Chapter 6: Environmental Justice

Preface

The environmental justice (EJ) analysis conducted herein is preliminary and subject to future revision. Any potential revision is expected to relate to revisions to public health effects and benefits quantified in Chapter 3.

The SCAQMD defines EJ as "equitable environmental policymaking and enforcement to protect the health of all residents, regardless of age, culture, ethnicity, gender, race, socioeconomic status, or geographic location, from the health effects of air pollution." It is akin to the U.S. EPA's definition: "Environmental justice is the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income, with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies."[1] California state law similarly defines EJ as "the fair treatment of people of all races, cultures, and incomes with respect to the development, adoption, implementation, and enforcement of environmental laws, regulations, and policies."[2]

For grant allocation purposes, the SCAQMD developed guidelines for EJ area designation. Currently, a community (geographically defined as a two-kilometer-by-two-kilometer grid cell) is designated as an EJ area if at least ten percent of the area's population falls below the federal poverty line, and if the area's PM2.5 concentration or toxic cancer risk is within the top 15th percentile among all areas within the Basin.[3] Additionally, for the allocation of the Greenhouse Gas Reduction Fund (GGRF), a local administering agency such as the SCAQMD relies upon a list of disadvantaged communities being created by the California Environmental Protection Agency (CalEPA). CalEPA created and updates the list using the California Communities Environmental Health Screening Tool (CalEnviroScreen) to "assess all census tracts in California to identify the areas disproportionately burdened by and vulnerable to multiple sources of pollution," whether air related or not.[4] Currently, the top 25 percent of most impacted census tracts are eligible for receiving grants funded by the GGRF.

The 2014 Abt report recommended that the SCAQMD expand the EJ analysis in its socioeconomic assessments with respect to its existing regulatory and policy impact analyses (Abt Associates 2014). It recommended that staff consider alternative designations of EJ areas by utilizing screening tools to identify vulnerable and susceptible populations. The report stated that a screening analysis could be used to identify geographic locations where the populations are potentially subject to disproportionate risk or exposure, based on an existing (baseline) profile of pollution emissions or releases, as well as

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[1] See http://www3.epa.gov/environmentaljustice/.

[2] California Senate Bill 115, Solis, 1999; California Government Code § 65040.12(c).

[3] For funding allocation purposes, the SCAQMD also designates EJ areas in Coachella Valley, which is not located within the Basin. An EJ area there has at least ten percent of the area's population falling below the federal poverty line and its PM10 concentration within the top 15th percentile among all areas in Coachella Valley.

[4] California Senate Bill 535 (De León) designated CalEPA as the agency in charge of identifying disadvantaged communities for GGRF allocation. The Bill directed that a quarter of the proceeds from the GGRF must go to projects that provide a benefit to disadvantaged communities; moreover, at least ten percent of the funds must be for projects located within those communities (see http://www.calepa.ca.gov/EnvJustice/GHGInvest/).

the affected population's health conditions and socioeconomic status. The report noted that these factors have been shown to be important determinants of the degree of vulnerability and susceptibility to pollution exposure. Furthermore, the report recommended that a distributional analysis of policy impacts be included for purposes of assessing and comparing the distribution of health risk with and without the proposed policy, and evaluating whether any changes in health risk distribution represent an increase or a decrease in health risk inequality between the most vulnerable and susceptible populations and all other residents in the Basin.

SCAQMD staff has worked closely with IEc and its scientific advisors to implement Abt's recommendations as described above. Based on a thorough review and update of EJ literature, alternative screening and designation methods were identified and tailored for the purpose of preparing the socioeconomic impact analysis for the Draft 2016 AQMP. Moreover, two inequality indices were proposed for evaluating the distribution of health risk and for comparing differential policy impacts, if any, between EJ and non-EJ communities. The interim drafts of IEc's report were reviewed by the 2016 AQMP Socioeconomic Assessment EJ Working Group (Group).[5] The Group's comments and suggestions were reported back to the STMPR Advisory Group and incorporated into IEc's final report (2016).[6]

Alternative EJ Screening and Designation Methods

For purposes of the socioeconomic impact analysis, IEc recommended the use of quantitative indicators based on state-of-the-science literature guidance in designating EJ communities. Following its review of the existing EJ screening tools and methodologies, IEc recommended a list of alternative definitions in designating EJ communities based on a screening method derived from CalEnviroScreen 2.0.[7] IEc recommended multiple alternative definitions based on two considerations: first, these alternative definitions can be used as a sensitivity analysis for the current grant distribution definition of EJ; second, these alternative definitions, all with a similar structure, can also serve as sensitivity analyses for one another.

Alternative Definition 1 consists of poverty status and air quality related environmental indicators, which are most akin to those used by the SCAQMD in the current EJ designation for grant allocation purposes. Definition 2 expands the indicators by also including other demographic indicators available in CalEnviroScreen 2.0, including age, asthma, education, linguistic isolation, low birth weight, and unemployment. Definition 3 further expands the indicators by adding other non-air related environmental indicators available in CalEnviroScreen 2.0, including drinking water, pesticides, toxic releases, and traffic that are directly related to pollution exposure, as well as environmental effects

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[5] The Socioeconomic Assessment EJ Working Group met for a total of three times in April, May, and September 2016 to discuss respectively the proposed alternative EJ screening and designation methods, distributional analysis, and finally, IEc's draft final report and staff's preliminary analysis results.

[6] The final report will be made available on the SCAQMD website. The draft final version is available on the EJ Working Group webpage at http://www.aqmd.gov/home/about/groups-committees/stmpr-advisory-group/2016-aqmd-socio-EJ.

