mr3ujum
Extreme temperature: Erie County Hazard Mitigation Plan: https://tinyurl.com/yckn5yvh
Energy burden: https://www.aceee.org/blog/2016/08/mobile-homes-move-toward-efficiency
Storm/Flood issues: https://stormrecovery.ny.gov/housing/manufactured-home-community-resiliency-program

Households without Internet Access or Internet Subscription

Metric Definition: Percentage of census tract households with no internet access
Data Source: US Census (2015-2019 ACS) table B28002 – Presence and Types of Internet Subscriptions in Household
Calculation Method: We divided the total population without internet access by the total population.
Rationale for Inclusion: Access to the internet is associated with services like telehealth, accessing medical records, and emergency communication for resilience to natural disasters. New York State has goals to increase internet access to improve access to these services.
Potential Limitations and Future Improvements: While this metric addresses access to internet, it does not address the financial cost of internet access. Stakeholders wanted to also capture potentially high costs of an internet or cellular subscription. When or if this information is available through another data source at the census tract geography level with New York State coverage a future metric could include the burden of a subscription as a percentage of income.
References:
https://health.gov/healthypeople/objectives-and-data/browse-objectives/health-care-access-and-quality
https://health.gov/healthypeople/objectives-and-data/browse-objectives/neighborhood-and-built-environment
https://health.gov/healthypeople/objectives-and-data/browse-objectives/neighborhood-and-built-environment/increase-proportion-adults-broadband-internet-hchit-05

Homes Built Before 1960

Metric Definition: Percentage of housing units that are built before 1960.
Data Source: EPA EJScreen (2017 American Community Survey CS 5-year - Table B25034)
Calculation Method: We rolled up the block group-level EJSCREEN data to the tract-level by taking a weighted average of the block group observations, weighted by the proportion of the census tract population that was in the block group.
Rationale for Inclusion: Associated with lead-based paint risk in un-remediated homes. Homes built before 1960, preceding the federal lead paint ban, are between 69-87% likely to contain lead paint or dust. Without remediation lead based paint or dust consumption poses a neurological damage risk in children (EPA).
Potential Limitations and Future Improvements: Homes Built Before 1960 was used as a proxy indicator due to its associate with lead-based paint and dust risk. A data source with reportable data at the census tract level on actual lead-based paint or dust records does not exist currently.
References:
https://www.epa.gov/lead/protect-your-family-sources-lead

7. FUTURE WORK

7.1 Future Indicator and Scoring Considerations

During multiple discussions of metrics and considered indicators, the CJWG identified several indicators for which data was not available or feasible to collect and include in this draft definition. As part of the annual review process and per statute, the CJWG will review the disadvantaged communities criteria, including indicators, at least annually.

8. APPENDIX

8.1 Census Tract Geography Considerations

After considering three different units of analysis: (1) block group, (2) census tract, and (3) sub-county areas such as NYS aggregate areas, we selected the census tract, which is commonly used for neighborhood-level analysis and EJ and DAC screen tools, as the unit of analysis and geographic definition of a community for the purposes of defining disadvantaged communities.

There were three primary areas of consideration in this decision: (1) the availability, reliability, and stability of data for the selected unit, (2) representing how NYS Agencies might manage actions or decisions that affect how spending or benefits flow to a community, and (3) selecting an area that people might identify as a community. Table 2 provides an overview of these three geographic definitions and key considerations gathered through reviewing technical documentation from EJScreen, CalEnviroScreen, NYSDOH, and NYC Planning and conferring with NYSDOH.

Table 9. Geographic Definitions Considered

Geographic Boundary	Number in New York	Key Considerations
Block Group (US Census Bureau)	15,464 in New York	Too small for reliable/stable estimates of some environmental, population and health indicators Much of the data we need is not available or differentiated at this level

		Too small for directing or allocating community-scale efforts and/or public engagement
Census Tract (US Census Bureau)	4,918 in New York Average of 3,989 people and 1,488 households per block group	Good environmental and census data available Some experts still caveat that data may be less stable at this level (especially health data). The NYSDOH Environmental Public Health Tracking Program has created aggregated areas, consisting of census tracts or aggregations of census tracts, to better accommodate issues with small numbers. Generally not too big nor too small relative to other options
Sub-county areas* (e.g., Aggregate Areas; Neighborhood Tabulation Areas[16] NY State Agencies	NYSDOH aggregate areas (as one example): 1,153 in New York State Average of 17,015 people and 6,346 households per area	More reliable data for some environmental, census and health indicators (lower measurement error) Developed and used by some state and local agencies (e.g., NYC Planning and NYSDOH) Might be too large for (a) prioritizing pollution reduction efforts or (b) measuring or allocating the benefits of clean energy and energy efficiency investments

*These could be a combination of one or multiple census tracts to define a slightly larger neighborhood or community, for the purposes of better data quality or reliability. For example, the NYC Department of Planning uses Neighborhood Tabulation Areas (NYC Planning) and for some health statistics (such as Environmental Public Health Tracking), the NYSDOH aggregates data to a sub-county level (sometimes called an Aggregate Area).

The following sections provide more detail on the rationale and considerations for selecting the census tract as our unit of analysis. While we considered representing how NYS Agencies might manage actions or decisions that affect how spending or benefits flow to a community and selecting an area that people might identify as a community, the availability, reliability, and stability of data weighed most heavily in the decision.

Availability, reliability, and stability of data

In selecting the unit of geography to use in our analysis, we needed to use a common definition that has reliable and publicly available data for the many things we need to measure; therefore, we had to use a Census-based designation like block groups or census tracts rather than political boundaries. We also needed to use data that is reliable and stable.

Considerations and trade-offs between the different geographic boundaries considered related to the availability, reliability, and stability of data include:

- **Census data availability** - Much of the census data we need is available at the block group level but has high measurement error. Some census data (e.g., housing/energy costs, disability status, nativity/citizenship, income by race) is not available at block group level (only census tract).

[16] The Population Division at NYC City Planning considers some demographic, housing and poverty data from the American Community Survey (ACS) to be unreliable for small areas. For better precision, they aggregate census tracts into Neighborhood Tabulation Areas (NTAs).

- **Health data availability** - Many state health indicators are reported at the county level. Fewer are reported at the sub-county level (i.e., ZIP code or census tract), and some of those are only available by ZIP codes which do not align with census tracts. Even if data confidentiality allows finer-grained reporting, some public health experts and epidemiologists think rates unreliable below sub-county level. The NYSDOH Environmental Public Health Tracking Program has created aggregated areas, consisting of census tracts or aggregations of census tracts (which for NYC are Neighborhood Tabulation Areas), to better accommodate issues with small numbers.

- **Pollution data availability** - EPA NATA variables ($PM_{2.5}$, diesel, respiratory hazard risk, cancer risk) are only differentiated at the census tract level. EJScreen publishes pollution and hazard data at the block group level, but anything from EPA NATA is applied from census tract level (all block groups within a census tract have the same values)

- **State GIS Data** - Many GIS-based indicators like air quality, land use and density, and storm surge/sea level risk, can be calculated at the block group level. However, when the underlying data is based on models (e.g., air quality diffusion model), measurement error will be higher for smaller areas.

- **Uncertainty and Measurement Error** - Data reliability and validity concerns are greater as the geographic areas get smaller, with margins-of-error generally larger for smaller areas. Though many federal and state government data users focus on small geographic areas such as census tracts and block groups, some agencies warn that uncertainty and measurement error is higher for smaller areas.[17] Even with 5 years of pooled data, ACS estimates for these small areas often have large margins-of-error (MOEs).[18] This means that these are not necessarily a strong or reliable measure to use to compare communities. For example, a wide margin-of-error could mean you falsely judge one community as more vulnerable (or facing more threats) than its neighbor, when really, they could be the same or the opposite relationship.

- **Confidentiality Concerns** - Some NY State agencies aggregate data above census tract level to protect confidentiality or improve stability and reliability of estimates. An **Aggregate Area** could be NYC Neighborhood Tabulation Areas, Multiple census tracts, or single census tracts.

- **Prevalence in EJ and DAC Screen tools** – The census tract is commonly used for neighborhood-level analysis and EJ and DAC screen tools. As noted in responses to CalEnviroScreen 3.0 comments, "We believe census tracts are currently the most useful scale of analysis for the CalEnviroScreen tool. Using census blocks groups, which are smaller than census tracts, and census designated places would be difficult since comparison would have to be made with census blocks groups statewide." "Further, some of the data used in CalEnviroScreen is either unavailable or statistically unreliable at the census block group scale."[19]

---

[17] Per EPA EJScreen Technical Documentation (https://www.epa.gov/ejscreen/technical-documentation-ejscreen) "Demographic estimates for a single block group are often based on a small sample of the local population and are uncertain. Similarly, some environmental indicator estimates are derived from lower-resolution data, and all involve uncertainty. Therefore, it is typically very useful and advisable to summarize EJSCREEN data within a larger area that covers several block groups" "The demographic uncertainty combined with uncertainty in environmental data means EJ index values are often quite uncertain for a single block group."
Per California OEHHA, Responses to CalEnviroScreen 3.0 comments (https://oehha.ca.gov/media/downloads/calenviroscreen/comment/ces3responsetocomments.pdf) "some of the data used in CalEnviroScreen is either unavailable or statistically unreliable at the census block group scale"

[18] See, for example: Census handbook: https://www.census.gov/content/dam/Census/library/publications/2020/acs/acs_state_local_handbook_2020_ch02.pdf
Patterns and causes of uncertainty in the American Community Survey: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4232960/

[19] California OEHHA, Responses to CalEnviroScreen 3.0 comments: https://oehha.ca.gov/media/downloads/calenviroscreen/comment/ces3responsetocomments.pdf

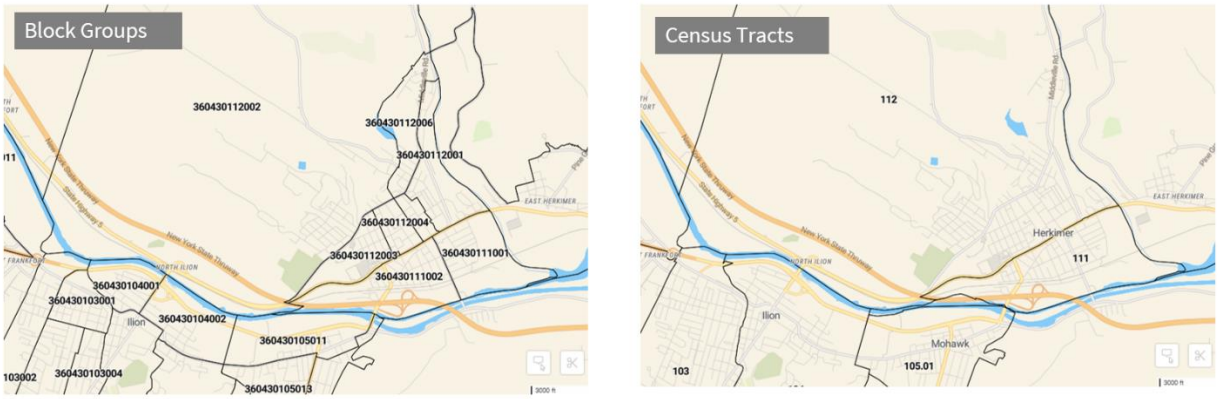
Representing how NYS Agencies might manage actions or decisions

Another area considered is how NYS agencies will use the DAC definition in decision-making.

