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Exploring Alternate Definitions of Environmental Justice and Inequality Indicators for SCAQMD's 2016 Socioeconomic Report

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Defining Environmental Justice (EJ)

SCAQMD EJ Definition

- An area with:
  - At least 10% of the population below the federal poverty line **and**
  - An annual mean $PM_{2.5}$ concentration > 11.1 µg/m^3 per year **or** a toxic cancer risk > 894 in a million (Top 15th percentile $PM_{2.5}$ and toxic cancer risk values; updated over time)
- Currently used for grant distribution purposes
- Analysis of 2012 Socioeconomic Review recommends an update of EJ definition
- Goal of this work is to create an alternative set of definitions for use in sensitivity analysis within 2016 Socioeconomic Review

Fit for Purpose

- There is no one "right" definition of EJ
  - We have done background research of EJ definitions and tools, but the definition that works best depends on the purpose and goals of your assessment and should reflect your needs to provide useful data for decision making.

Methods

- Understanding SCAQMD goals
- EPA guidance on EJ
- Review of EJ definitions employed by other state and local environmental protection agencies
- Review of EJ tools

CRITERIA
GENERAL:
1. Study is peer-reviewed. 2. Study is written in English. 3. Study analyzes definition of environmental justice areas, vulnerable and sensitive areas, or environmental justice screening method. 4. Study was published after 2010. Earlier studies were considered if they were in the South Coast Air Basin or California.
GEOGRAPHY AND STUDY POPULATION:
1. Study uses a location whose characteristics are similar to the South Coast Air Basin. Order of preference of study location: a. South Coast Air Basin (Los Angeles, Orange, Riverside, and San Bernardino Counties) b. Within State of California c. Within Western United States d. Within United States or Canada 2. Study uses study population with similar characteristics as found in Los Angeles, Orange, Riverside, and San Bernardino counties.

Considerations

- An alternative definition of EJ:
  - Must include air quality measures,
  - Should include relevant socioeconomic and sociodemographic data,
  - May include non-air quality environmental indicators.

EJ Screening Tools

- Tools were evaluated based on:
  - Data resolution
  - Data availability
  - Ranking methodology
  - Inclusion of key environmental and population indicators
- Evaluated:
  - EJScreen
  - CalEnviroScreen2.0
  - Environmental Justice Screening Method (EJSM)
  - Cumulative Environmental Vulnerabilities Assessment (CEVA)

CalEnviroScreen2.0 Method for SCAQMD

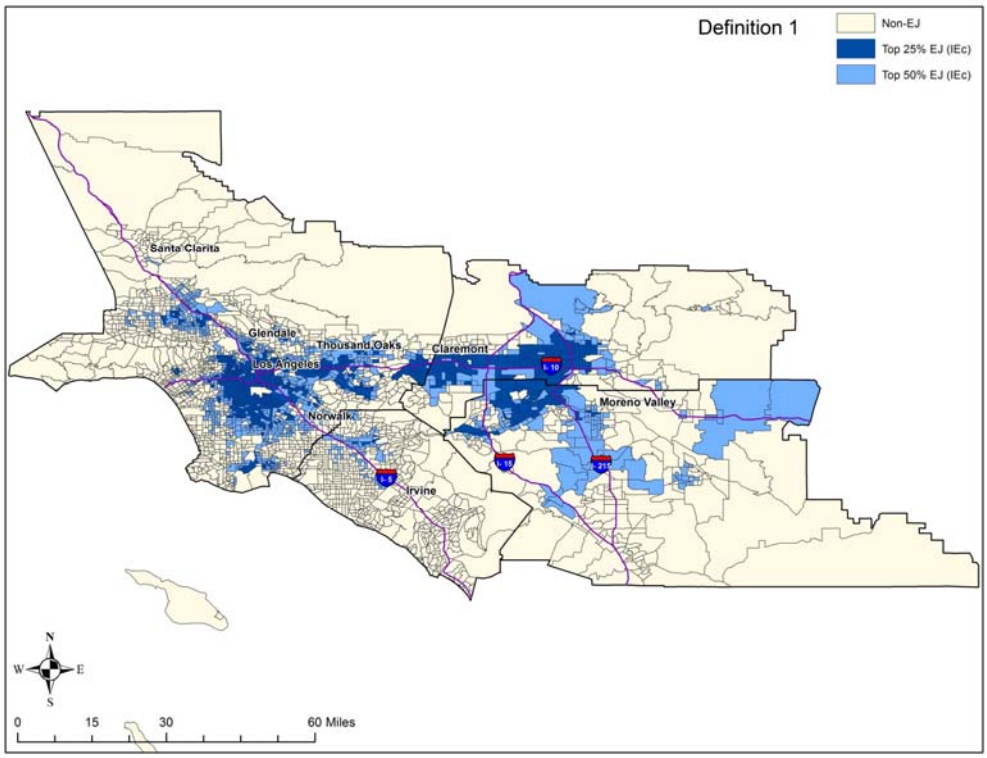
- For each indicator, raw data from CalEnviroScreen for each SCAB census tract is used to assign a percentile ranking to each tract based on the mean value, relative to SCAB
- SCAQMD cancer risk estimates included
- Environmental indicators of potential hazard are given half weights
- Environmental burden indicators and demographic indicators averaged separately and given a 1-10 score, then multiplied together for an overall percentile in SCAB
- Top 25% and 50% of census tracts are included as EJ communities