[7] IEc reviewed the current version of CalEnviroScreen (version 2.0), EJScreen and Community-Focused Exposure and Risk Screening Tool (C-FERST) both developed by the U.S. EPA, Environmental Justice Screening Method (EJSM) developed by researchers at the University of Southern California, UC Berkeley, and Occidental College, Cumulative Environmental Vulnerabilities Assessment (CEVA) developed by UC Davis, the Social Vulnerability Index (SoVI) 2006-10 developed by University of South Carolina, the 2010 Social Vulnerability Index (SVI) developed by the Agency for Toxic Substances & Disease Registry.

such as cleanup sites, groundwater threats, hazardous waste, impaired water bodies, and solid waste that are considered to contribute less to possible pollution burden than the environmental indicators that are directly associated with pollutant exposure (CalEPA and OEHHA 2014). Definitions 2a and 3a include an additional indicator of race/ethnicity to Definitions 2 and 3, respectively. These alternative definitions are listed in Table 6-1 below.

Table 6-1: Alternative Definitions for EJ Community Designation

Alternative Definition	Demographic Indicators		Environmental Indicators	
	Income	Other Demographic	Air Quality	Other Environmental
1	Poverty status[1]		PM2.5, toxic cancer risk,[2] ozone	
2	Poverty status[1]	Age, asthma, education, linguistic isolation, low birth weight, unemployment	PM2.5, toxic cancer risk,[2] ozone	
2a	Poverty status[1]	Age, asthma, education, linguistic isolation, low birth weight, unemployment, race/ethnicity[3]	PM2.5, toxic cancer risk,[2] ozone	
3	Poverty status[1]	Age, asthma, education, linguistic isolation, low birth weight, unemployment	PM2.5, toxic cancer risk,[2] ozone	Drinking water, pesticides, toxic releases, traffic, *cleanup sites, groundwater threats, hazardous waste, impaired water bodies, solid waste*[4]
3a	Poverty status[1]	Age, asthma, education, linguistic isolation, low birth weight, unemployment, race/ethnicity[3]	PM2.5, toxic cancer risk,[2] ozone	Drinking water, pesticides, toxic releases, traffic, *cleanup sites, groundwater threats, hazardous waste, impaired water bodies, solid waste*[4]

Notes:

[1] Unlike the SCAQMD's current EJ definition where poverty status is considered as at least ten percent of population below federal poverty line, the poverty status here is the share of population below twice the federal poverty line to account for the higher than average cost of living in the Basin and the conservative federal poverty level value.

[2] Toxic cancer risk is based on estimates from the SCAQMD's Multiple Air Toxics Exposure Study IV (MATES IV).

[3] Race/ethnicity is not included as an indicator in CalEnviroScreen 2.0. It is expressed as the percent of population within a census tract with minority status using the U.S. Census Bureau's American Community Survey five-year estimates for 2010-2014. Based on the federal National Environmental Policy Act (NEPA) Guideline, "minority" is defined as "[i]ndividual(s) who are members of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic."

[4] Consistent with CalEnviroScreen 2.0, the "other environmental" indicators that are shown in *italics* are given half the weight when calculating the overall score for all environmental indicators whereas all other indicators were given the weight of one.

Source: Industrial Economics, Levy, and Harper 2016.

As in CalEnviroScreen 2.0, each indicator is calculated at the level of census tract. All the individual indicators, except for toxic cancer risk and race/ethnicity, are derived from the same raw data provided on the CalEnviroScreen 2.0 website. The diesel PM concentration indicator in CalEnviroScreen 2.0 is replaced by toxic cancer risk, which is based on estimates in the SCAQMD's Multiple Air Toxics Exposure Study IV (MATES IV). While diesel PM accounted for 76.2 percent of the overall toxic cancer risk (SCAQMD 2015), the MATES IV estimates additionally account for other important contributors to toxic cancer risk. These toxic cancer risk estimates are used for the SCAQMD's current EJ area designation for grant allocation purposes. Race/ethnicity is not included as an indicator in CalEnviroScreen 2.0.[8] However, it is included in this analysis based on state-of-the-science literature guidance and input from the EJ Working Group. In order to facilitate potential use of an alternative EJ definition in circumstances where race and ethnicity are legally prohibited from being used, race/ethnicity is included in this analysis as a sensitivity test to Alternative Definitions 2 and 3.

Similar to CalEnviroScreen 2.0, each census tract within the Basin was ranked from the most to the least impacted areas, based on a tract's overall screening score.[9] IEc recommended two potential thresholds to designate EJ communities. The first threshold option would define an EJ community as the worst impacted census tracts until the total population residing in these tracts reaches approximately 50 percent of the Basin's population. This threshold roughly reflects the same number of residents as the SCAQMD's current EJ designation, which covers about 47 percent of the Basin's population. In comparison, the second and more stringent threshold option includes the worst impacted census tracts as EJ communities until approximately 25 percent of the Basin's population are identified to live in these communities. This 25-percent population threshold reflects the current practice of setting statewide CalEnviroScreen threshold to allocate the GGRF.[10]

Table 6-2 shows the EJ population distribution across the four counties within the Basin for each EJ definition and based on the two population thresholds. Compared to the SCAQMD's current EJ definition for grant allocation purposes, the EJ population identified by Alternative Definitions 1-3 all consist of a larger share of residents in the Inland region and a smaller share of residents in the coastal counties. While this difference ranges from 4 to 12 percent, depending on the alternative definition and population threshold used, the largest differences appear when the designation threshold is set at the more restrictive population cut-off of top 25 percent and when other non-air related environmental indicators are not included.