For the purposes of directing, allocating, and measuring the benefits of investments to DACs, the technical team considered the level that best represents how benefits can be "placed" in or directed to a geographic area. For example, there are some investments where 100% of benefits really do go to one particular point on a map, while some may have a slightly wider influence, so assigning them all to one very small place may underrepresent the flow of benefits. Similarly, one has to consider the usefulness of block-group-level information for directing or managing Agency actions such as public outreach or engagement, directing resources or understanding the impact of those actions. Figure 11 illustrates the difference in size between block groups and census tracts.

For the purpose of prioritizing pollution reduction efforts and preparing regulatory impact statements, for some exposures and burdens with known boundaries, smaller geographic areas may provide a better way to target efforts than larger areas (e.g., city/town or aggregate area), though a block group may be smaller than the extent of environmental exposures or burdens.

Figure 4. Illustration of Block Groups and Census Tracts in and near Herkimer, NY



Selecting an area that people identify as a community

Lastly, the Technical Team took into account what areas might reasonably be considered a community as we wanted to select a geographic boundary that people might identify as a community, while also balancing not selecting an area that would be too big or too small.

As shown above in Table 9, there are 1,153 Aggregate Areas, 4,918 census tracts, and 15,464 block groups in New York. While none of the geographic boundaries we considered have a name that someone might recognize as a community like a town or neighborhood name, census tracts are about the right size to represent a community for the purposes of a DAC definition.

The Aggregate Areas are the largest of the boundaries considered, averaging 17,015 people and 6,346 households in each, which is on the large size and more likely to include a wider range of demographics. The New York census tracts average 3,989 people and 1,488 households each, and they generally nest into towns. Each census tract is comprised of multiple block groups which average 1,269 people and 473 households each.

8.2 Considered Indicators

This section lists all indicators that the CJWG considered for inclusion into the disadvantaged community criteria, including indicators that were selected for the draft criteria (highlighted rows) and not selected (white rows). The table indicates if the Technical Team identified potential data for each indicator, and if so, whether the data was obtained, calculated or screening for include. Additionally, the rationale for potential inclusion has been listed for

each indicator and potential limitation to the inclusion of indicators that were not selected for the criteria.

Indicators Considered to Represent Environmental Burdens and Climate Change Risks

Bolded indicators are included in the draft criteria. All others were considered but not currently included (though they may be similar to, or correlated with, included indicators).

Table 10. Indicators Considered to Represent Community Burdens (Pollution, hazards, land use and environmental factors, built environment & access, climate and weather risks)

Indicator	Potential Data Source(s)	Data Collected and Analyzed?	Included in Draft DAC Criteria?	Rationale for Inclusion	Potential Limitations
Factor #1: Pollution Exposures					
Air Toxics and Water Toxins					
Particulate matter (2.5) air concentration	**USEPA EJScreen (Office of Air and Radiation (OAR)) estimated 2016 $PM_{2.5}$ ambient annual average concentrations using a Bayesian space-time downscaling fusion model.**	**Yes**	**Yes**	**Studies have demonstrated that exposures to fine particulate matter (2.5 microns and less in size) illicit health effects, including elevated risk of premature mortality from cardiovascular diseases or lung cancer, and increased health problems such as asthma.[1]**	**$PM_{2.5}$ modeled concentrations are based upon 2016 estimates and may no longer reflect current conditions. The estimates are annual averages. Short-term averaging times may have been used in studies where health effects have been documented.**
Vehicle traffic density	**USEPA EJScreen - Count of vehicles based on average annual daily traffic at major roads within 500 meters of a census tract, divided by distance in meters. Calculated from 2017 USDOT traffic data.**	**Yes**	**Yes**	**Motor vehicles are a significant source of air pollution with documented health effects. Studies have shown that exposure to these pollutants aggravates asthma and upon long-term exposure causes childhood asthma onset and is associated with increased mortality rates.[2,3]**	**Studies show impacts from traffic decrease significantly as distance from the road increases.[4, 5]** **500 meters may be too great of a distance and could be including neighborhoods less likely to be considered disproportionately burdened. This large distance could be diluting localized effects and may make it difficult to identify disproportionate impacts in densely populated urban areas.**
Benzene air concentration	**USEPA National Air Toxics Assessment modeled annual average ambient concentration based on emissions from 2014**	**Yes**	**Yes**	**Benzene is a known human carcinogen,[6] and ambient concentrations are primarily from petroleum storage facilities, gasoline service stations, motor vehicle exhaust and industrial facilities.[7] Outdoor air concentrations tend to be higher in population dense areas due to density of mobile sources.**	**Represents historical emissions from 2014 and may not accurately reflect current conditions. Emissions inventory is developed from surrogate information such as population density and not an actual count of vehicles or gasoline-powered equipment. Monitored benzene concentrations in New York show a decrease in ambient levels since 2014.**
Diesel truck and bus traffic	**NYS Roadway Inventory System NYSDOT Traffic Viewer, annual average daily traffic counts for 2019 using Federal Highway Administration vehicle classes 4-13**	**Yes**	**Yes**	**Studies on diesel exhaust exposures have document increased asthma symptoms and attacks along with decreases in lung function for children and individuals with existing respiratory disease.[8,9]** **Studies also found associations between cardiovascular effects, including coronary vasoconstriction and**	**Traffic count is one indicator of the magnitude of emissions. A notable limitation with this method is the assumption of a uniform distribution within the buffer zone of vehicle class and emissions. Other variables including vehicle mix, vehicle speed, traffic flow, meteorology, built environment, and vegetation may cause considerable variation in exposure to emissions around roads.**

Indicator	Potential Data Source(s)	Data Collected and Analyzed?	Included in Draft DAC Criteria?	Rationale for Inclusion	Potential Limitations
				premature death from cardiovascular disease from diesel particulate matter exposure.[10]	
Diesel particulate matter concentrations	EPA EJScreen from EPA's National Air Toxics Assessment modeled annual average ambient concentrations based on emissions from 2014	Yes	No	Pollutant with health risks from heavy and medium duty on-road mobile sources and diesel-powered equipment.	Diesel exhaust is a mixture of particulate matter and gaseous pollutants for which a health-based air quality standard is difficult to develop. Because of uncertainties in the emission inventory development and errors identified by DEC staff, DEC recommends using proximity of trucks and buses as a surrogate for diesel exposures.
Formaldehyde concentration	EPA EJScreen from EPA's National Air Toxics Assessment modeled annual average ambient concentrations based on emissions from 2014	Yes	No	Known human carcinogen.[11] The use of alternate fuels such as compressed natural gas and ethanol has been shown to increase ambient concentrations of formaldehyde.	Formaldehyde is mostly a secondary formation from volatile organic compounds released from biogenic, industrial, and mobile sources. Formaldehyde is highly correlated with benzene. The emission inventory developed for formaldehyde is based on information which involves population density. Inclusion of this layer would be redundant.
Volatile organic compounds (VOCs)	Total VOCs are not monitored or modeled	No	No	VOCs are mixtures of non-harmful and harmful pollutants, some of which are associated with risks of central nervous system damage and cancer.[12]	VOCs do not have a health-based comparison value. Limited monitoring locations in the State for specific VOCs.
Ozone concentrations	EPA EJScreen (Office of Air and Radiation (OAR)) estimated 2016 concentrations using a Bayesian space-time downscaling fusion model)	Yes	No	Driver of asthma development.[13] Ozone is formed from VOCs in the presence of sunlight. The concentrations are higher downwind of the source or sources releasing VOCs (biogenic, industrial and mobile). Nitrogen oxides have a role in ozone chemistry.	Not a consistent measure of local (on-the-ground) air quality and could be from out of State sources. Ozone concentrations are generalized over a large area and not reflective of a local hotspot.
Sulfur oxides concentrations	DEC (monitored data)	No	No	Air pollutant associated with smelting sources, wood burning, high-sulfur fuel use, and some industrial sources, and associated with asthma risk.[14]	Little variation and low concentrations due to the requirement for low-sulfur fuels in New York State. Limited monitoring locations in the State.
Nitrogen oxides concentrations	DEC (monitored data)	No	No	Emitted by fuel combustion and is a criteria pollutant with a federal air quality standard; associated with asthma risk, acid rain, and respiratory infections.[15]	Nitrogen oxides play a role in ozone chemistry. Limited monitoring locations in the State.
Carbon monoxide concentrations	DEC (monitored data)	No	No	Pollutant monitored for population and near-road exposures due to associated risks of for people with heart disease[16]	Low carbon monoxide levels in the State, demonstrate attainment for this pollutant with the federal National Ambient Air Quality Standards. Limited monitoring locations in the State.
Woodsmoke emissions	NYSERDA spatial modeling of woodsmoke (2010)	No	No	Leading source of in-state $PM_{2.5}$ emissions in NY [17] and linked to premature deaths. Not captured by EJScreen's $PM_{2.5}$ data.	Sub-county data are not available.
Cancer risk from air toxics	EPA EJScreen from EPA's National Air Toxics Assessment modeled annual average ambient concentrations based on emission from 2014	Yes	No	Metric of cancer risk from continuous lifetime exposure via inhalation. Correlated with benzene and formaldehyde which are primary cancer risk drivers.	Not necessary to include due to correlation with benzene, which is included.

