

Executive summary of
Putting the Environment back in “Environmental Justice”:
A Two-Dimensional Approach for Area Identification.

by

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President Biden’s Executive Order 14008 brought the importance of overburdened communities to the forefront of environmental policy, prioritizing the “fair treatment” and “meaningful involvement” fundamental environmental justice (EJ) concepts to address environmental and health disparities. State-level EJ policies typically define EJ areas based on community-level socioeconomic characteristics. Consequently, EJ area identification processes can potentially conceal severely overburdened communities by not including environmental factors in the designation process.

Most states define EJ areas based on socioeconomic characteristics (such as race, ethnicity, and income) and do not include environmental factors in their EJ area identification. This one-dimensional approach emphasizes only socioeconomic characteristics and does not successfully address the EJ priorities of overburdened communities set forth by EO 14008. EJ area designation should satisfy the EJ duality requirement to meet these priorities. In terms of procedure, this implies that all the designated communities should be identified by accounting for both the socioeconomic disparity (SD) and environmental burden (EB) dimensions.

The EJ duality requirement can be achieved through the employment of a coincidence (also known as confusion or error) matrix as an assessment tool and an approach to identify EJ areas. In doing so, we can more precisely identify socio-economically vulnerable communities that are also disproportionately impacted by environmental burdens. The city of Chicago is used as a case study to demonstrate how the one-dimensional binary classification of EJ communities has the potential to conceal communities facing environmental burdens, which may exacerbate environmental injustice. In addition, we implement the proposed two-dimensional approach and demonstrate the importance of incorporating the community-level SD and EB characteristics in EJ area identification. This practice contributes to the achievement of EJ priorities in an efficient and equitable way.

This two-dimensional approach provides the required granularity to prioritize EJ measures and advance the objectives of EJ legislative measures such as the proposed Illinois HB 4093 (i.e., sec. 5/39.15 Environmental justice considerations in permitting). for the protection of EJ communities since it defines areas of EJ severity.

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ABSTRACT

State-level environmental justice (EJ) policies typically define EJ areas based on community-level socioeconomic characteristics. Consequently, EJ area identification processes can miss overburdened communities by excluding environmental factors. President Biden’s Executive Order 14008 prioritizes the “fair treatment” and “meaningful involvement” of overburdened communities to address environmental and health disparities. First, we review ten state-level EJ frameworks to understand how EJ areas are defined. Then, we introduce the EJ duality to address the lack of environmental factors in EJ area identification. This two-dimensional approach requires simultaneously assessing socioeconomic and environmental disparities to identify EJ areas. Finally, we use Chicago as a case study to demonstrate how classifying EJ communities through a one-dimensional method conceals communities facing environmental burdens, which may exacerbate environmental injustice. We recommend that state-level agencies adopt an efficient and equitable two-dimensional approach to achieve EJ priorities.

INTRODUCTION

The U.S. Environmental Protection Agency (EPA) defines environmental justice (EJ) as “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. President Biden's Executive Order 14008 *Tackling the Climate Crisis at Home and Abroad* calls for federal agencies to prioritize the fair treatment and meaningful involvement of overburdened communities.² Disadvantaged communities are primarily home to racial/ethnic minorities, low-income, and tribal or indigenous populations; historically marginalized and potentially affected by adverse environmental health harms and risks.³ Ten states define EJ areas based on one quantifiable measure, which we refer to as a one-dimensional approach.⁴ This approach does not simultaneously consider social and

¹ U.S. EPA. “Environmental Justice.” Environmental Protection Agency. Accessed June 14, 2022. <<https://www.epa.gov/environmentaljustice>>.
² U.S. President. Executive Order 14008. Sec. 219. January 27, 2021.
³ U.S. EPA. Evaluation report: EPA needs to consistently implement the intent of the executive order on environmental justice. Report No. 2004-P-00007. March 1, 2004. Accessed June 14, 2022. <<https://www.epa.gov/sites/default/files/2015-12/documents/20040301-2004-p-00007.pdf>>
⁴ Fusi, F., Zhang, F., and Liang, J. "Unveiling environmental justice through open government data: Work in progress for most US states." *Public Administration* (2022).

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environmental factors in the identification process, which can omit disproportionately impacted communities, and does not address EO 14008 mission. In this brief, we first review how ten selected states define EJ areas. Second, we propose a two-dimensional EJ area identification approach. Third, using Chicago as a case study, we provide a comprehensive approach to identifying overburdened communities. The proposed method measures polluting source(s) at the community level, is accessible to the public, and prioritizes relief for overburdened communities.

DEFINING ENVIRONMENTAL JUSTICE AREAS

According to Fusi et al. (2022), twenty-three states have no EJ definition; ten have at least one quantifiable measure for EJ, and seventeen define EJ yet do not have measurable criteria.⁵ For instance, Tennessee's EJ definition does not prioritize overburdened communities, “[EJ] means only protecting human health and the environment for everyone, but also ensuring that all people are treated fairly and allowed to participate meaningfully in the development, implementation, and enforcement of environmental laws, regulations, and policies.”⁶

We review ten state-level EJ frameworks with at least one EJ measure and examine their EJ area definitions and the accompanying threshold-based screening practices. Finally, we discuss EJ area identification practices by unit of analysis: block groups, census tract, municipality, and neighborhood.