Table 6-2: EJ Population Distribution by Definition and Designation Threshold

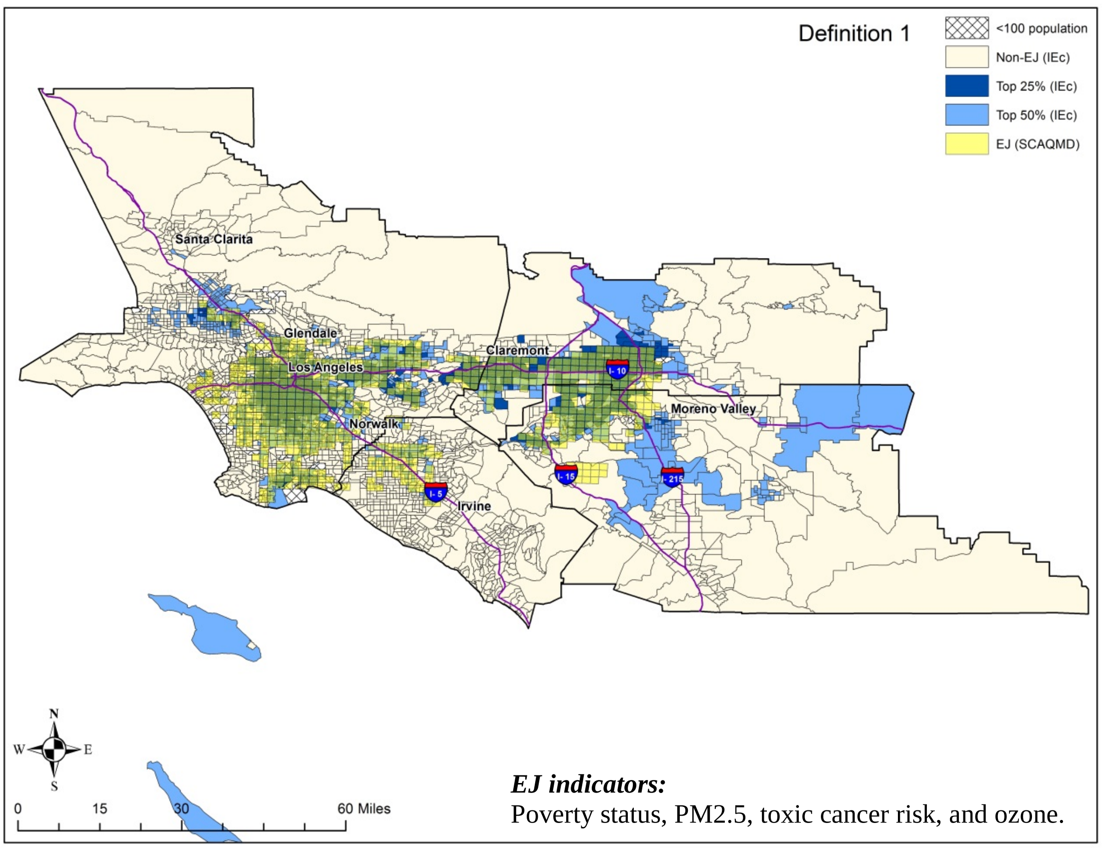
County	SCAQMD Definition (~ 50%)	Alternative Definition 1		Alternative Definition 2		Alternative Definition 3	
		Top 50%	Top 25%	Top 50%	Top 25%	Top 50%	Top 25%
Los Angeles	74.4	70.6	72.1	72.5	72.0	68.1	75.2
Orange	10.0	5.7	1.0	3.9	0.1	11.2	4.8
Riverside	5.9	10.0	7.2	9.5	7.1	8.1	6.6
San Bernardino	9.8	13.7	19.7	14.1	20.8	12.5	13.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Note: County-specific values may not sum up to 100 percent due to rounding error.
Sources: Industrial Economics, Levy, and Harper (2016) and Industrial Economics (2016).

[8] However, a post-screening analysis conducted by OEHHA showed that the more impacted communities identified by CalEnviroScreen 2.0 also have higher shares of minority population (OEHHA 2014).
[9] The calculation of screening score is identical to the CalEnviroScreen 2.0 method. See Appendix 6-A for an example.
[10] Notice, however, that the Basin has a higher concentration of EJ communities as identified for GGRF allocation purposes based on the statewide ranking using CalEnviroScreen 2.0. Therefore, the number of residents living in the Basin's EJ communities according to the GGRF designation effectively accounts for about 39 percent of the Basin's total population.

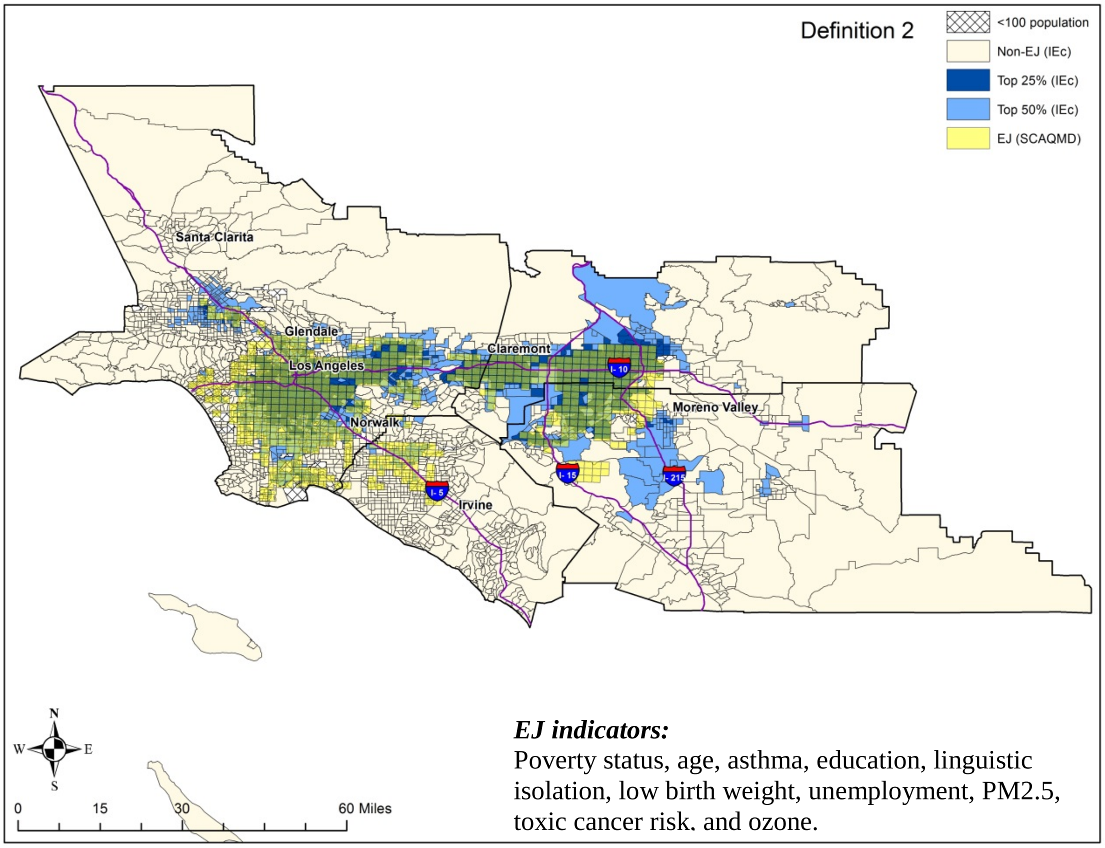
Figures 6-1, 6-2, and 6-3 present the maps of EJ designation results based on Alternative Definitions 1, 2, and 3 respectively. In general, communities that have been designated as EJ communities by the SCAQMD largely overlap with those designated as EJ communities by the alternative definitions recommended by IEc. Particularly, the current SCAQMD EJ designation covers the majority of the worst impacted EJ areas, as identified by the 25-percent population threshold under any of the three alternative definitions. Consistent with the EJ population distribution shown in Table 6-2, however, all three maps demonstrate a slight eastward shift away from the coast and toward the inland area when the recommended alternative definitions are used instead of the current SCAQMD EJ designation. Moreover, the eastward shift is somewhat more pronounced under Alternative Definitions 1 and 2, and under these two definitions, there are also visibly fewer EJ communities located in Orange County. The map for Alternative Definition 3 shows the largest difference from the current SCAQMD EJ designation. It includes a number of large, rural, and sparsely populated census tracts at the southeastern most corner of the Basin, as well as a number of census tracts in Orange County between Interstate 405 and the Santa Ana Freeway portion of Interstate 5. Residents in these census tracts are relatively more impacted by other water- and hazardous waste-related environmental burdens, more so than air pollution-related burdens.