Indicator	Potential Data Source(s)	Data Collected and Analyzed?	Included in Draft DAC Criteria?	Rationale for Inclusion	Potential Limitations
Respiratory risk from air toxics (hazard index)	EPA EJScreen from EPA's National Air Toxics Assessment modeled annual average ambient concentrations based on emission from 2014	Yes	No	Represents the cumulative impacts of all the relevant air toxics for which respiratory effects were the key health effect.	Modeled rather than direct measurement. Estimate is a hazard quotient, which is the ratio of modeled air concentration to a chemical's health-based reference concentration. Not necessary to include because highly correlated with $PM_{2.5}$ and benzene.
Water Quality Exposures					
Proximity to wastewater discharge	**USEPA EJScreen Toxic Release Inventory (TRI) Risk Screening Environmental Indicators (RSEI)**	**Yes**	**Yes**	**Captures proximity and toxicity-weighted stream concentrations of pollutants with potential human health hazards.**	**The RSEI model calculates results for direct water releases from facilities to streams and waterbodies. The results may not represent actual population exposures. Individuals would need to come into contact with the contaminated water either by swimming or drinking the water.**
Impaired water bodies	New York State 2018 Section 303(d) List of Impaired/TMDL Water	No	No	Identified as medium priority by DEC staff.	Many decisions required on what suspected sources, causes, pollutants to include and how to weight. Deprioritized for draft scenarios.
Clean Watersheds Needs Survey	Did not pursue	No	No	Indicator of poor water quality	Not a direct measure of water quality
Combined sewer overflows (CSOs)	Did not pursue	No	No	Discharges from CSO outfalls may contain mixtures of domestic sewage, stormwater runoff, and sometimes, industrial wastewater, including high levels of suspended solids, toxic chemicals, floatable material and other pollutants. The outfalls contribute to water pollution in urban areas. The locations of CSOs indicate areas more prone to pluvial flooding (when rainfall intensity exceeds capacity of drainage system).	The presence of CSOs is not a direct measure of water quality and may not represent direct human exposure. Municipalities with CSO discharges are permitted by DEC and are subject to discharge control policies by USEPA. Communities with CSO systems prepare control plans to address discharges and comply with State and federal requirements. The amount and type of contaminants in the discharge are unknown and, if occurring, highly variable during a rain or snow event.
State Pollution Discharge Elimination System permits (SPDES)	Did not pursue	No	No	Indicator of potential sites of water pollution.	Not a direct measure of water quality. Does not represent direct human exposure. Individuals would need to come into contact with the contaminated water either by swimming or drinking the water.
NYSDOH fish consumption advisories	Did not pursue	No	No	Potential surrogate for water quality concerns	More direct water quality measures may be available. This may not be the best indicator for water quality exposures.
Concentrated animal feeding operations (CAFOs)	DEC	No	No	Toxic air pollutants (such as ammonia, hydrogen sulfide) and particles are released from CAFOs into the environment, and these operations can be a source of discharges to groundwater and surface waters.	Research has documented that CAFO emissions can negatively impact human health for individuals who work inside buildings with poor ventilation for extended periods of time. Less is known about the human health impacts on neighboring residents.
Per- and Polyfluoroalkyl Substances (PFAS)	Did not pursue	No	No	PFAS are a group of chemicals used to make coatings and products that resist heat, oil, stains, grease, and water. PFAS can be found in many common products such as water-repellent clothing, furniture, adhesives, paint and varnish, food packaging, and heat-resistant non-stick	Research is still ongoing to determine how different levels of exposure to different PFAS can lead to a variety of health effects. Research is also underway to better understand the health effects associated with low levels of exposure to PFAS over long periods of time, especially in children.

Indicator	Potential Data Source(s)	Data Collected and Analyzed?	Included in Draft DAC Criteria?	Rationale for Inclusion	Potential Limitations
				cooking surfaces. PFAS chemicals do not break down easily in the environment and can build up in the bodies of exposed animals and humans. Current scientific research suggests that exposure to high levels of certain PFAS may lead to adverse health outcomes.	Additionally, air, water and soil measurements of PFAS chemicals have been collected in communities where PFAS contamination has been identified but measurements are not routinely made and are not Statewide. Due to their widespread production and use, as well persistence in the environment, surveys conducted by the Centers for Disease Control and Prevention show that most people in the United States have been exposed to some PFAS.
Algal blooms in freshwater lakes	Did not pursue	No	No	Driver of water contamination.[18]	Data source unavailable at census tract geography level.
Other Exposures					
Childhood lead exposure	DOH Possible data sources to evaluate: https://health.data.ny.gov/Health/Childhood-Blood-Lead-Testing-and-Elevated-Incidenc/d54z-enu8	No	No	Studies show that no amount of lead exposure is safe for children. Even low levels of lead in blood can affect children's health including: reduced growth indicators; delayed puberty; lowered IQ; and hyperactivity, attention, behavior, and learning problems.	Data not available at census tract level.
Pesticide use	Did not pursue	No	No	Exposure to high levels of some pesticides can cause health effects.	Data available only for commercial permit holders who sell or offer for sale restricted use pesticides and those who sell agricultural pesticides. Data does not represent location of applied pesticides and therefore would not represent community exposures.
Noise pollution	Did not pursue	No	No	Can induce stress-related illnesses and lead to high blood pressure, hearing loss, sleep disruption and other health effects.[19]	No threshold for the determination of a health effect; noise is not measured on a routine basis. Could use surrogates such as proximity to railyards, airports, trucking routes/roadways.
Radon	Did not pursue	No	No	Radon exposure is directly linked to the incidence of lung cancer.	Data not available at the census tract level.
Factor #2: Land Use Associated with Historical Discrimination or Disinvestment					
Proximity to Former or Potential Hazards					
Proximity to remediation sites	**NYSDEC's database on the State's Brownfield Cleanup program and Class II, and federal environmental remediation sites (USEPA National Priority List) sites as of July 26, 2010**	**Yes**	**Yes**	**Some remediation sites may carry risk of air toxics within a certain radius, while others no longer pose a public health threat but may represent historical discrimination.**	**Does not consider dispersion and toxicity of pollutants and magnitude of emissions. Metric is based on counts of overlap between tract and a buffer around facility, but not degree of overlap.**
Proximity to risk management plan (RMP) sites	**USEPA EJScreen (RMP database) – count of facilities within 5 km, divided by distance and weighted by population**	**Yes**	**Yes**	**Facilities that use hazardous regulated chemicals - 72 substances because of their high acute toxicity and 60 because of their flammable or explosive potential.**	**While these data may not represent direct exposure, it does represent risk of exposure during accidental releases and that could be considered a disproportionate burden on a community.**
Proximity to power generation facilities	**NYSDEC 2019 fossil-fuel power generation facilities, including peakers, and EPA Emissions & Generation Resource Integrated Database (eGRID)**	**Yes**	**Yes**	**Studies have demonstrated health outcomes for residents near fossil-fuel fired power plants.[20, 21]**	**Captures location but does not consider dispersion and toxicity of pollutants and magnitude of emissions. Metric is based on counts of overlap between tract and a**

Indicator	Potential Data Source(s)	Data Collected and Analyzed?	Included in Draft DAC Criteria?	Rationale for Inclusion	Potential Limitations
					buffer around facility, but not degree of overlap.
Proximity to major oil storage facilities	**NYSDEC major oil storage facilities as of July 20, 2010 (NYSDEC, 2010).**	**Yes**	**Yes**	**These types of facilities process large quantities of petroleum products and could be a source of hazardous air pollutants. Siting may represent historical discrimination, and burden due to truck traffic, noise, and potential past exposures.**	**Does not consider type of petroleum product stored, dispersion and toxicity of pollutants and magnitude of emissions. Metric is based on counts of overlap between tract and a buffer around facility, but not degree of overlap.**
Proximity to active landfills	**Locations of active landfills operating in 2021, obtained from NYSDEC's Division of Materials Management (NYSDEC 2021).**	**Yes**	**Yes**	**Community burdens in line with national EJ movement which found siting of waste sites predominately in EJ neighborhoods.[22] Odors and the presence of waste may affect the health and quality of life.[23]**	**Community burden without known exposures. Proximity indicator does not consider movement of pollutants from the landfill (either by water or air), toxicity of pollutants and magnitude of releases. Metric is based on counts of overlap between tract and a buffer around facility but not degree of overlap.**
Proximity to scrap metal processing and vehicle dismantlers	**Locations of active vehicle dismantlers and scrap metal processing facilities operating in 2021, obtained from NYSDEC's Division of Materials Management (NYSDEC 2021).**	**Yes**	**Yes**	**Community burdens from fires, smoke, dust, noise, and odors. Studies have documented higher levels of metals outside some facilities. Studies have found elevated metals in communities near scrap metal processors.[24,25]**	**Community burden without known exposures. Proximity indicator does not consider dispersion and toxicity of pollutants and magnitude of emissions. Metric is based on count within tract.**
Proximity to municipal waste combustors	**Locations of active municipal waste combustors operating in 2021, obtained from NYSDEC's Division of Materials Management (NYSDEC 2021).**	**Yes**	**Yes**	**Community complaints of fires, smoke, dust, noise, and odors from scrap metal processing facilities are common.**	**Community burden without known exposures. Proximity indicator does not consider dispersion of pollutants from, toxicity of pollutants and magnitude of releases. Municipal waste combustors are highly regulated with strict emission requirements. Metric is based on counts of overlap between tract and a buffer around facility but not degree of overlap.**
Proximity to National Priority List (NPL) Sites (Superfund sites)	USEPA EJScreen (Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) database) count of sites within 5 km of the census tract, divided by distance and weighted by population	Yes	No	Represents remediation sites that EPA has designated as most hazardous and priority for cleanup.	Most if not all NPL sites are already included in this indicator, Proximity to State and federal environmental remediation sites (EPA National Priority List and DEC Brownfield and Class II sites).
Proximity to Hazardous Waste Management Facilities (treatment, storage, disposal facilities; TSDFs)	USEPA EJScreen (RCRAInfo Database)	Yes	No	Improper handling, storage, or accidental releases of hazardous waste at these facilities could lead to community exposures. Research suggests these facilities are disproportionately located in low income and minority communities.[26]	DEC staff identified issues with these data and thought the discrepancies found provided unreliable information. For example, both permitted and non-permitted hazardous waste generators are included and given the same weight. A non-permitted generator would be a pharmacy with nicotine patches onsite. Additionally, staff were uncertain that every hazardous waste generator was included in EPA's data.
Facilities with Hazardous Waste Reduction Plan	NYSDEC	No	No	Improper handling, storage, or accidental releases of hazardous waste at these facilities could lead to community exposures.	*Proximity to Risk Management Plan Sites* and *Proximity to Wastewater Discharge Facilities* are better indicators of risk from sites handling waste. Inclusion of Facilities with Hazardous Waste Reduction Plans would be redundant.
Proximity to air toxic release	NYSEPA Toxic Release Inventory (TRI)	No	No	Point source of air toxic emissions associated with an increased risk of	Due to reporting criteria of minimum number of employees, specific industry sector, and chemical