Recommended Alternative EJ Definitions

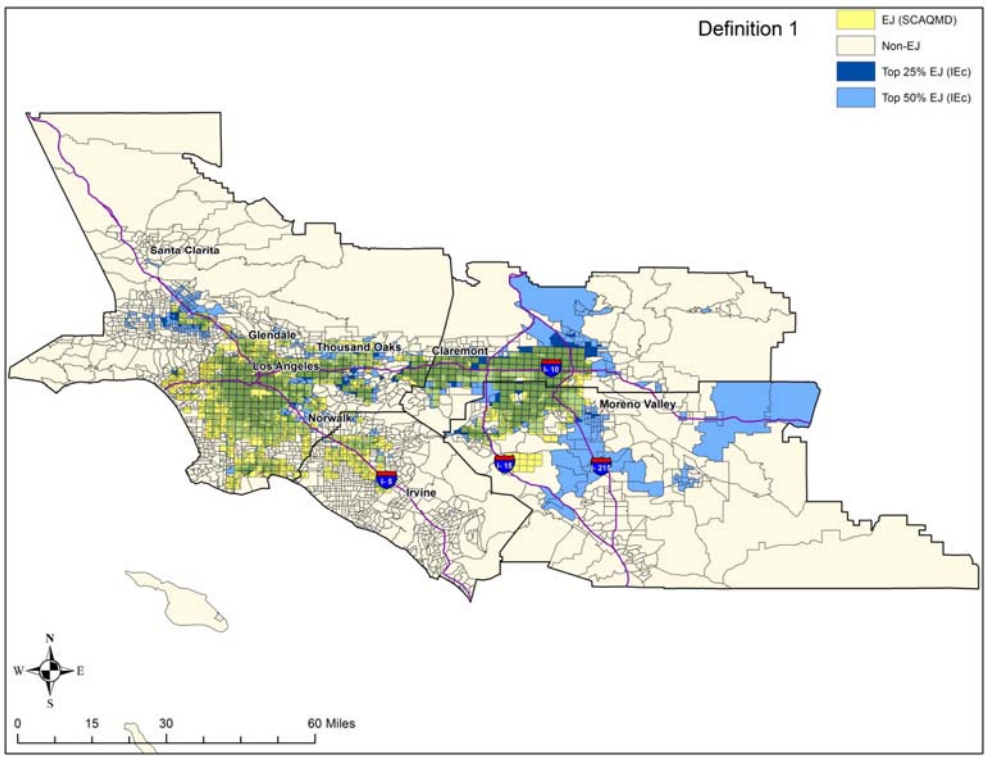
ALTERNATIVE DEFINITION	DEMOGRAPHIC INDICATORS		ENVIRONMENTAL INDICATORS	
	Income	Other Sociodemographics	Air Quality	Other Environmental Burdens
1	Poverty status		$PM_{2.5}$, toxic cancer risk, ozone	
2	Poverty status	Age, asthma, education, linguistic isolation	$PM_{2.5}$, toxic cancer risk, ozone	
3	Poverty status	Age, asthma, education, linguistic isolation, low birth weight, unemployment	$PM_{2.5}$, toxic cancer risk, ozone	Drinking water, pesticides, toxic releases, traffic, *cleanup sites, groundwater threats, hazardous waste, impaired water bodies, solid waste**