Figure 6-1: EJ Communities Designated under Alternative Definition 1 *versus* SCAQMD's Current EJ Designation



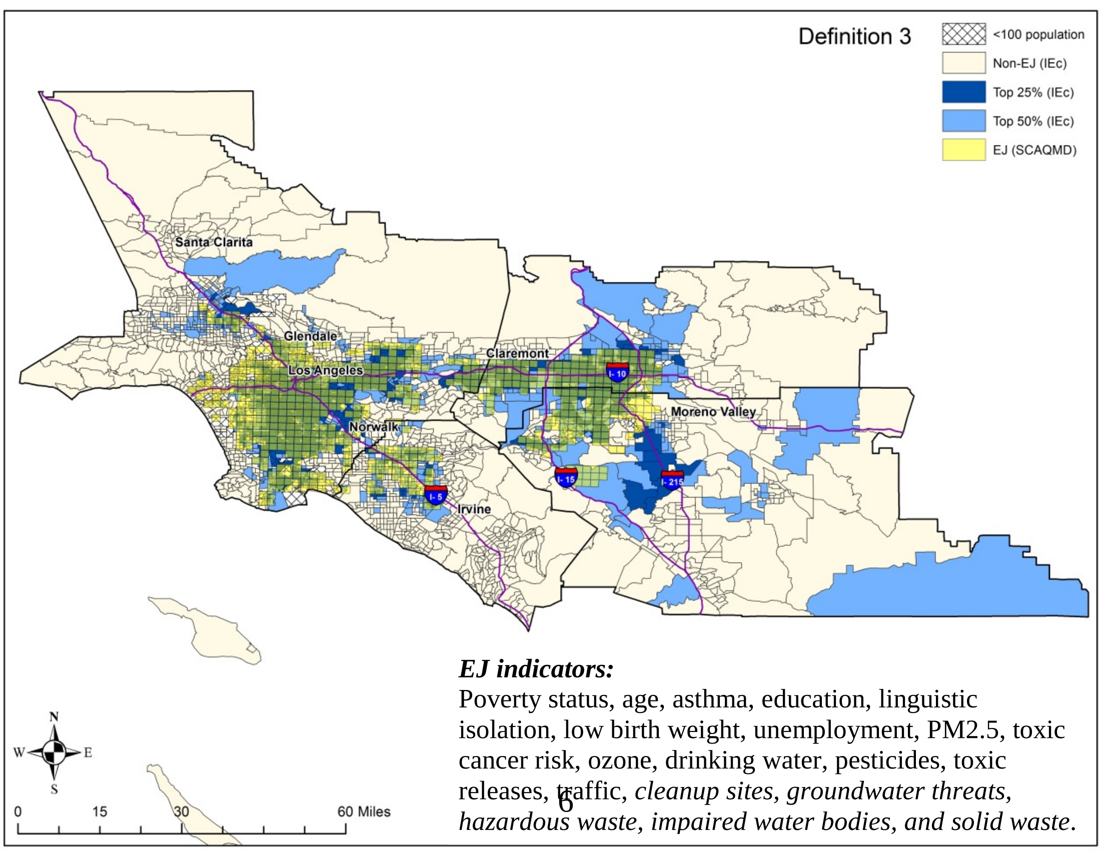
Source: Industrial Economics, Levy, and Harper 2016.

Figure 6-2: EJ Communities Designated under Alternative Definition 2 *versus* SCAQMD's Current EJ Designation



Source: Industrial Economics, Levy, and Harper 2016.

Figure 6-3: EJ Communities Designated under Alternative Definition 3 *versus* SCAQMD's Current EJ Designation



Source: Industrial Economics, Levy, and Harper 2016.