Indicator	Potential Data Source(s)	Data Collected and Analyzed?	Included in Draft DAC Criteria?	Rationale for Inclusion	Potential Limitations
				adverse health outcomes.	threshold criteria, these data do not represent a complete inventory of sources releasing air toxics. Reporting metrics are binned. These sources are already included in benzene NATA and $PM_{2.5}$ modeling results. Proximity indicator does not consider dispersion and toxicity of pollutants and magnitude of emissions.
Proximity to peaker plants only	NYSDEC	No	No	Localized, point source of air pollution emissions with high short-term emissions impacts with associated health risks.	Covered by Proximity to power generation facilities burning fossil fuel, includes peaker units, and therefore not needed separately.
Waste Transfer Stations	NYSDEC	No	No	May be seen as disamenity by neighbors.	Community burden without known exposures. DEC receives fewer complaints about transfer stations than other larger, waste handling facilities.
Disinvestment and Discrimination					
Industrial, mining, and manufacturing land area	**HCR (NYS); PLUTO (NYC)**	**Yes**	**Yes**	**Siting may represent historical discrimination and there is an increased risk of air and water contamination.**	**Not all areas represent exposures, risks, or threats.**
Vacant housing units	**2019 ACS 5-year DP024**	**Yes**	**Yes**	**Represents community outmigration, affordability, and disinvestment.**	**n/a**
Indigenous/Indian Nation territory	**Census (federally-designated reservation); DEC (Nation-owned land parcels outside of reservations)**	**Yes**	**Yes (all 19 tracts automatically included)**	**Territories ("reservations") are the locations of Indigenous communities and generally include both low-income populations and environmental burdens because of colonial practices.**	**Not all Indigenous communities are the same, and different communities have different histories. Some may not have environmental burdens, and others may not have low-income populations. However, all Native people within the United States have experienced colonial practices resulting in ethnocide, genocide, and attacks to political sovereignty.** **Additionally, Indigenous/Indian Nations are political sovereigns, and the State relates to the Nations on a government-to-government basis with appropriate leadership, rather than on an individual level.**
Public utility and waste treatment land area	HCR (NYS); PLUTO (NYC)	Yes	No	Siting may represent historical discrimination, and there is an increased risk of air, soil, and water contamination.	Not all areas represent exposures, risks, or threats. May be duplicative/redundant with other waste-related indicators.
Bank branches in area	NYS GIS (Federal Deposit Insurance Corporations data)	Yes	Yes	Access to banks represents the legacy of redlining and systemic present-day disinvestment.	Less direct measure of redlining than *Historical Redlining Score*.
Mortgages to people of color	Did not pursue	No	No	Home ownership represents the legacy of redlining and systemic present-day disinvestment.	Captured by Census data on renters and race/ethnicity (mortgage discrimination means more renters).
Unbanked or underbanked households	FDIC	No	No	Access to banks represents the legacy of redlining and systemic present-day disinvestment.	Data source unavailable at census tract geography level.
Brownfield Opportunity Areas	NYS DOS	Yes	No	Represents property affected by real or perceived environmental contamination.	Not necessary because remediation sites are included. BOAs are identified through a self-nomination process (in addition to income level).

Indicator	Potential Data Source(s)	Data Collected and Analyzed?	Included in Draft DAC Criteria?	Rationale for Inclusion	Potential Limitations
Transportation land area	HCR (NYS); PLUTO (NYC)	Yes	Yes	Siting may represent historical discrimination and there is an increased risk of air and water contamination.	Upon review, land use codes do not cover some large transportation facilities, which may be classified elsewhere (e.g., as public utility or industrial use).
Displacement or Out-Migration	Census (but not at tract level)	No	No	Capture forced migration from EJ community due to threats of burdens (e.g., climate, gentrification).	Unable to know the starting place of a migrant population with available data; meaningful migration data is county-level. While possible to capture net migration by census tract, difficult to assess whether a net decrease or increase is a burden.
In-migration / Gentrification	Census (but not at tract level)	No	No	Capture potential burdens on community due to gentrification or threats in other areas (e.g., climate migration from higher-risk risk).	Unable to know the starting place of a migrant population with available data; meaningful migration data is county-level. While possible to capture net migration by census tract, difficult to assess whether a net decrease or increase is a burden.
Factor #3: Climate Risks and Land Use Affecting Climate Vulnerabilities					
Flooding, Storm Surge and Sea Level Rise					
Flooding in coastal and tidally influenced areas (projected)	**NYSDOS**	**Yes**	**Yes**	**Combines federal flooding flood risk mapping to represent total area at risk with risk of infrastructure and land damage. Projections to 2100 account for sea level rise.**	**Though projections are useful for identifying future risk areas, there is uncertainty in forecasting models.**
Flooding in inland areas (projected)	**Modeled from National Center for Atmospheric Research (NCAR)**	**Yes**	**Yes**	**Represents potential economic damage from flooding. Projections to 2090 account for climate change scenario (middle of the road emissions scenario).**	**Though projections are useful for identifying future risk areas, there is uncertainty in forecasting models.**
Pluvial flooding (flash and surface flooding)	First Street Foundation https://floodfactor.com/	No	No	Flooding independent of rivers, streams and coastline is increasing from extreme and high-volume rainfall, and can be deadly for people in substandard housing including basement apartments and mobile homes. Represents risk of flash floods and surface water flooding associated with extreme precipitation outside mapped coastal and inland floodplains, as well as risk of damages and deaths from associated tropical storms and hurricanes	Data (outside of NYC) not available. First Street Foundation (FSF) has estimated current and future combined risk of fluvial, pluvial, tidal and surge flooding at 30m resolution. Only combined risk for residential properties is available on website, but data on pluvial risk may be available through arrangement with FSF. See https://firststreet.org/data-access.
Damage ratio of coastal flooding	FEMA National Risk Index for Natural Hazards (NRI)	Yes	No	Represents risk of infrastructure damage, as well as health risks associated with living in a saturated home.	Based on past damage, which may not reflect extent of climate change risk. State agency staff prefer NYSDOS metric.
Damage ratio of riverine flooding	FEMA NRI	Yes	No	Represents risk of infrastructure and land damage, as well as health risks associated with living in a saturated home.	State agency staff prefer custom metric using FEMA floodplain + 100-year-flood return interval.
Land area (or housing units) in flood zone	FEMA, or NYU Furman Center	No	No	Represents potential economic damage from flooding.	Captured by NYSDOS coastal hazard risk areas.
Sea level rise (historic or projected)	NYSERDA ClimAID models	No	No	Represents risk of infrastructure and land damage.	Captured by *Flooding in coastal and tidally influenced areas* ,which accounts for sea level rise, among other factors. Comparability to other metrics depending on