*Indicators in italics are given half-weight in analysis

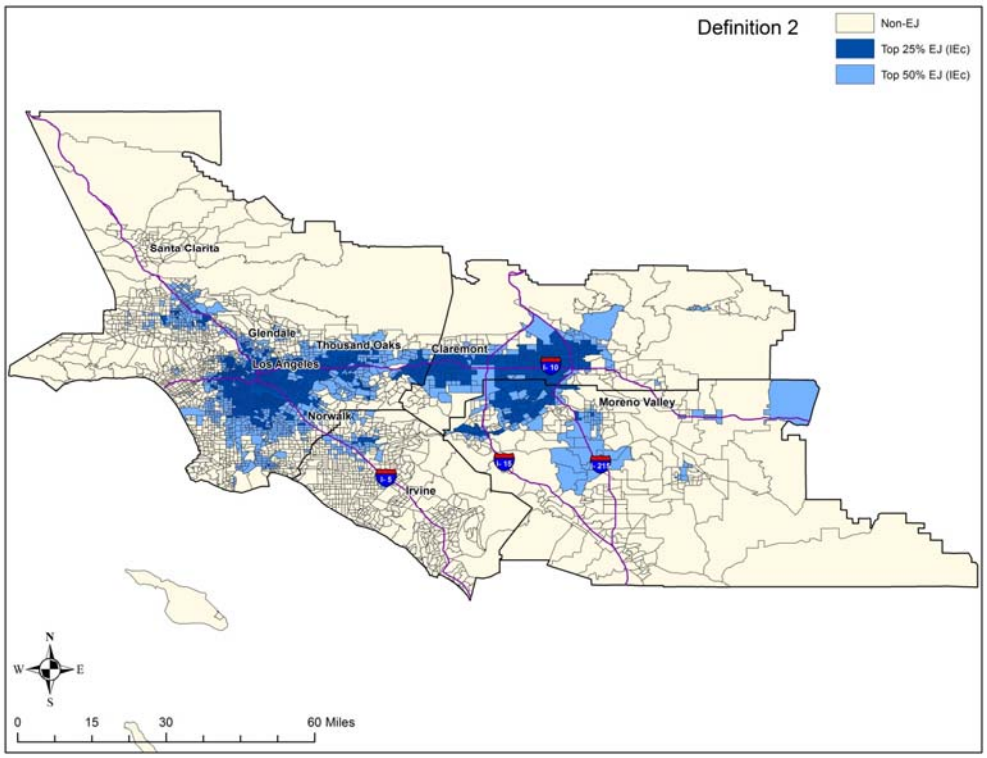
Alternative Definition 1



Alternative Definition 1