According to the literature survey conducted by IEc and its scientific advisors (Industrial Economics et al. 2016), race/ethnicity has been shown to be an important indicator of vulnerability to pollution exposure. Table 6-3 illustrates the impact of adding race/ethnicity to Alternative Definitions 2 and 3 on the EJ population distribution across the four counties. This additional EJ indicator is based on the percent minority population within a census tract, with the definition of minority being "[i]ndividual(s) who are members of the following population groups: American Indian or Alaskan Native; Asian or Pacific Islander; Black, not of Hispanic origin; or Hispanic." (Council on Environmental Quality 1997) Table 6-3 allows the comparison of population distributions between EJ definitions without and with race/ethnicity (i.e., between Alternative Definitions 2 and 2a and between Alternative Definitions 3 and 3a). It can be seen that the inclusion of race/ethnicity results in very minor changes to how the EJ population is distributed.

Table 6-3: Impact of Race/Ethnicity Inclusion on EJ Population Distribution

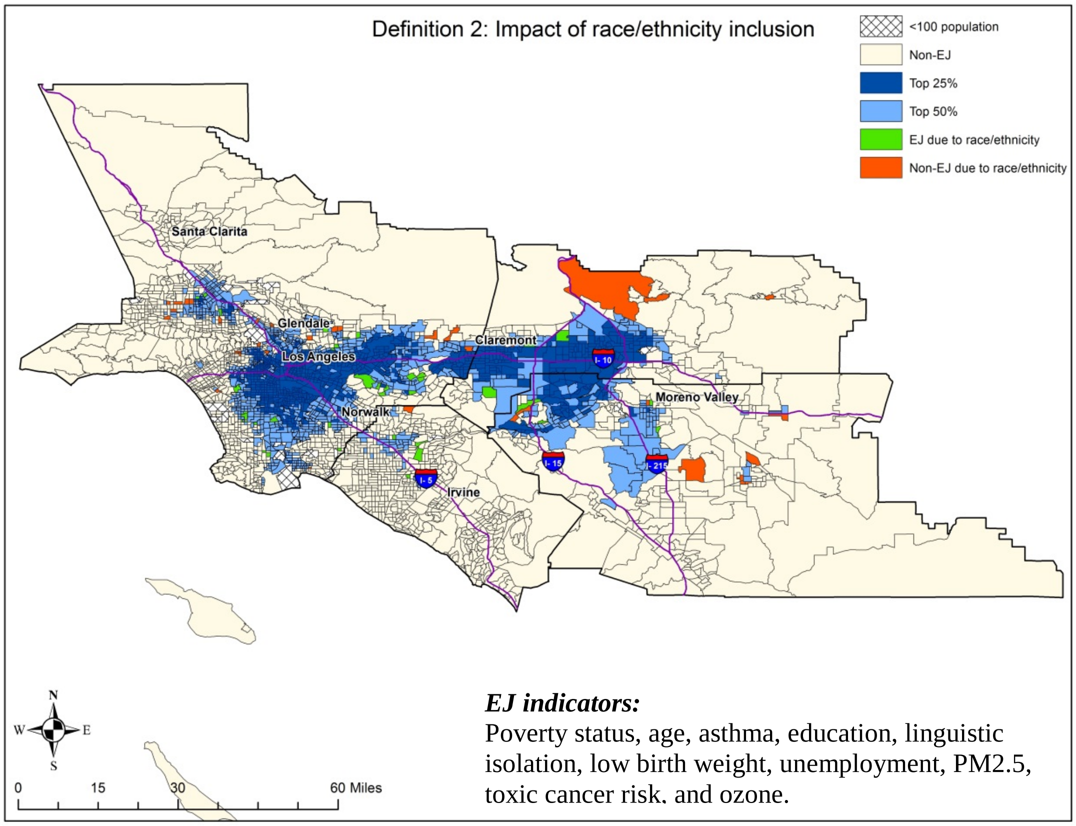
County	Top 50%		Top 25%		Top 50%		Top 25%	
	Def. 2	Def. 2a	Def. 2	Def. 2a	Def. 3	Def. 3a	Def. 3	Def. 3a
Los Angeles	72.5	72.2%	72.0	72.8%	68.1	68.6%	75.2	76.4%
Orange	3.9	4.2%	0.1	0.0%	11.2	11.1%	4.8	4.6%
Riverside	9.5	9.2%	7.1	6.4%	8.1	7.9%	6.6	6.3%
San Bernardino	14.1	14.3%	20.8	20.8%	12.5	12.4%	13.5	12.7%
Total	100.0	100%	100.0	100%	100.0	100%	100.0	100%

Note: County-specific values may not sum up to 100 percent due to rounding error.
Source: Industrial Economics, Levy, and Harper (2016).

Similarly, marginal changes in EJ designations are observed in Figures 6-4 and 6-5, where race/ethnicity was added to the existing list of demographic indicators under Alternative Definitions 2 and 3, respectively. Generally speaking, some census tracts outside of the main contiguous EJ area are now non-EJ communities, and at the same time, some census tracts within the contiguous area from central Los Angeles east along the Interstate 10 corridor are now EJ communities. For either designation threshold, these changes affect only about two percent of the Basin's population.