Indicator	Potential Data Source(s)	Data Collected and Analyzed?	Included in Draft DAC Criteria?	Rationale for Inclusion	Potential Limitations
					time horizon of chosen projection.
Other Extreme Weather					
Susceptibility to extreme weather	NREL	Yes	No	Measure of risk of infrastructure and land damage from cyclones, droughts, and floods.	This is not a continuous variable, but rather, an index created from modeling. Individual indicators may better represent regional and local differences in climate risks.
Damage ratio of strong winds	FEMA NRI	Yes	No	Represents risk of agricultural and infrastructure damage.	Based on past damage, which may not reflect extent of future climate change risk.
Damage ratio of ice storms	FEMA NRI	Yes	No	Represents risk of infrastructure damage and unsafe home conditions.	Based on past damage, which may not reflect extent of future climate change risk.
Damage ratio of droughts	FEMA NRI	Yes	No	Represents risk of agricultural losses.	Only calculated for agricultural land, though droughts can have non-agricultural impacts. Based on past damage, which may not reflect extent of future climate change risk.
Heat Island and Extreme Heat					
Projected high temperature (90+) days	**New York Climate Change Science Clearinghouse (NYCCSC)**	**Yes**	**Yes**	**Contributor to ozone formation. Driver of heat vulnerability and its associated health risks including aggravated asthma and heat related hospitalizations. Risk to agriculture.**	**Considered, but did not try to forecast, the number of heat waves (consecutive 90+ degree days).**
Low vegetative cover	**USGS National Land Cover Database**	**Yes**	**Yes**	**Driver of heat vulnerability and its associated health risks including aggravated asthma and heat related hospitalizations.**	**Some areas without vegetative cover may still have natural cover like sand rather than developed land. Does not account for protective effect of open water.**
Agricultural land use	**USGS National Land Cover Database**	**Yes**	**Yes**	**Represents potential risk to agriculture productivity and rural and migrant population due to climate change.**	**n/a**
Current number of high temperature (90+) days	New York Climate Change Science Clearinghouse (NYCCSC) (1980-2020)	Yes	No	Driver of ozone. Driver of heat vulnerability and its associated health risks including aggravated asthma and heat related hospitalizations. Risk to agriculture.	Current state may not reflect future risks -Staff recommend projections.
Housing density	2019 ACS 5-year S2501, NYS GIS shapefiles	Yes	No	Driver of heat vulnerability and its associated health risks including heat related hospitalizations.	Not necessary to include because of high correlation with *vehicle traffic density*, $PM_{2.5}$ (modeled on density), *benzene concentration* (modeled on density), and *vegetative cover*.
Housing stock (single family, multifamily)	Census data	No	No	Driver of heat vulnerability and its associated health risks including heat related hospitalizations.	Correlated with *housing density.*
Developed land	USGS National Land Cover Database	Yes	Yes	Driver of heat vulnerability and its associated health risks including heat related hospitalizations.	Correlated with vegetative cover, and vegetative cover also reflects green space.
Green space per capita	EnviroAtlas	Yes	No	Driver of heat vulnerability and its associated health risks including heat related hospitalizations.	Correlated with vegetative cover and vegetative cover is more commonly used to represent heat island effect.
Limited water storage	None found at tract level	No	No	More limited access to fresh water for those with well water, small public water supply, and in drought prone areas.	Could not locate suitable data source.
Percent of workforce in agricultural jobs /	Bureau of Labor Statistics	No	No	Represents potential risk to rural and migrant	Not available at census tract level. Using agricultural land

Indicator	Potential Data Source(s)	Data Collected and Analyzed?	Included in Draft DAC Criteria?	Rationale for Inclusion	Potential Limitations
Percent of economy from agricultural industry				population due to climate change.	use instead for geographic granularity.
Proximity to Services **(Note: Availability of a private care and internet access are included in Vulnerabilities)**					
Drive time to healthcare facilities	**NYSDOH and Oak Ridge National Laboratory (ORNL)**	**Yes**	**Yes**	**Local access to healthcare is a social determinant of health.[27]** **Captures burden of long distances/drive times in more rural areas.**	**Does not account for traffic or public transportation options.**
Public transportation	EPA Smart Location Database	Yes	No	Driver of access to economic opportunities and resources and a social determinant of health.[28]	Missing statewide transportation system coverage; only includes transit in NYC area, Albany, Buffalo, Syracuse. Missing data too significant to include.
Walkability	EPA Smart Location Database	Yes	No	Driver of access to economic opportunities and resources and a social determinant of health.	Measured as intersection density, which may not reflect a walkable neighborhood in some areas. Data appeared to have extreme outliers.
Distance to food stores (or low access/food deserts)	USDA ERS	Yes	No	Availability of healthy foods is a social determinant of health. Representation of urban vs. rural disadvantage.	This indicator uses a binary approach to flag low access areas across the state. It is a static distance threshold for both rural and urban areas, with alignment needed on either the appropriate threshold for different regions or the creation of a continuous variable.

Indicators Considered to Represent Population and Health Vulnerabilities

Bolded indicators are included in draft scenarios. All others were considered but not currently included (though they may be similar to, or correlated with, included indicators).

Table 11. Indicators Considered to Represent Population and Health Vulnerabilities

Indicator	Potential Data Source(s)	Data Collected and Analyzed?	Included in Draft DAC Criteria?	Rationale for Inclusion	Potential Limitations
Factor #1: Income, Education and Employment					
Income					
Population earning less than 80% of Area Median Income	**Housing and Urban Development (from Census data)**	**Yes**	**Yes**	**Common income threshold for NYS program eligibility. Income may affect rates of disease, health outcomes, and access to medical care.[29] Normalized by household size.**	**Does not capture extreme poverty (therefore we recommend including <100% FPL as well)**
Population at or below 100% Federal Poverty Level	**2019 ACS 5-year C17002**	**Yes**	**Yes**	**Economic stability is a social determinant of health.[30] Normalized by household size. This is a lower income threshold than <80% AMI to capture living conditions and burdens of higher poverty.**	**Indexed to a federal level rather than regional (therefore we recommend including <80% AMI as well)**
Single parent households	**2019 ACS 5-year DP02**	**Yes**	**Yes**	**Associated with lower income and childhood poverty. Represents susceptibility to power outages and**	**n/a**

Indicator	Potential Data Source(s)	Data Collected and Analyzed?	Included in Draft DAC Criteria?	Rationale for Inclusion	Potential Limitations
				emergency situations due to extreme weather events.	
Median income	2019 ACS 5-year B19013	Yes	No	Income may affect rates of disease, health outcomes, and access to medical care.	Not normalized by area or household size (whereas <80% area median income accounts for both, and <100% FPL accounts for household size.
Tract median income as a percent of area median income	Census	No	No	Income may affect rates of disease, health outcomes, and access to medical care.	Data source unavailable at census tract geography level. Not necessary after including *Population earning less than 80% AMI* indicator.
HUD Qualified Census Tracts	HUD	Yes	Yes	Represents community-level economic and social disadvantage.	Binary metric that includes income and poverty rates, which are already included.
Household savings	Did not pursue	No	No	Represents systemic racism in wealth-building, and potential burden of financial insecurity.	Data source unavailable at census tract geography level.
Access to capital	FDIC	No	No	Represents systemic racism in wealth-building, and potential burden of financial insecurity.	Data source unavailable at the census tract geography and correlated with unbanked and underbanked population.
High debt burden	Did not pursue	No	No	Represents financial security and risk of poverty.	Data source unavailable at census tract geography level.
Ability to pay index	National Renewable Energy Lab (NREL)	Yes	No	Proxy for available household budget, representing financial security and risk of poverty.	Modeled metric with a higher weight on income than on housing costs. Not necessary after including several income, rental cost burden and energy burden indicators.
Income constrained population	Asset Limited, Income Constrained, Employed (ALICE)	No	No	Represents financial security and risk of poverty.	Data source unavailable at census tract geography level. Not necessary after including other income indicators.
Income inequality	Did not pursue	No	No	Represents community-level economic and social disadvantage.	Data source unavailable at census tract geography level.
Child poverty rate	2019 ACS 5-year S1701	Yes	Yes	Economic stability is a social determinant of health and may indicate disadvantage in long term quality of life outcomes.	Not necessary after including population poverty rate and single-parent households.
Free or reduced-price lunch recipients	NYS Department of Education	Yes	No	Represents low-income populations and risk of food security, which is a social determinant of health.[31]	Less direct measure of income than other included income indicators. Requires transformation from city and town or school geography basis to the census tract level.
Education					
Adults without a bachelor's degree	**2019 ACS 5-year B15003**	**Yes**	**Yes**	**Education is a social determinant of health, and represents systemic educational disadvantage, long term income potential, long term health, and lifespan.**	**n/a**
Adults without a high school diploma	2019 ACS 5-year S1501	Yes	No	Education is a social determinant of health,[32] and represents systemic educational disadvantage, long term income potential, long term health, and lifespan.	Not necessary after including percentage of adults without bachelor's degree.
School class size	NYS Department of Education	Yes	No	Represents underinvestment in schools and faculty, and educational disadvantage.	Not as direct a measure of income or SES as other proposed metrics. Requires transformation from city and town or school geography basis to the census tract level.

Indicator	Potential Data Source(s)	Data Collected and Analyzed?	Included in Draft DAC Criteria?	Rationale for Inclusion	Potential Limitations
School closings	Did not pursue	No	No	Represents outmigration from rural areas and disinvestment in education.	Data not available consistently throughout the state.
Employment					
Unemployment rate	**2019 ACS 5-year B23025**	**Yes**	**Yes**	**Indicator of economic stability, risk of poverty, and access to health care.**	**n/a**
Free or reduced-price lunch recipients	NYS Department of Education	Yes	No	Represents low-income populations and risk of food security, which is a social determinant of health.[33]	Less direct measure of income than other included income indicators. Requires transformation from city and town or school geography basis to the census tract level.
Factor #2: Race, Ethnicity and Language					
Race and Ethnicity, and Country of Origin					
Historical Redlining Score (from 1930s redline)	**National Community Reinvestment Coalition (NCRC)**	**Yes**	**Yes**	**Starting in 1930s, mortgage lenders rated neighborhoods for lending risk, giving lower scores to areas with Black and lower-income residents. Significant literature shows persistent effects of this discrimination on segregation, neighborhood investment, inequality, vegetative cover and air quality.**	**Missing values for areas without scoring coverage.**
Black or African American population	**2019 ACS 5-year B02009**	**Yes**	**Yes**	**Historical discrimination on the basis of race. Indicator of health risk, pollution risk, heat vulnerability, and mortality rates.[34]**	**n/a**
Hispanic/Latino population	**2019 ACS 5-year B03003**	**Yes**	**Yes**	**Historical discrimination on the basis of ethnicity. Indicator of health risk, pollution risk, heat vulnerability, and mortality rates.**	**Broad definition of Latino/a population that does not capture unique experiences, burdens or vulnerabilities by culture or country of origin. However, more granular data is not reliable for small geographies.** **Underrepresents undocumented people due to census participation/eligibility and limitations in questions on ethnicity.[35]**
Asian and Asian American population	**2019 ACS 5-year B02011**	**Yes**	**Yes**	**Indicator of low English-speaking population[36, 37] Represents legacies of historical discrimination on the basis of race and ethnicity.**	**Census definition of Asian includes diversity of ethnicities, at diversity of income and education levels. However, more granular data is not reliable for small geographies.** **Highly correlated with language variables; language indicators may better capture vulnerabilities of some Asian and Asian American communities.**
American Indian, Alaska Native, Native Hawaiian or other Pacific Islander population	**2019 ACS 5-year B02010 and B02012**	**Yes**	**Yes**	**Indicator of health risk, pollution risk, and mortality rates.**	**Very few census tracts have high proportions of Native/Indigenous individuals, such that using percentile scores (as in our scoring system) does not effectively capture these communities.** **Staff is considering including Native/Indigenous land or territories more explicitly (outside of scoring)**
Non-White alone population (at least one race	2019 ACS 5-year B03002	Yes	Yes	Indicator of health risk, pollution risk, and mortality rates.	Too general of an indicator; CJWG prefers to represent racial and ethnic groups separately.