Alternative Definition 2



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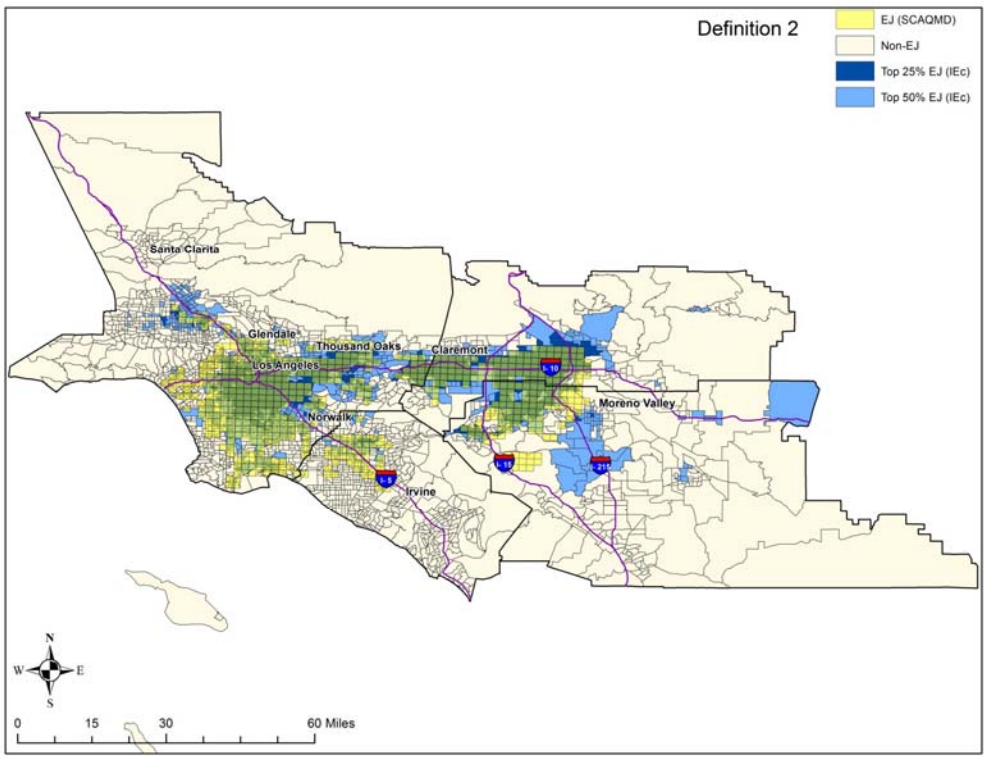
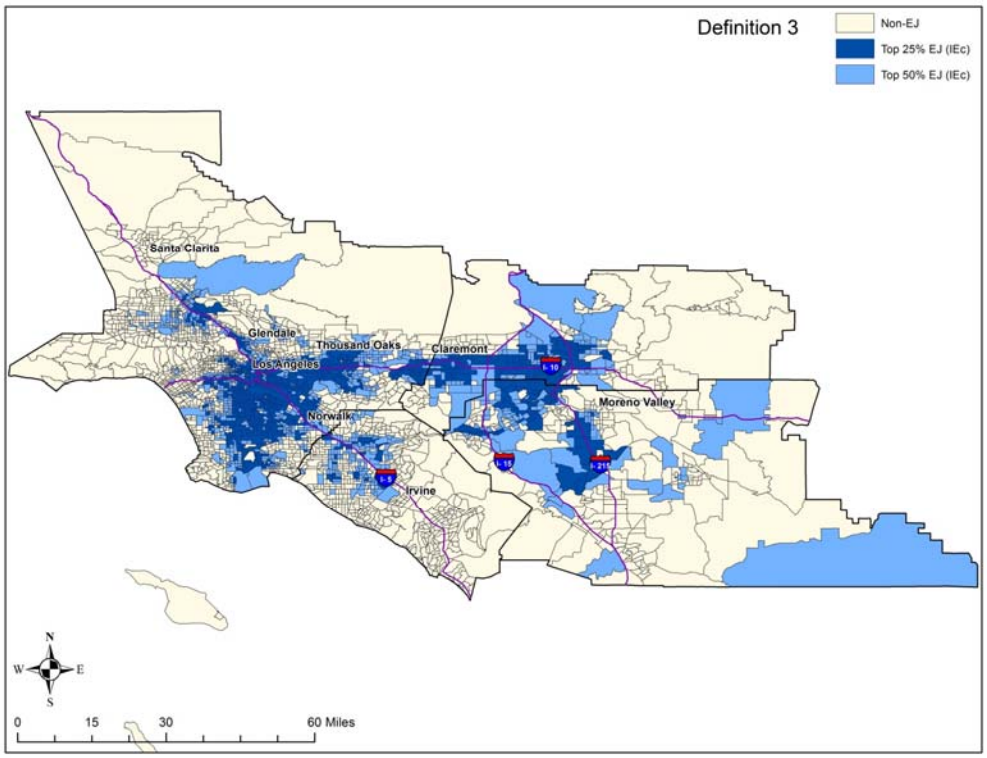


