Narragansett Bay Estuary Program's EJMap

Technical Documentation for Version 1.0

Last Updated August 17, 2023

Introduction

Environmental justice is the just and equitable distribution of environmental benefits and burdens for all communities, regardless of race, culture, ethnicity, or income.

Mapping tools such as EPA's EJScreen serve to identify communities that face disproportionate negative environmental impacts, or are particularly vulnerable to those impacts. The Narragansett Bay Estuary Program's EJMap is designed to supplement EJScreen with data from additional sources and to allow local communities to build and design customized maps that meet their needs and concerns.

EJMap allows users to select from a list of 31 indicators, and calculates an overall environmental justice score based on the selected criteria. Each map produced by the tool should be viewed as a distinct, independent entity and interpreted accordingly.

Although EJMap was developed for communities in the Narragansett Bay region of the northeast United States, all of the code is freely available under the MIT license. The code can be found on Github in the EJMap_prep and EJMap repositories; users are encouraged to copy and modify the code to match their local needs.

Indicators

Indicators are assigned to one of four categories: social vulnerability, health, environmental burden, and climate risk.

Category	**Indicators**
Social Vulnerability	People of Color, Low Income, Less than High School Education, Limited English Speaking, Under Age 5, Over Age 64, Unemployment Rate
Health	Life Expectancy, Cancer, Asthma, Diabetes, High Blood Pressure, Mental Health
Environmental Burden	Diesel Particulate Matter, Particulate Matter 2.5, Ozone, Air Toxics Cancer Risk, Respiratory Hazard Index, Toxic Releases to Air, Lead Paint, Traffic Proximity, RMP Facility Proximity, Hazardous Waste Proximity, Superfund Proximity, Wastewater Discharge, Underground Storage Tanks, Impervious Surfaces, Lack of Trees
Climate Risk	Flood Risk, Heat Risk, Sea Level Rise

Selection Criteria

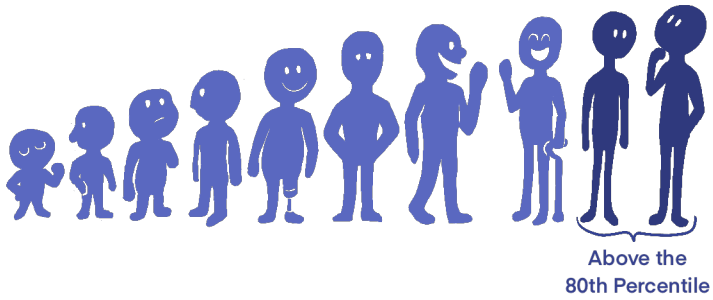
In order to be included in the model, all indicators must meet the following criteria:

1. Accurate and Reliable. Data must be from a trusted source and regularly updated.
2. Relevant. The data must be relevant to environmental justice. Data must either quantify population characteristics (social vulnerability, health) or environmental hazards (environmental burden, climate).
3. Resolution and Coverage. Data must be available for all of Connecticut, Massachusetts, and Rhode Island. Data must be available at a consistent resolution and quality. Data must either be available at the block group level or projected to the block group level without loss of resolution.

Model

Indicator Scores

Instead of reporting raw numbers, indicator values are presented as **percentiles**. Percentiles are calculated by ranking block groups from lowest to highest, then assigning each block group a score of 0-100 according to what percent of block groups have a lower score. This means that if a block group is in the 80th percentile, it is facing a higher burden than 80% of the remaining block groups.



The two tallest people in a group of ten people are above the 80th percentile for height.

Two different percentiles are calculated for each indicator: a **state** percentile and a **regional** percentile.

- **State percentiles** rank block groups within a state. State percentiles should be used when identifying environmental justice areas within a single state.
- **Regional percentiles** rank block groups within the Narragansett Bay estuary region. Regional percentiles should be used when identifying environmental justice areas that cross state lines.

When identifying environmental justice areas, the user must determine which type of percentile is more appropriate. All subsequent calculations will be based on either state percentiles or regional percentiles, but not both.

Indicators are assigned a score of 0 or 100 according to whether or not they meet the **minimum percentile**. The default minimum percentile is 80, but this can be changed to 50, 60, 70, 80, 90, or 95.