Indicator	Potential Data Source(s)	Data Collected and Analyzed?	Included in Draft DAC Criteria?	Rationale for Inclusion	Potential Limitations
other than white)					
Country of Origin among Hispanic/Latino Population	2019 ACS 5-year B03001	No	No	Country of origin may relate to different barriers or opportunities that people or communities experience, including discrimination on the basis of race or ethnicity.	This more granular data is not reliable for small geographies. May underrepresent undocumented people due to census participation/eligibility and limitations in Census questions on ethnicity.
Foreign-born population	2019 ACS 5-year B05002	Yes	Yes	May represent communication and access issues as language affects ability to seek and access energy solutions, medical care and social services.	Highly correlated with limited English Proficiency which more directly represents the concept.
Undocumented and unauthorized population	Did not pursue	No	No	This population is undercounted and may be vulnerable to extreme weather and housing insecurity.	Data source unavailable at census tract geography level.
Racially and Ethnically Concentrated Areas of Poverty (R/ECAP)	HUD	Yes	No	Indicator of health risk, pollution risk and mortality rates.	Modeled index metric Not necessary after including its components (income, race and ethnicity).
Language					
Limited English proficiency	**2019 ACS 5-year C16002**	**Yes**	**Yes**	**Language affects ability to seek and access energy solutions, medical care and social services; also serves to identify groups of people excluded from race and ethnicity indicators due to insufficient resolution.**	**n/a**
Language other than English spoken at home	2019 ACS 5-year S1601	Yes	No	Affects ability to seek and access housing, energy solutions, medical care and social services.	Correlated with Limited English Proficiency, which may be a stronger indicator of communication challenges with respect to climate and energy investments.
Linguistically isolated	EPA EJScreen (ACS 5-year)	Yes	No	Affects ability to seek and access housing, energy solutions, medical care and social services.	Replaced with "Limited English Proficiency," which captures people's self-report of how well they speak English.
Policing and Incarceration					
Incarceration rates	Division of Criminal Justice Services	No	No	Systemic racism leads to higher policing and incarceration in some communities. Incarceration affects family financial insecurity, and long-term family unit disadvantage for children, which is a social determinant of health.[38]	Data source unavailable at census tract geography level (though future improvements could request and process data to census tract level).
Shooting or deaths by police officers	Division of Criminal Justice Services	No	No	Could capture systemic racism in policing.	Data source unavailable at census tract geography level (though future improvements could request and process data to census tract level).
Factor #3: Health Outcomes and Healthcare					
Health Outcomes					
Asthma Emergency Department Visits	DOH	Yes	Yes (emergency department visits only)	Multifactorial disease for which incidence or exacerbation has been linked with environmental	Asthma is a multifactorial disease with many potential causes. ED visits don't capture asthma that is managed in a primary care setting. Need to

Indicator	Potential Data Source(s)	Data Collected and Analyzed?	Included in Draft DAC Criteria?	Rationale for Inclusion	Potential Limitations
				exposures. Managing asthma is linked with socioeconomic status and healthcare access. Outdoor and indoor air pollution can affect asthma (*e.g.*, ozone and particulate matter) and increase visits to emergency departments. Heat stress has also been shown to be associated with complications of lung disease such as asthma.	aggregate over time and space for rate stability and confidentiality. NYS residents seeking care in other states may not be counted. This may especially impact aggregated areas that border another state.
COPD Emergency Department Visit	DOH	Yes	Yes	COPD refers to a group of severe lung diseases that includes chronic bronchitis and emphysema. Managing COPD is linked with socioeconomic status and healthcare access. People who have COPD may be more vulnerable to the impacts of heat.	Although there is insufficient information to determine a causal relationship, outdoor air pollution, as well as tobacco and biomass smoke exposures are considered environmental factors contributing to the development and progression of COPD. Need to aggregate over time and space for rate stability and confidentiality. NYS residents seeking care in other states may not be counted. This may especially impact aggregated areas that border another state.
Myocardial Infarction (MI; heart attack) hospitalization	DOH	Yes	Yes	Myocardial Infarction (MI) or "heart attack," is caused by coronary artery disease. According to the USEPA, the evidence for associations between fine PM exposure and cardiovascular morbidity has grown, while the results from studies are not entirely consistent, epidemiological studies report positive associations with ischemic heart disease and MI. People who experience a MI may subsequently be more vulnerable to the impacts of heat.	Only captures hospitalization for MI, not broader cardiovascular or heart disease that may affect more people. Need to aggregate over time and space for rate stability and confidentiality. NYS residents seeking care in other states may not be counted. This may especially impact aggregated areas that border another state.
Premature Deaths	DOH	Yes	Yes	Preventive interventions around certain factors related to premature death could lead to improvement on this indicator. Could also be indicator that reflect historical policy decisions. USEPA's primary National Ambient Air Quality Standard for	Need to aggregate over time and space for rate stability and confidentiality. NYS residents who died in other states may not be counted.

Indicator	Potential Data Source(s)	Data Collected and Analyzed?	Included in Draft DAC Criteria?	Rationale for Inclusion	Potential Limitations
				PM is based on premature mortality.	
Low birthweight births	DOH	Yes	Yes	Broadly represents maternal health, which is a factor of environmental, social, and structural factors and policies. Some studies have found associations between temperature extremes, particulate matter, ozone and low birth weight births, although further research is necessary to confirm that relationship.	Need to aggregate over time and space for rate stability and confidentiality. NYS residents who died in other states may not be counted.
Population with a disability	**2019 ACS 5-year B18101**	**Yes**	**Yes**	**Represents susceptibility to power outages and emergency situations due to extreme weather events as well as heat vulnerability**	**n/a**
Population over age 65	**2019 ACS 5-year S0101**	Yes	Yes	**Represents susceptibility to power outages and emergency situations due to extreme weather events as well as heat vulnerability**	**n/a**
COVID-19 cases	DOH Possible data sources to evaluate: New York State Statewide COVID-19 Admissions by Zip Code (https://health.data.ny.gov/Health/New-York-State-Statewide-COVID-19-Admissions-by-Zi/kmxh-hz9i)	No	No	If available, COVID-19 burden could be an indicator of vulnerabilities and cumulative impacts. Some of the socioeconomic and health indicators already included may represent or approximate vulnerabilities to COVID-19.	Data not available at census tract level. Suitability for identifying DACs is unclear. Case counts for small geographies may reflect variation in test availability and testing over the course of the pandemic, adherence to other public health recommendations (e.g. vaccination, masking and social distancing), and time period represented by the data (which could reflect localized community cluster for a particular time period).
Diabetes	DOH Possible data sources to evaluate: Medicaid 3M Clinical Risk Group chronic disease data (ZIP code level) CDC modeled diabetes data	No	No	Represents a chronic health condition that requires regular access to healthcare and may be exacerbated by climate change. Correlated with sociodemographic indicators.	Data not available at census tract level.
Premature births	DOH	No	No	Represents maternal health, which is a factor of environmental, social, and structural factors and policies.	Data not available at census tract level.
Infant mortality	DOH	No	No	Represents maternal health, which is a factor of environmental, social, and	Data not available at census tract level. Relatively small numbers raise confidentiality concerns.

Indicator	Potential Data Source(s)	Data Collected and Analyzed?	Included in Draft DAC Criteria?	Rationale for Inclusion	Potential Limitations
				structural factors and policies.	
Cancer incidence rates	Available data sources: National Environmental Public Health Tracking program posting subcounty cancer data in 1st half of 2022. Environmental Facilities and Cancer Mapping Application	No	No	Significant burden associated with care and treatment of cancer. Environmental and occupational links with some cancers.	Cancer is a common outcome. Cancers are multifactorial and represent a range of diseases. Variation in environmental-relatedness of certain cancers. Total cancer incidence reflects a mix of specific cancer types that show both a positive and negative correlation with socioeconomic status.
Heat-related ED visits, hospitalization, or deaths	DOH	No	No	Represents direct, health-related health effects of hot temperature days, which is a product of the surrounding environment and global warming.	Data not available at census tract level. Relatively small numbers mean raise confidentiality concerns and potential that data would be unstable/unreliable at small geographies.
Mental health	None found at tract level	No	No	Represents susceptibility to power outages and emergency situations due to extreme weather events as well as access to health care and medications.	Data unavailable at census tract level. Mental health not well-captured in DOH ED visits & hospitalization; would only see co-occurring ICD-9 codes. Clinic/pharmacy data may better capture mental illnesses.
Households with chronically ill people	Census microdata	No	No	Represents susceptibility to power outages and emergency situations due to extreme weather events.	Requires census microdata, which is less statistically stable than census data.
Cigarette smoking	DOH	No	No	Represents a chronic health risk behavior that leads to a need for healthcare especially in rural counties of NYS.	Data unavailable at census tract level.
Vector-borne illness	DOH	No	No	Vector-borne illnesses like Lyme disease and West Nile virus are expected to increase in future years due to climate change.	Data unavailable at census tract level.
Air conditioning availability	DOH	No	No	Access to a spot to cool-off can decrease the potential for heat-related illness	Data unavailable at census tract level.
Population under age 6	2019 ACS 5-year S1101	Yes	No	Potential vulnerability to heat, power outages or emergency situations due to extreme weather events.	May not be necessary after including single-parent households (which has stronger income correlation and may be a better indicator of children's vulnerabilities to climate events).
Healthcare and Health Access					
Percent of population without health insurance	**2019 ACS 5-year B28002**	**Yes**	**Yes**	**Represents access to screening, ability to manage conditions, affordable care.** **May indicate structural and**	**n/a**