Alternative Definition 3



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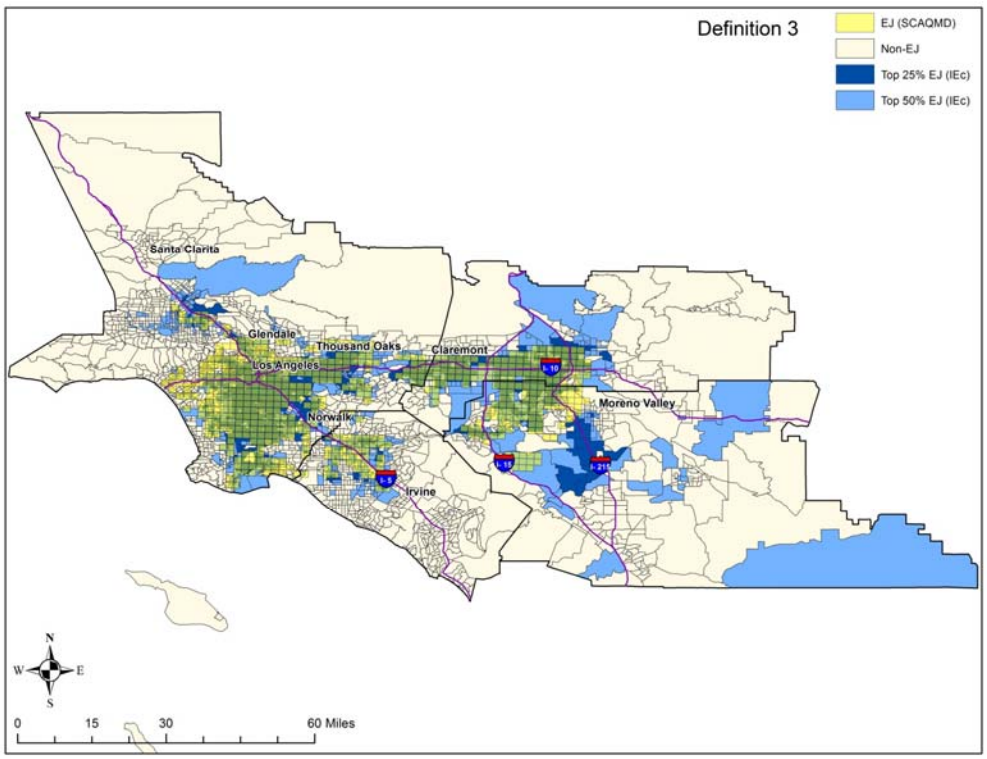


Comparison of EJ Definitions

	SCAQMD DEFINITION	DEF. 1, TOP 25%	DEF. 1, TOP 50%	DEF. 2, TOP 25%	DEF. 2, TOP 50%	DEF. 3, TOP 25%	DEF. 3, TOP 50%
Los Angeles	74.4%	72.1%	70.5%	72.5%	72.5%	74.7%	68.1%
Orange	10.0%	1.2%	5.9%	1.0%	5.2%	5.0%	11.4%
Riverside	5.9%	7.4%	10.1%	7.0%	8.4%	6.6%	8.1%
San Bernardino	9.8%	19.3%	13.4%	19.5%	13.9%	13.7%	12.4%
Total SCAB	100%	100%	100%	100%	100%	100%	100%