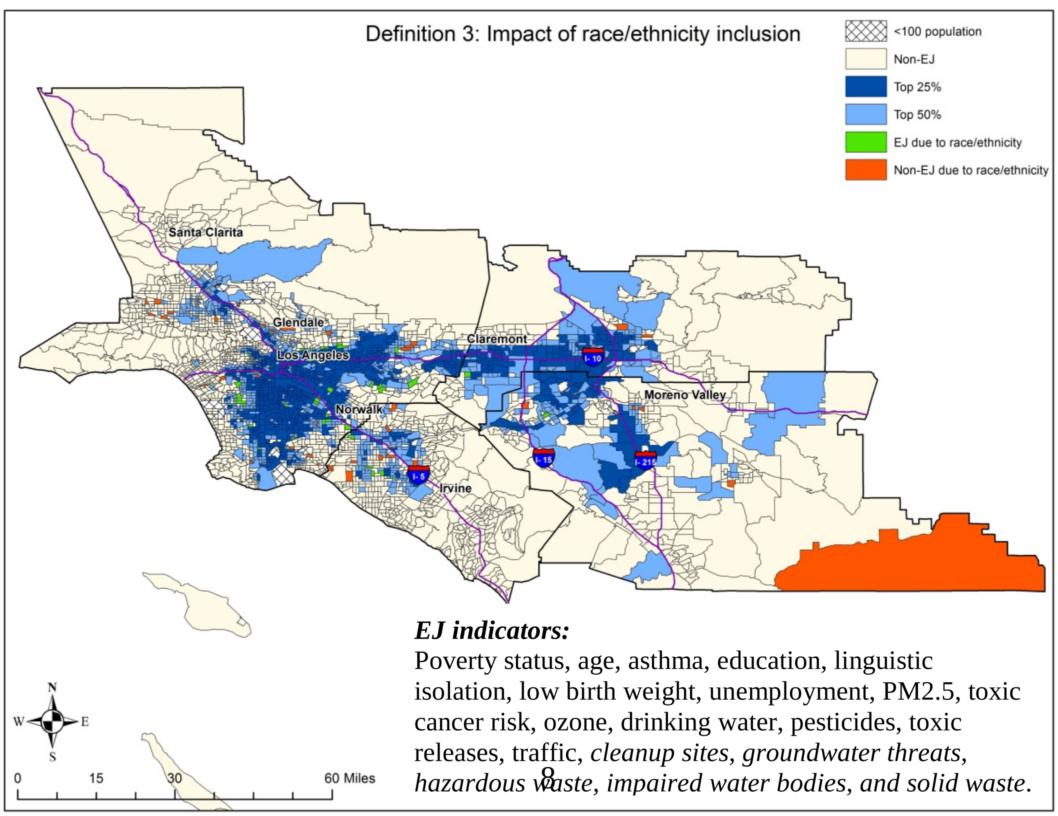
Nonetheless, it should be emphasized that the minimal changes as a result of adding race/ethnicity do not imply a lack of significance of race/ethnicity as an EJ indicator. Rather, these minimal changes suggest a likely high correlation between race/ethnicity and many, if not all, of the indicators that are already included under Alternative Definitions 2 or 3.

Figure 6-5: Impact of Race/Ethnicity Inclusion on EJ Community Designation under Alternative Definition 2



Source: Industrial Economics, Levy, and Harper 2016.

Figure 6-4: Impact of Race/Ethnicity Inclusion on EJ Community Designation under Alternative Definition 3



Source: Industrial Economics, Levy, and Harper 2016.

Quantified Public Health Effects and Monetized Benefits in EJ and non-EJ communities

For the purpose of analyzing the distributional impacts of the Draft 2016 AQMP, it was recommended by IEc that the analysis be conducted for PM2.5- and ozone-related mortality risk in adults, as well as for morbidity risk of asthma-related emergency department (ED) visits in children, as different age groups could experience varying impacts for a particular health endpoint. This section summarizes the health effects for these recommended health endpoints and the monetized overall public health benefits, as a result of implementing the Draft 2016 AQMP, based on the annual estimates for year 2031 within the Basin.[11]

Table 6-4 compares the projected decreases in the number of premature deaths per million residents in 2031 in EJ and non-EJ communities due to implementation of the Draft 2016 AQMP. Similarly, Table 6-5 compares the projected decreases in the number of asthma-related ED visits per million residents in 2031 in EJ and non-EJ communities. Both tables show that, on average, EJ communities are projected to experience greater health benefits as a result of Plan implementation, whether the benefit is related to avoided premature deaths among adults or avoided asthma-related ED visits among children, than non-EJ communities.

Table 6-4: Annual Avoided Premature Deaths among Adults (25 Years or Older)* Anticipated Through Implementing the Draft 2016 AQMP

By EJ Designation and for Year 2031

		Decrease in Number of Premature Deaths per Million Residents 25 Years or Older		Difference
EJ Designation		EJ Communities	Non-EJ Communities	(EJ) – (Non-EJ)
Definition 1	Top 50%	154	125	30
	Top 25%	167	131	37
Definition 2	Top 50%	159	121	38
	Top 25%	170	129	41
Definition 3	Top 50%	153	124	28
	Top 25%	161	131	30

*Due to both long-term exposure to PM2.5 and short-term exposure to ozone
Note: Numbers may not sum up due to rounding.

[11] The health effects and monetized public health benefits are slightly less than those reported in Chapter 3. The difference of about one percent is due to the effects and benefits estimated within the four-county region but outside the Basin.

Table 6-5: Annual Avoided Asthma Related ED Visits among Children (Younger than 18)* Anticipated Through Implementing the Draft 2016 AQMP

By EJ Designation and for Year 2031

		Decrease in Number of Asthma-Related ED Visits per Million Residents Younger than 18		Difference
EJ Designation		EJ Communities	Non-EJ Communities	(EJ) – (Non-EJ)
Definition 1	Top 50%	126	114	12
	Top 25%	127	117	10
Definition 2	Top 50%	125	114	11
	Top 25%	129	117	12
Definition 3	Top 50%	124	115	9
	Top 25%	119	119	0

*Due to short-term exposure to ozone only

Note: Numbers may not add up due to rounding.

Finally, Table 6-6 shows the per capita monetized public health benefits in EJ and non-EJ communities, respectively. As previously discussed in Chapter 3, these monetized benefits are largely driven by projected avoided premature deaths; therefore, consistent with the comparison results shown in Table 6-4, EJ communities are projected to experience a larger per capita health benefits. In other words, proportionally more of the quantified public health improvement due to implementing the Draft 2016 AQMP are projected to accrue to EJ communities than non-EJ communities, regardless of the alternative definition or designation threshold chosen.