Indicator	Potential Data Source(s)	Data Collected and Analyzed?	Included in Draft DAC Criteria?	Rationale for Inclusion	Potential Limitations
				socioeconomic disadvantage.	
Doctor visits in past 12 months	None found at tract level	No	No	Represents access to affordable healthcare services and may indicate structural and socioeconomic disadvantage.	Data source unavailable at census tract geography level.
Percent of population without primary care physician	None found at tract level	No	No	Represents access to affordable healthcare services and may indicate structural and socioeconomic disadvantage.	Data source unavailable at census tract geography level.
Factor #4: Housing, Mobility and Communications					
Renters and Rental Costs					
Rented housing units	**2019 ACS 5-year B25003**	**Yes**	**Yes**	**Rented housing units**	**2019 ACS 5-year B25003**
Rent as percent of income	**2019 ACS 5-year B25070**	**Yes**	**Yes**	**Represents financial stability and stress.** **May capture regional income inequality.** **May capture lower-income renters.**	**n/a**
Ownership costs as percent of income	2019 ACS 5-year B25092	Yes	Yes	Represents home ownership potential and community investment	Only applicable to homeowners; where homeownership rates are low, this may not reflect housing cost burden well.
Rate of rent increase	None found at tract level	No	No	Represents disparities in the change of cost burden over time.	Data source not available at the census tract geography level.
Ability to pay index	National Renewable Energy Lab (NREL)	Yes	No	Proxy for available household budget, representing financial security and risk of poverty.	Modeled metric with a higher weight on income than on housing costs.
Proximity to Former or Potential Hazards					
Homes built before 1960	**EPA EJScreen (2017 ACS 5-year B25034)**	**Yes**	**Yes**	**Associated with lead-based paint risk in un-remediated homes (with risk of neurological damage in children).**	**Renovations/remediation in some areas affect presence and risk of lead-based paint (i.e., age of homes may no longer reflect risk). Remediation is highly regionalized so the same percentage of older homes in one area may represent less risk than in another.**
Energy and Energy Costs					
Energy cost burden (energy costs as a percentage of income) affordability	**DOE Low Income Affordability Data (LEAD) Tool**	**Yes**	**Yes**	**Energy cost burden (energy costs as a percentage of income) affordability**	**DOE Low Income Affordability Data (LEAD) Tool**
Manufactured and mobile homes	**2019 ACS 5-year B25024**	**Yes**	**Yes**	**Driver of property risk in storms/natural disasters and associated with health risks from mold and mildew; represents energy inefficient housing and high energy costs.**	**n/a**
Air conditioning availability	None found at tract level	No	No	Driver of heat related emergency department visits and hospitalizations.	Data source unavailable at census tract geography level.
Primary heating fuel	2019 ACS 5-year B25040	Yes	No	Indicator of indoor air quality from emissions from heating.	Census data has primary heating fuel only but not secondary, which could include woodsmoke or other fuels with negative health effects.
Sick buildings	Did not pursue	No	No	Toxins, mold, and allergens in buildings, from outdoor and indoor sources, can affect occupant health.[39]	No single data source available, though several included indicators capture risk factors (e.g., mold/moisture problems, indoor air quality, proximity to remediation sites and other regulated facilities, age of home).

Indicator	Potential Data Source(s)	Data Collected and Analyzed?	Included in Draft DAC Criteria?	Rationale for Inclusion	Potential Limitations
Power shutoffs	Electric service providers across state	No	No	Represents risk of energy insecurity and indicator of financial insecurity.	Data source unavailable at census tract geography level.
Internet and Communications					
Households without access to internet or without a subscription	**2019 ACS 5-year B28002**	**Yes**	**Households without access to internet or without a subscription**	**2019 ACS 5-year B28002**	**Yes**
Households without cell service	Did not pursue	No	No	Represents resiliency to emergency situations due to extreme weather events.	Data source unavailable at census tract geography level.
Monthly cost of home internet or cell service	Did not pursue	No	No	Represents resiliency to emergency situations due to extreme weather events.	Data source unavailable at census tract geography level.
Vehicle Access					
Households without a private vehicle	2019 ACS 5-year S2504	Yes	Yes	Households without a private vehicle	n/a

Heat Vulnerability

One of the three pillars of DAC criteria mentioned in the Climate Act is *"Areas vulnerable to the impacts of climate change such as flooding, storm surges, and urban heat island effects."*

Indicators selected for the DAC criteria include numerous vulnerabilities to increased temperatures and heat waves expected from climate change, including but not limited to urban heat island effects. Sociodemographic and health vulnerabilities are included as well as geographic and environmental attributes that could create an urban heat island effect. Table 12 below lists vulnerabilities and risk factors cited in state, national and academic literature about the urban heat island effect and heat vulnerability. The draft DAC criteria include indicators representing nearly all factors, either directly or indirectly (e.g., through strong correlates).

Together, the included indicators identify the areas at greatest risk of urban heat island effect, as well as populations most at risk of heat stress, illness, and death during heat waves and extreme temperatures.

The CJWG recognizes that increases in deaths, hospitalizations, and emergency room visits occur during heat waves. According to the NYSDOH, "A 5°F change in temperature can double a New Yorker's risk of heat-related illness." While some emergency department visits, hospitalizations, and deaths may be classified as heat-related, others may present as health problems including dehydration, confusion, dizziness, fatigue, nausea, headaches, muscle cramps, strokes, and seizures (NYC Hazard Mitigation). High-risk populations include those over age 65, infants, children, those with chronic health conditions including mental illness, and those who work outdoors or do not have air conditioning in their homes (NYC DOH Extreme Heat). Additionally, an increase in body temperature is known to bring on labor, preterm birth or lower birth weight (NYC DOH Extreme Heat). Access to cool spaces is important in reducing the risk of heat-related illness. The NYS Office of Temporary and Disability Assistance (OTDA) provides cooling assistance to households meeting criteria related to income and documented medical conditions, among other factors.[20]

Compared to other causes of death, deaths classified as heat-related in New York State are relatively rare, and for confidentiality and data reliability/stability reasons, **data cannot be displayed statewide for subcounty areas.** Because geographic risk factors and health vulnerabilities vary so much within a county, the NYSDOH does not recommend including county-level rates, and instead, recommends using all of the indicators in Table 12 to capture heat vulnerability. While we are unable to include health outcomes directly (heat-related hospital admissions or deaths), together these indicators can highlight communities most at risk of elevated heat-related illnesses or deaths due to both geography and population vulnerabilities.

[20] https://otda.ny.gov/programs/heap/#cooling-assistance.

Table 12. Indicators Associated with Heat Vulnerability

Vulnerability	Source (referenced below)	Covered by DAC Indicators?	Notes
Sociodemographic Components of Heat Vulnerability			
Older adults	US EPA Climate Change and Heat Islands	Yes – Adults over age 65	
Young Children	US EPA Climate Change and Heat Islands	Partial – Single-parent households	This was selected rather than presence of children in general to reflect economic and mobility vulnerabilities as well
Low-income populations	US EPA Climate Change and Heat Islands NYCDOH HVI	Yes – Percent below 80% of AMI; Percent below 100% of Federal Poverty Lime	
People who work outdoors	US EPA Climate Change and Heat Islands	Partial – Agricultural land	Labor and employment data by sector is not available for small geographies so we recommend using agricultural land area to approximate agricultural workers. We do not have an option for construction, highway repair or other sectors with high outdoor exposure.
Race or ethnicity (Black and Hispanic/Latino)	NYCDOH HVI	Yes – Percent Black or African American; Percent Hispanic or Latino	In NYC, Black people die of heat-related illness at a disproportionately high rate (NYC DOH)
English proficiency and/or foreign-born	NYSDOH HVI NYSDOH Heat and Health	Yes – Percent with Limited English Proficiency (census)	
Health conditions or vulnerabilities	NYSERDA ClimAID CalEPA	Yes – Heart attacks, asthma and COPD hospitalization No – Diabetes	Underlying cardiovascular disease can interfere with a body's ability to regulate temperature in response to heat stress (ClimAID, 2014)
Disability Status	CalEPA	Yes - Percent with disabilities	
Mobility Constraints	NYSERDA ClimAID	Yes – Personal vehicle ownership	Access to public transportation or private vehicle associated with ability to seek alternative shelter or healthcare in extreme weather. Statewide data on access to public transportation is currently insufficient.
No air conditioning	US EPA Climate Change and Heat Islands NYCDOH HVI NYSDOH Heat and Health	Partial – Low income, renters, older housing	Air conditioning penetration is not available for smaller geographies, but lower-income households, rental units and older homes are less likely to have air conditioning.
Geographic and Environmental Components of Heat Vulnerability			
High temperatures	NYSERDA ClimAID NYCDOH HVI	Yes – Number of 90+ degree days expected in 2050	
Land Cover (vegetative cover vs. developed land)	NYSDOH HVI	Yes – Vegetative cover (inversely correlated with developed land), vehicle density	Several heat indices include either vegetative cover or green space. We included vegetative cover.
Housing density and developed land	NYSDOH HVI	Partial – Inversely correlated with vegetative cover, and highly correlated with	Other heat indices include developed land instead of vegetative or land cover. Several included variables are highly

		vehicle/traffic metrics, $PM_{2.5}$ and Benzene	correlated with density (and $PM_{2.5}$ and Benzene were modeled using density), so we did not include density separately.
Heat-absorptive surfaces	CalEPA	Yes – Vehicle traffic density and truck counts	The two vehicle indicators (vehicle traffic and truck counts) are correlated with roads as well
Air pollution exacerbated by temperature increases	NYSERDA ClimAID	Partial – $PM_{2.5}$ and Benzene	Did not include ozone because it is not a consistent measure of local (on-the-ground) air quality and could be from out of state sources. Ozone concentrations are generalized over a large area and not reflective of local hotspots.