Category Scores

A **score** of 0-100 is calculated for each category by taking a weighted average of the indicator scores in that category. Null data is excluded from the calculation, and if no indicators were selected within a given category, then that category is excluded from further calculations.

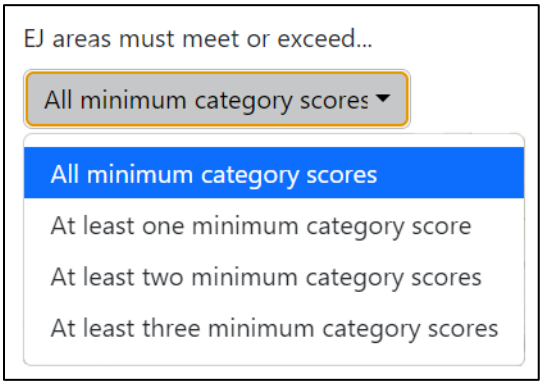
By default, all indicators are assigned equal weight, but a unique weight can be assigned for each indicator.

$$\frac{Weight_A \times Indicator_A + Weight_B \times Indicator_B + Weight_C \times Indicator_C}{Weight_A + Weight_B + Weight_C} = Category\ Score$$

Minimum Category Scores

Each category can be assigned a **minimum score**; if the minimum score is set to 0 or null then it is ignored.

By default, the minimum score for each category is null. If, however, a minimum score is assigned to one or more categories, then a block group must meet or exceed all category scores in order to be considered an environmental justice area. This option can be further customized so that a block group only needs to meet 1-3 minimum category scores instead of all of them.



Screenshot from EJMap

EJ Scores

An **EJ score** of 0-100 is calculated for each block group by taking a weighted average of all the category scores. Although all category scores are equally weighted by default, each category can be assigned a custom weight.

$$\frac{Weight_A \times Category_A + Weight_B \times Category_B + Weight_C \times Category_C}{Weight_A + Weight_B + Weight_C} = EJ\ Score$$

If a minimum score has been assigned to one or more categories, then block groups that fail to pass enough minimum category scores will be assigned an EJ score of 0, regardless of what the score would have otherwise been.

EJ Areas

By default, all block groups with an EJ score above 0 are considered to be **EJ areas**. A minimum EJ score can be set, however, in which case only block groups that meet or exceed the minimum EJ score are counted as EJ areas.

Users that do not wish to have a strict division between EJ areas and non-EJ areas should ignore this value and refer to the EJ score instead.

Data Overview

Acronyms

ACS: American Community Survey

CDC: Centers for Disease Control

DOT: Department of Transportation

EPA: Environmental Protection Agency

NLCD: National Landcover Database

NOAA: National Oceanic and Atmospheric Administration

USFS: US Forestry Service

Data Processing

Unless otherwise noted, data was copied from EJScreen. For detailed methodology, please consult the EJScreen technical documentation.

The code used to compile and analyze data, in addition to calculating percentiles, can be found in the EJmap_prep GitHub repository.

Social Vulnerability

Indicator	Description	Year	Source
People of Color	% of the population who identifies as Hispanic, mixed race, and/or a race other than white	2017-2021	ACS
Low Income	% households who earn equal to or less than twice the federal poverty level	2017-2021	ACS
Less than High School Education	% of the population, age 25 or older, with no high school diploma	2017-2021	ACS
Limited English Speaking	% of households where nobody age 14 or older speaks English “very well”	2017-2021	ACS
Under Age 5	% of population under the age of 5	2017-2021	ACS
Over Age 64	% of population over the age of 64	2017-2021	ACS

Indicator	Description	Year	Source
Unemployment Rate	% of civilian labor force, 16 or older, that is unemployed	2017-2021	ACS

Health

Indicator	Description	Year	Source
Life Expectancy	Inverse of normalized life expectancy	2017-2021	ACS
Cancer	% of the population, age 18 or older, that has had cancer (excluding skin cancer)	2020	CDC PLACES [1]
Asthma	% of the population, age 18 or older, with asthma	2020	CDC PLACES [1]
Diabetes	% of the population, age 18 or older, that has diabetes (excluding diabetes during pregnancy)	2020	CDC PLACES [1]
High Blood Pressure	% of the population, age 18 or older, with high blood pressure	2020	CDC PLACES [1]
Mental Health	% of the population, aged 18 or older, with poor mental health for 14 or more days during the past 30 days	2020	CDC PLACES [1]

[1] Data was copied from CDC PLACES. For additional information, please refer to the CDC PLACES methodology.