Table 6-6: Monetized Annual Public Health Benefits

By EJ Designation and for Year 2031

		Per Capita Monetized Benefits (in 2015 Dollars)		Difference in Per Capita Benefits
EJ Designation		EJ Communities	Non-EJ Communities	EJ - Non-EJ
Definition 1	Top 50%	$2,268	$1,836	$432
	Top 25%	$2,456	$1,917	$538
Definition 2	Top 50%	$2,329	$1,772	$557
	Top 25%	$2,491	$1,897	$594
Definition 3	Top 50%	$2,240	$1,823	$417
	Top 25%	$2,358	$1,920	$438

Notably, the difference in per capita health benefits is consistently larger when the designation threshold is set at the top 25-percent of population. This indicates that the most vulnerable and susceptible communities will experience proportionally more of the projected health benefits of cleaner air. It is also observed that, regardless of the threshold used, the difference in per capita health benefits is the smallest under Alternative Definition 3, where other non-air related environmental indicators are included for EJ screening. This implies that, as clean air policy is not designed to alleviate other types of environmental risks or degradation, Alternative Definition 3 may not be the best way to designate EJ communities for the purpose of evaluating the effectiveness of air regulations and programs in reducing health risk disparity, which is used in the recent EJ literature as the barometer for environmental justice.

Evaluating Distributional Impact of the Draft 2016 AQMP via Health Risk Inequality Index

According to the U.S. EPA's latest *Guidelines for Preparing Economics Analyses* (2016), examining the distribution of changes in health benefits alone may not completely reflect the distributional impact since "an unequal distribution of environmental improvements may actually help alleviate existing disparities (Maguire and Sheriff 2011)" (p. 10-7). The *Guidelines* recommend the consideration of changes in distributions of health and environmental outcomes, such as health risk, between baseline and policy scenarios.

Consistent with the *Guidelines*, IEc recommended that the distributional impact of the Draft 2016 AQMP be analyzed by comparing the distributions of exposure-related mortality and morbidity risk between baseline and policy scenarios (Industrial Economics et al. 2016). The purpose of analyzing more than one health endpoint is two-fold: first, health risk for different health endpoints cannot easily be combined into one meaningful risk metric; second, different health endpoints may have varying impacts on different population groups, such as age cohorts. Therefore, the distribution of PM2.5 and ozone exposure related mortality risk is analyzed, as premature death is the most severe effect of air pollution among all health endpoints. However, it is more likely that a larger effect of mortality risk changes will be experienced by the older age cohort. To complement the distributional analysis of mortality risk, the exposure related morbidity risk distribution is also analyzed for asthma-related ED visits among children, whose lungs are not yet fully developed and are therefore more susceptible than adults to respiratory health impacts.

The distributional analysis consists of three main steps as described below:[12]

1. Health risk related to the exposure of a pollutant was estimated separately for the baseline and the policy (control) scenario using BenMAP-CE and accounting for exposure to all emission sources of the pollutant, whether anthropogenic or biogenic.[13]
2. Inequality index values, which summarize the distribution of exposure related health risk among all census tracts within the Basin, were calculated for the baseline and the policy scenario separately.[14]
3. The inequality index values calculated in Step 2 were decomposed into the inequality *between* the EJ and the non-EJ group of communities and the inequality *within* either group of communities.

Based on IEc recommendations, the analysis uses both Atkinson and Kolm-Pollak Inequality Indices to show the potential changes in health risk inequality. Generally speaking, a higher inequality index value indicates greater inequality. However, it should be noted that an inequality index value is, in essence, a single number that indicates the statistical dispersion of a distribution,[15] and the directional

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[12] A similar methodology was used in Fann et al. (2011). See Appendix 6-B for further discussion.

[13] BenMAP-CE was also used to quantify health benefits in Chapter 3. See Appendix 3-B for a discussion of BenMAP-CE operational steps.

[14] Some studies have shown that using inequality index to summarize the distribution of a "bad" (e.g., health risk), as opposed to a "good" (e.g., income) can lead to violations of some axioms that an inequality index must satisfy. Further sensitivity tests will be conducted in Appendix 6-B using transformed health risk following Levy et al. (2009) and Maguire and Sheriff (2011) so that a higher value of the transformed metric indicates a more desirable outcome.

[15] Not all measures of statistical dispersion can qualify as an inequality index. Only those that satisfy a list of required axioms can be used as inequality indices. See Industrial Economics et al. (2016) for a discussion of the axioms.

change is much more meaningful than the precise value of an inequality index. Moreover, the index value and changes in index value cannot be compared across different indices.[16] An analogous example is stock market indices: the *directional changes* of Dow Jones Industrial Average and S&P 500 are both important financial market indicators, but the value of the indices do not carry much meaning and the values and their absolute changes also should not be compared against each other.

Additionally, it should also be noted that the Atkinson Inequality Index is based on *relative* inequality whereas the Kolm-Pollak Inequality Index is based on *absolute* inequality. As an illustrative example of the difference, let us assume that there is no within-group inequality (i.e., identical health risk at each census tract within either the EJ or non-EJ group of communities), and therefore, the overall inequality can be entirely attributed to inequality between the EJ and the non-EJ group of communities. In this example, if the ratio of health risk between EJ and non-EJ groups stays constant across the baseline and the policy scenario (e.g., health risk ratio for baseline: 0.0004/0.0002 = health risk ratio for policy: 0.0002/0.0001), then the Atkinson Index will also stay constant and show no change in inequality. In contrast, the Kolm-Pollak Index will show a decrease in inequality in this example as the absolute difference in health risk shrinks (i.e., [0.0004-0.0002 = 0.0002] > [0.0002-0.0001 = 0.0001]).