For some purposes these indicators are combined into a Heat Vulnerability Index (in New York and elsewhere), heat vulnerability is only one of multiple burdens and vulnerabilities enumerated in the Climate Act for the DAC criteria. Many of the indicators relevant for heat vulnerability are also central to representing other aspects of environmental burden, climate change risk, sociodemographic or health vulnerabilities (addressing other aspects of DAC criteria). Therefore, we recommend including each of these indicators individually rather than combining them into an index to specifically represent heat vulnerability. For example, income, race, and ethnicity are key criteria for identifying communities that have historically experienced discrimination and pollution burden. Additionally, the New York State Heat Vulnerability Index is published at the county level, and the NYC Heat Vulnerability Index at the Neighborhood Tabulation Area level, both larger than census tracts.

Heat Vulnerability Sources:

California EPA. Understanding the Urban Heat Island Index. https://calepa.ca.gov/climate/urban-heat-island-index-for-california/understanding-the-urban-heat-island-index/

Hoffman et al. (2020). The Effects of Historical Housing Policies on Resident Exposure to Intra-Urban Heat: A Study of 108 US Urban Areas. https://www.researchgate.net/publication/338556690_The_Effects_of_Historical_Housing_Policies_on_Resident_Exposure_to_Intra-Urban_Heat_A_Study_of_108_US_Urban_Areas

Nayak et al. (2017). Development of a heat vulnerability index for New York State. https://reader.elsevier.com/reader/sd/pii/S003335061730327X

New York City Department of Health. Extreme Heat and Your Health. https://www1.nyc.gov/site/doh/health/emergency-preparedness/emergencies-extreme-weather-heat.page

New York City Department of Health. Heat Vulnerability Index. https://a816-dohbesp.nyc.gov/IndicatorPublic/HeatHub/hvi.html

New York City Hazard Mitigation. https://nychazardmitigation.com/hazard-specific/extreme-heat/what-is-the-risk/

New York State Department of Health. Heat and Health in New York State. https://www.health.ny.gov/publications/6636.pdf

New York State Department of Health. Heat Vulnerability Index for New York State. https://www.health.ny.gov/environmental/weather/vulnerability_index/

NYSERDA, 2014. Responding to Climate Change in New York State (ClimAID). Chapter 11: Public Health. https://www.nyserda.ny.gov/About/Publications/Research%20and%20Development%20Technical%20Reports/Environmental%20Research%20and%20Development%20Technical%20Reports/Response%20to%20Climate%20Change%20in%20New%20York

Rosenzweig, C., and W.D. Solecki, 2001: Climate change and a global city: Learning from New York. Environment, 43, no. 3, 8-18. https://pubs.giss.nasa.gov/docs/2001/2001_Rosenzweig_ro07800y.pdf

US EPA. Climate Change and Heat Islands. https://www.epa.gov/heatislands/climate-change-and-heat-islands

Indicators Included in CalEnviroScreen 4.0

California's Draft CalEnviroScreen 4.0 (June 2021) includes the following indicators to represent exposures, environmental effects, sensitive populations, and socioeconomic factors[21] :

- Pollution Burdens
    - Exposure Indicators
        - Air Quality: Ozone
        - Air Quality: $PM_{2.5}$
        - Diesel Particulate Matter
        - Drinking Water Contaminants
        - Children's Lead Risk from Housing (New in version 4.0)
        - Pesticide Use
        - Toxic Releases from Facilities
        - Traffic Impacts
    - Environmental Effects Indicators
        - Cleanup Sites
        - Groundwater Threats
        - Hazardous Waste Generators and Facilities
        - Impaired Water Bodies
        - Solid Waste Sites and Facilities
- Population Characteristics
    - Sensitive Population Indicators
        - Asthma
        - Cardiovascular Disease
        - Low Birth Weight Infants
    - Socioeconomic Factor Indicators
        - Educational Attainment
        - Housing-Burdened Low-Income Households

[21] https://oehha.ca.gov/media/downloads/calenviroscreen/presentation/calenviroscreen40webinarslidesd12021.pdf.

- Linguistic Isolation
- Poverty
- Unemployment

[1] US Environmental Protection Agency. *Integrated Science Assessment (ISA) for Particulate Matter (Final Report, Dec 2019)*. EPA/600/R-19/188.
[2] Baumann, L, et al. Effects of distance from a heavily transited avenue on asthma and atopy in a peri-urban shanty-town in Lima, Peru. Journal of Allergy Clinical Immunology. April 2012. 127(4):875-82.
[3] Health Effects Institute (HEI). Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects. Special Report 17, 2010.
[4] New York State Department of Environmental Conservation. Albany South End Community Air Quality Study, October 2019. https://www.dec.ny.gov/docs/air_pdf/albanysouthendreport.pdf
[5] Karner, A., Eisinger, D.S., Niemeier, D.A. Near-Roadway Air Quality: Synthesizing the Findings from Real-World Data. Environmental Science and Technology 44, 5334-5344. 2010.
[6] US Environmental Protection Agency (USEPA). Carcinogenic Effects of Benzene: An Update. April 1998. EPA/600/P-97/001F
[7] Agency for Toxic Substances and Disease Registry. Toxicological Profile for Benzene. August 2007. https://www.atsdr.cdc.gov/toxprofiles/tp3.pdf
[8] Brunekreef, Bert, et al., Air pollution from truck traffic and lung function in children living near motorways. Epidemiology. May 1997. 8(3). 298-303.
[9] McCreanor, James, et al. Respiratory effects of exposure to diesel traffic in persons with asthma. New England Journal of Medicine. December 2007. 357(23):2348-58.
[10] Krivoshto IN, Richards JR, Albertson TE, Derlet RW. The toxicity of diesel exhaust: implications for primary care. Journal of the American Board Family Medicine. January 2008. 21(1):55-62.
[11] National Cancer Institute. Formaldehyde and Cancer Risk. https://www.cancer.gov/about-cancer/causes-prevention/risk/substances/formaldehyde/formaldehyde-fact-sheet
[12] https://www.lung.org/clean-air/at-home/indoor-air-pollutants/volatile-organic-compounds
[13] https://www.epa.gov/ground-level-ozone-pollution/health-effects-ozone-pollution
[14] https://www.epa.gov/isa/integrated-science-assessment-isa-sulfur-oxides-health-criteria
[15] https://www.epa.gov/no2-pollution/basic-information-about-no2#What%20is%20NO2
[16] https://www.epa.gov/co-pollution/basic-information-about-carbon-monoxide-co-outdoor-air-pollution
[17] https://www.nyserda.ny.gov/-/media/Files/Publications/Research/Biomass-Solar-Wind/monitoring-residential-woodsmoke.pdf
[18] https://www.niehs.nih.gov/health/topics/agents/algal-blooms/index.cfm
[19] EPA, Clean Air Act Title IV – Noise Pollution. https://www.epa.gov/clean-air-act-overview/clean-air-act-title-iv-noise-pollution
[20] Liu, Xiaopng, et.al. Association between Residential Proximity to Fuel-Fired Power Plants and Hospitalization Rate for Respiratory Diseases. Environmental Health Perspectives. June 2012. 120(6):807 810.
[21] Liu, Xiaopng, et.al. Association between Residential Proximity to Fuel-Fired Power Plants and Hospitalization Rate for Respiratory Diseases. Environmental Health Perspectives. June 2012. 120(6):807 810.
[22] Ahmed, Amal, Civil Rights: Robert Bullard isn't Done yet. 2021. Texas Observer. May 3, 2021. Online. https://www.texasobserver.org/robert-bullard-isnt-done-yet/, accessed January 18, 2022.
[23] Heaney, C, et al. Relation between malodor, ambient hydrogen sulfide, and health in a community bordering a landfill. Environmental Research. August 2011. 111(6): 847-852.
[24] Han, I., et al., Evaluation of metal aerosols in four communities adjacent to metal recyclers in Houston, Texas, USA. Journal of the Air & Waste Management Association. May 2020. 70(5) 568-579.
[25] Folarin, S., Thompson, S. Spatial Analysis of Heavy Metal Emissions in Residential, Commercial and Industrial Areas Adjacent to a Scrap Metal Shredder in Winnipeg, Canada. Journal of Geoscience and Environment Protection. May 2020. 8:359-386.
[26] U.S. General Accounting Office, Siting Hazardous Waste Landfills and Their Correlation with Racial and Economic Status of Surrounding Communities, June 1983. Environmental Equity and the Siting of Hazardous Waste Facilities in OECD Countries: Evidence and Policies (https://www.oecd.org/greengrowth/tools-evaluation/38436943.pdf)
[27] https://health.gov/healthypeople/objectives-and-data/browse-objectives/health-care-access-and-quality
[28] https://health.gov/healthypeople/objectives-and-data/browse-objectives/neighborhood-and-built-environment

[29] https://illumeadvisors.sharepoint.com/:b:/s/ILLUMECollaboration/ERQA548ZVslBipDMHBbBqw8BOzb0Vp3UX45poyx7QO7LBQ?e=briqww
[30] https://health.gov/healthypeople/objectives-and-data/browse-objectives/economic-stability
[31] https://health.gov/healthypeople/objectives-and-data/browse-objectives/economic-stability
[32] https://health.gov/healthypeople/objectives-and-data/browse-objectives/education-access-and-quality
[33] https://health.gov/healthypeople/objectives-and-data/browse-objectives/economic-stability
[34] https://www.health.ny.gov/statistics/community/minority/county/newyorkstate.htm
[35] https://www.census.gov/newsroom/releases/archives/2010_census/cb12-95.html
[36] https://www2.census.gov/library/publications/2013/acs/acs-22/acs-22.pdf
[37] https://www.napca.org/wp-content/uploads/2017/10/65-population-report-FINAL.pdf
[38] https://health.gov/healthypeople/objectives-and-data/browse-objectives/social-and-community-context
[39] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2796751/