Environmental Burden

Indicator	Description	Year	Source
Diesel Particulate Matter	Estimated diesel particulate matter concentration in micrograms per cubic meter	2019	EPA
Particulate Matter 2.5	Annual average concentration of PM 2.5 in micrograms per cubic meter	2019	EPA
Ozone	Annual mean of the 10 highest average daily maximum 8-hour ozone concentrations	2019	EPA
Air Toxics Cancer Risk	Estimated lifetime inhalation cancer risk from analyzed carcinogens in ambient outdoor air	2019	EPA
Respiratory Hazard Index	Noncancer respiratory hazard index from analyzed pollutants in ambient outdoor air	2019	EPA
Toxic Releases to Air	Average annual toxicity-weighted concentration of toxic chemicals released to air by facilities	2021	EPA

Indicator	Description	Year	Source
Lead Paint	% of occupied housing units build before 1960	2017-2021	ACS
Traffic Proximity	Traffic within 500 meters, inversely weighted by distance	2020	DOT
RMP Facility Proximity	Active RMP facilities within 5 km, divided by distance	2022	EPA
Hazardous Waste Proximity	Number of hazardous waste facilities within 5 km, divided by distance	2022	EPA
Superfund Proximity	Number of superfund facilities within 5 km, divided by distance	2022	EPA
Wastewater Discharge	Toxicity-weighted concentrations of pollutants in water bodies within 500 meters, divided by distance	2020	EPA
Underground Storage Tanks	Weighted sum of leaking underground storage tanks (multiplied by 7.7) and underground storage tanks within 1,500 ft of the block group	2022	EPA
Impervious Surfaces	% land covered in impervious surfaces	2021	NLCD [2]
Lack of Trees	% land with no tree cover	2021	NLCD, USFS[2]

[2] For NLCD raster data, invalid raster values (VALUE > 100) were dropped and an average raster value was calculated for each block group; this value was divided by 100 in order to normalize the data on a 0-1 scale. To account for large water bodies, the data was multiplied by the percent area land per block group.

$$Indicator\ Value = \frac{Average\ Raster\ Value}{100} \times \frac{Area\ Land}{Total\ Area}$$

In order to calculate lack of trees, the NLCD data for tree cover was inverted.

$$Indicator\ Value_{No\ Trees} = 1 - Indicator\ Value_{Trees}$$

Climate Risk

Indicator	Description	Year	Source
Flood Risk	Predicted average flood risk per property, 2022-2052	2022	First Street [3]
Heat Risk	Predicted average heat risk per property, 2022-2052	2022	First Street [3]
Sea Level Rise	% land inundated by 2050	2016-2017	NOAA [4]

[3] For First Street data, property risk level was averaged at the census block level. Block groups were assigned the risk level of their accompanying census tract.

[4] Under an intermediate climate change scenario and relative to a 2000 baseline, sea level rise in Rhode Island is estimated to rise 0.39-0.43 feet by 2020 and 1.25-1.28 feet by 2050 (NOAA Sea Level Rise Viewer), marking a difference of 0.82-0.89 ft between 2020 and 2050. To approximate the amount of land covered under an additional 0.85 feet of sea level rise, the area inundated by 1 ft sea level rise and 0 ft sea level rise was calculated for each block group. The area for 1 ft sea level rise was multiplied by 0.85, with the area for 0 ft sea level rise subtracted from this value. Finally, the area of inundated land was divided by the total land area, which provided the percent land inundated per block group.

$$\%\ Land\ Inundated = \frac{(0.85 \times Area\ Inundated_{1ft}) - Area\ Inundated_{0ft}}{Area\ Land}$$