Distribution of EJ populations for each proposed definition by county

Comparison of EJ Definitions

	SCAQMD DEFINITION	DEF. 1, TOP 25%	DEF. 1, TOP 50%	DEF. 2, TOP 25%	DEF. 2, TOP 50%	DEF. 3, TOP 25%	DEF. 3, TOP 50%
Los Angeles	58.7%	28.6%	58.1%	28.9%	59.4%	31.3%	57.1%
Orange	24.7%	1.5%	15.3%	1.2%	13.5%	6.6%	30.0%
Riverside	25.2%	15.9%	45.0%	15.2%	37.4%	14.9%	36.6%
San Bernardino	47.6%	47.3%	68.3%	48.1%	70.3%	35.5%	64.4%
Total SCAB	47.4%	23.8%	49.4%	23.9%	49.2%	25.1%	50.3%
	Note: Values by definition do not add up to 100%, as this table depicts the percent of county population affected.						

Proportion of county population living in an EJ community by proposed EJ definition

Sensitivity Analyses

- Each of these definition types can be used as a sensitivity analysis to compare with EJ areas as defined by SCAQMD.
- Alternative definitions were designed to include alternative environmental and demographic indicators incrementally.
- Alternative definitions were built from SCAQMD's current grant distribution definition of EJ for ease of sensitivity analysis comparison.
- Identification of EJ areas based on these alternative definitions were calculated using a commonly used methodology, CalEnviroScreen2.0.

Distributional Analysis and Inequality Indicators

Objectives

- SCAQMD wishes to analyze the effect of its control measures on any baseline inequalities in health risks between EJ areas and the rest of the SCAB population.
- To accomplish this, they asked IEc to identify and evaluate potential metrics for characterizing inequality that could be applied in a distributional analysis of health risks before and after implementation of the 2016 AQMP.

Objectives

- Using inequality indicators, SCAQMD will perform a distributional analysis of mortality and morbidity risk associated with $PM_{2.5}$ and O_3 exposure.
  - Risk estimates will be generated by BenMAP-CE, comparing:
    - Baseline scenario
    - Mitigation strategy / policy scenarios from 2016 AQMP
  - Inequality indicators will be applied to EJ and non-EJ groups for baseline and policy scenarios. Change in inequality indicator values will be analyzed. Overall changes in population health risk inequality will also be estimated.
- Inputs to BenMAP for mortality and morbidity risk calculations include:
  - SCAQMD-provided air quality values
  - SCAB baseline health data
  - Concentration-response functions
  - Local population characteristics

Methods

- Understand SCAQMD goals
- Review of inequality metric and distributional analysis literature
  - Review of literature, e.g., Fann et al. (2011), Post et al. (2011), Maguire and Sheriff (2011), Sheriff and Maguire (2013), Harper et al. (2013)
    - Examples of the use of inequality indicators in health benefits analysis
    - Guidance or review articles recommending inequality indicators for health benefits analysis, e.g., Levy et al. (2006)
    - Literature identified by Dr. Sam Harper of McGill University and Dr. Jon Levy of Boston University
- Developed set of potential inequality indicators and criteria to serve as the basis for choosing appropriate indicators for SCAQMD's distributional analysis.

Background

- Distributional analyses have focused on:
  - $PM_{2.5}$ exposure, mortality risk, asthma-related hospitalizations
  - Allow analysis of efficiency and equality of control scenario
- Inequality indicators:
  - Are derived from economics literature for analysis of distribution of wealth or income
  - Convert a distribution to a single index value to provide a concise and easily utilized metric to order a set of outcomes

Considerations

- What is the appropriate reference group or value for analysis of inequality in the SCAB region?
- Should the indicator compare relative inequalities between groups or absolute inequalities between groups?
- Should EJ and non-EJ groups be considered as ordinal or nominal?
- Does the indicator need to be subgroup decomposable?
- Should an indicator include an explicit inequality aversion parameter to allow SCAQMD to determine the sensitivity of the indicator to changes in different parts of the risk distribution?