Table 6-7 reports the impact of the Draft 2016 AQMP on the overall distribution of health risk within the Basin in 2031. The inequality in PM2.5 and ozone exposure related mortality risk among adults is projected to decrease with either inequality index. However, the Atkinson Index demonstrates a slight increase of about one percent in the *relative* morbidity risk inequality associated with ozone exposure related asthma ED visits among children, whereas the Kolm-Pollak Index shows a decrease in the *absolute* inequality of the same morbidity risk.[17]

Table 6-7: Overall Distributional Impact of the Draft 2016 AQMP in 2031

	PM2.5 and Ozone Exposure Related Mortality Risk (Among Residents 25 Years or Older)		**Ozone Exposure Related Asthma ED Visits for Asthma (Among Residents Younger than 18)**	
	Atkinson Index [Relative Inequality] Inequality Aversion = 0.5	**Kolm-Pollak Index [Absolute Inequality]** Inequality Aversion = 0.5	**Atkinson Index [Relative Inequality]** Inequality Aversion = 0.5	**Kolm-Pollak Index [Absolute Inequality]** Inequality Aversion = 0.5
	(Values in 10^{-3})	(Values in 10^{-8})	(Values in 10^{-3})	(Values in 10^{-8})
Baseline	24.0	5.0	7.5	16.5
Policy	22.2	3.4	7.6	13.6
Change	↓	↓	↑	↓

Note: Inequality aversion parameters take on non-negative values only, and a higher value indicates that a society is more "inequality averse". However, the same parameter value does not imply the same degree of inequality aversion between Atkinson and Kolm-Pollak Indices.

[16] The inequality index values also cannot be compared across different inequality aversion parameters even with the same inequality index. See Appendix 6-B for more discussion on the inequality aversion parameter.

[17] The degree of inequality aversion can also potentially contribute to the different directional changes between Atkinson and Kolm-Pollak Indices. Although Table 6-7 applies the same inequality aversion parameter value (0.5) to both indices, it does not imply the same degree of inequality aversion; moreover, there is no direct conversion of inequality aversion between these indices. See Industrial Economics et al. (2016) and Appendix 6-B for more discussion on inequality aversion.

Tables 6-8 and 6-9 decompose the overall inequality of health risk, for Atkinson and Kolm-Pollak Indices respectively, into two components: inequality *between* EJ and non-EJ groups of communities and a weighted average inequality *within* each group; moreover, the decomposition was conducted for all three alternative EJ definitions and the two population thresholds for EJ designation. In terms of *relative* inequality as measured by the Atkinson Index (see Table 6-8), it is observed that there is consistently greater within- than between-group dispersion for both mortality and morbidity risk analyzed here. Nonetheless, both between- and within-group inequalities are reduced for PM2.5 and ozone exposure related mortality risk among adults. In the meantime, the inequality between EJ and non-EJ communities is shown to increase for the health risk of ozone exposure related asthma ED visits among children, although the corresponding within-group inequality decreases. This implies that the increase in overall inequality, as measured by the Atkinson Index for the same morbidity risk shown in Table 6-7, is largely driven by an increase in relative inequality between EJ and non-EJ group of communities.

In terms of *absolute* inequality as measured by the Kolm-Pollak Index (see Table 6-9), it also shows greater within- than between-group dispersion. Furthermore, the changes of absolute inequality largely corroborate the results shown for relative inequality: the between-group inequality also increases for the health risk of ozone exposure related asthma ED visits among children, with the only exception when EJ is designated at the top 50 percent of Basin-wide population under Alternative Definition 2. Therefore, the decrease in overall inequality, as measured by the Kolm-Pollak Index for the same morbidity risk shown in Table 6-7, is due to a larger reduction in the absolute within-group inequality, which dominates any increase in the absolute between-group inequality.

Table 6-8: Decomposed Distributional Impact of the Draft 2016 AQMP in 2031 Using Relative Inequality-Based Atkinson Index (Inequality Aversion = 0.5)

	PM2.5 and Ozone Exposure Related Mortality Risk (Among Residents 25 Years or Older)				**Ozone Exposure Related Asthma ED Visits for Asthma (Among Residents Younger than 18)**			
	Top 50%		*Top 25%*		*Top 50%*		*Top 25%*	
	Between	Within	Between	Within	Between	Within	Between	Within
	(All values are in 10^{-3})							
Def. 1								
Baseline	1.6	22.4	1.6	22.4	0.9	6.6	0.7	6.83
Policy	1.3	20.9	1.3	21.0	1.1	6.5	0.8	6.77
Change	↓	↓	↓	↓	↑	↓	↑	↓
Def. 2								
Baseline	2.3	21.7	1.8	22.3	1.3	6.2	0.8	6.74
Policy	1.9	20.4	1.4	20.9	1.5	6.1	0.9	6.66
Change	↓	↓	↓	↓	↑	↓	↑	↓
Def. 3								
Baseline	2.2	21.9	1.5	22.5	0.5	7.0	0.3	7.15
Policy	1.9	20.4	1.3	21.0	0.7	6.9	0.5	7.09
Change	↓	↓	↓	↓	↑	↓	↑	↓

Table 6-9: Decomposed Distributional Impact of the Draft 2016 AQMP in 2031 Using Absolute Inequality-Based Kolm-Pollak Index (Inequality Aversion = 0.5)

	PM2.5 and Ozone Exposure Related Mortality Risk (Among Residents 25 Years or Older)				**Ozone Exposure Related Asthma ED Visits for Asthma (Among Residents Younger than 18)**			
	Top 50%		*Top 25%*		*Top 50%*		*Top 25%*	
	Between	Within	Between	Within	Between	Within	Between	Within
	(All values are in 10^{-8})							
Def. 1								
Baseline	0.3	4.7	0.3	4.6	1.9	14.6	1.4	15.1
Policy	0.2	3.3	0.2	3.3	2.0	11.7	1.5	12.2
Change	↓	↓	↓	↓	↑	↓	↑	↓
Def. 2								
Baseline	0.4	4.5	0.3	4.6	2.74	13.8	1.6	14.9
Policy	0.2	3.2	0.2	3.2	2.72	11.0	1.7	12.0
Change	↓	↓	↓	↓	↓	↓	↑	↓
Def. 3								
Baseline	0.4	4.6	0.3	4.7	1.0	15.5	0.7	15.8
Policy	0.2	3.2	0.2	3.3	1.2	12.5	0.9	12.8
Change	↓	↓	↓	↓	↑	↓	↑	↓

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