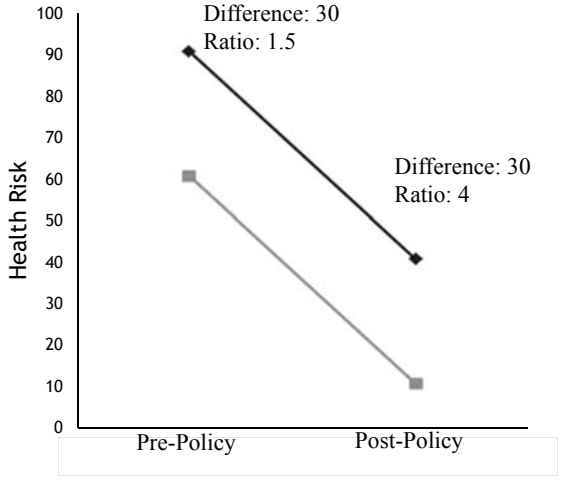
Inequality Indicators

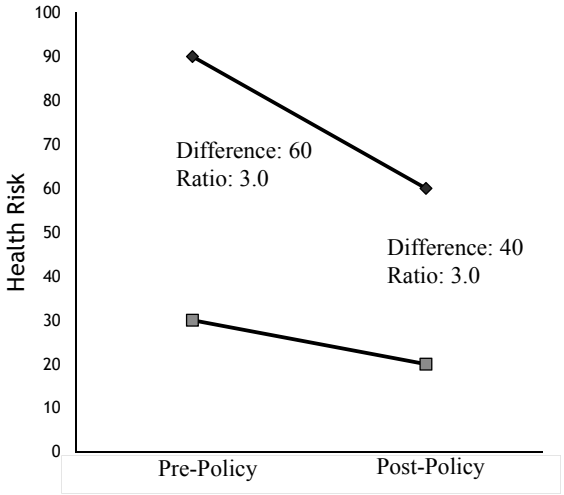
INEQUALITY INDICATOR	REFERENCE GROUP	ABSOLUTE OR RELATIVE INEQUALITY?	ACCOMMODATES ORDERED SOCIAL GROUPS?	SUBGROUP DECOMPOSABLE?	ADJUSTABLE INEQUALITY AVERSION PARAMETER?
Atkinson Index	Average	Relative	Yes	Yes	Yes
Gini coefficient	Average/ those better off	Relative or Absolute	No	No	No
Theil index	Average	Relative	No	Yes	No ($\varepsilon = 1$)
Mean log deviation	Average	Relative	No	Yes	No ($\varepsilon = 0$)
Kolm-Pollak index	Average	Absolute	Yes	Yes	Yes

Reference Group

Options	Considerations
Average health risk of SCAB population	Intuitive comparison; changes over time
Health risk of best-off in SCAB population	Maximum health potential; changes over time
Health risk of other non-SCAB EJ communities	Depends on other area's definitions; changes over time
Goal or target health risk	Must be realistic

Relative v. Absolute Measures of Inequality





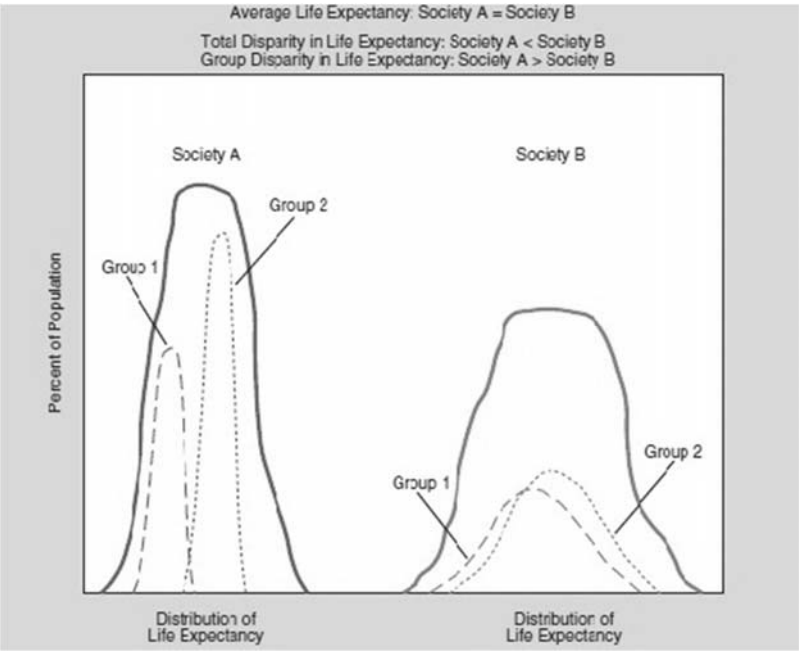
Options	Considerations
Absolute measure	Difference between values; affected by multiplication of risk
Relative measure	Ratio of values; affected by addition or subtraction of risk

Categorization Type

Options	Considerations*
Ordinal groups (e.g., income, education)	EJ status can be considered to be ordinal, but is not necessarily so; ordinal groups allow quantification of health gradients; however assumes more well-off areas are inherently different than EJ areas, which may or may not be the case
Nominal groups (e.g., race, ethnicity, gender)	EJ status can more conservatively be considered nominal

*Depending on other choices, categorization type may not be a necessary decision to make, as some inequality indicators can accommodate both ordinal and nominal groups.

Subgroup Decomposable



Explicit Value Judgment

- Inclusion of an inequality aversion parameter:
  - Allows the user to assess robustness of results to value judgments about the desirability of equality in a given population
  - Higher values mean a stronger preference of the population for equality
  - Allows differential weighting of transfers at the bottom of the distribution

Inequality Indicators

INEQUALITY INDICATOR	REFERENCE GROUP	ABSOLUTE OR RELATIVE INEQUALITY?	ACCOMMODATES ORDERED SOCIAL GROUPS?	SUBGROUP DECOMPOSABLE?	ADJUSTABLE INEQUALITY AVERSION PARAMETER?
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Mean log deviation	Average	Relative	No	Yes	No ($\varepsilon = 0$)
Kolm-Pollak index	Average	Absolute	Yes	Yes	Yes

Recommendation

- We recommend use of the Atkinson index with the Kolm-Pollak index as sensitivity analysis measure, based on:
  - Comparison group should be the average of the health risks of the SCAB population.
  - Both absolute and relative inequality should be considered. Absolute inequality can be assessed through use of the Kolm-Pollak index; relative inequality can be assessed through use of the Atkinson index.
  - Index should include an adjustable inequality aversion parameter.
  - Index should be subgroup decomposable.
  - Index does not need to accommodate ordered social groups, as EJ is not an inherently ordered measure based on its many parameters.
- Using two indices allows sensitivity analysis, though we can consider whether including additional indices would provide more insight.

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Atkinson Index

- Generalized entropy indicator
- Ranges from 0 (perfect equality) to 1 (maximum inequality)
- Based on the true outcome (rather than ranking of outcomes)
- Measure of relative inequality
- Subgroup decomposable to between-group and within-group components
- Accommodates ordered and non-ordered groups
- In reference to an average member of the population
- Utilizes an explicit parameter ε to allow greater sensitivity to the high risk end of a distribution over the low risk end with increasing ε, where high values indicate greater aversion to inequality

Kolm-Pollak Index

- Based on the true outcome (rather than ranking of outcomes)
- Measure of absolute inequality
- Additively subgroup decomposable to between-group and within-group components
- Accommodates ordered and non-ordered groups
- In reference to an average member of the population
- Utilizes an explicit parameter ε to allow greater sensitivity to the high risk end of a distribution over the low risk end with increasing ε, where high values indicate greater aversion to inequality