Five state-level EJ frameworks use census block groups (BGs) as the unit of analysis to define EJ areas. For example, Illinois designates a BG as an EJ community if its racial/ethnic minority population is greater than or equal to twice the state average for the current ACS 5-year estimate within each BG.⁷ In New York, “Potential EJ Areas” are BGs with 250 to 500 households that meet or exceed at least one of the following thresholds: at least 52.42% of the population in an urban area or 26.28% of the population in a rural area are racial/ethnic minorities; at least 22.82% of the population in an urban or rural area have household incomes below the federal poverty level.⁸ To identify EJ communities, Rhode Island focuses on areas where a minority group or low-

⁵ Fusi, F., Zhang, F., and Liang, J. “Unveiling environmental justice through open government data: Work in progress for most US states.” *Public Administration* (2022).

⁶ State of Tennessee. “Environmental Justice.” Environmental Justice. Accessed August 4, 2022. <<https://www.tn.gov/health/cedep/environmental/healthy-places/healthy-places/health-equity/he/environmental-justice.html>>

⁷ State of Illinois. “Illinois EPA EJ Start - Data Sources & Definitions.” Illinois EPA. Accessed June 30, 2022. <<https://illinois-epa.maps.arcgis.com/apps/webappviewer/index.html?id=f154845da68a4a3f837cd3b880b0233c>>

⁸ State of New York. “Maps & Geospatial Information System (GIS) Tools for Environmental Justice.” NYS Dept. of Environmental Conservation. Accessed July 5, 2022. <<https://www.dec.ny.gov/public/911.html>>

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income population is in the top 15% of BGs state-wide.⁹ Colorado defines disproportionately impacted communities as BGs with one of three demographic factors: more than 40% low-income households; more than 40% racial / ethnic minority households; or more than 40% housing cost-burdened households.¹⁰ In New Jersey, an overburdened community is any BG with at least 35% of low-income households; at least 40% of the residents identified as members of a state-recognized tribal community; or at least 40% of the households with limited English proficiency.¹¹

Minnesota, Pennsylvania, and California define EJ areas at the census tract (CT) level. Minnesota considers a CT an EJ area if it meets one or both demographic criteria: the minority population is greater than 50%, or more than 40% of households have a household income less than 185% of the federal poverty level. Additionally, Minnesota considers communities within tribal boundaries as EJ areas.¹² In Pennsylvania, an EJ area is any CT where 20% or more individuals live at or below the federal poverty line or 30% or more of the population identifies as non-white.¹³ Unlike the other states reviewed, California recently began integrating a two-dimensional approach. In May 2022, California updated its “disadvantaged communities” designation, which considers socioeconomic characteristics and overall environmental scores in CalEnviroScreen 4.0.¹⁴

Two states use municipality and neighborhood geographies. For example, Connecticut defines EJ areas using a “distressed municipality ranking” with weighted components summed to rank 169 towns. A distressed municipality has high unemployment and poverty, aging housing stock, low or declining job creation growth rates, population, and per capita income.¹⁵ If a municipality is not distressed but has BGs with 30% of the population living below 200% of the federal poverty level, then the state considers those BGs EJ area.¹⁶ In Massachusetts, a community is designated as an EJ area if it meets one or more of the following four criteria: the annual median household income is not more than 65% of

⁹ State of Rhode Island. “Department of Environmental Management.” Rhode Island - Department of Environmental Management. Accessed July 5, 2022. <<http://www.dem.ri.gov/programs/wastemanagement/site-remediation/environmental-justice.php>>
¹⁰ State of Colorado. “Environmental Justice.” Department of Public Health & Environment. Accessed July 5, 2022. <<https://cdphe.colorado.gov/environmental-justice>>
¹¹ State of New Jersey. “What Are Overburdened Communities (OBC)?” New Jersey Department of Environmental Protection. Accessed July 5, 2022. <<https://www.nj.gov/dep/ej/communities.html>>
¹² State of Minnesota. “MPCA and Environmental Justice.” Minnesota Pollution Control Agency, May 16, 2022. <<https://www.pca.state.mn.us/about-mpca/mpca-and-environmental-justice>>
¹³ State of Pennsylvania. “PA Environmental Justice Areas.” Department of Environmental Protection. Accessed July 5, 2022. <<https://www.dep.pa.gov/PublicParticipation/OfficeofEnvironmentalJustice/Pages/PA-Environmental-Justice-Areas.aspx>>
¹⁴ State of California. “California Climate Investments to Benefit Disadvantaged Communities.” CalEPA. Accessed July 5, 2022. <<https://calepa.ca.gov/envjustice/ghginvest/>>
¹⁵ State of Connecticut. “Environmental Justice Communities.” CT.gov. Accessed July 5, 2022. <<https://portal.ct.gov/DEEP/Environmental-Justice/Environmental-Justice-Communities>>
¹⁶ State of Connecticut. “Environmental Justice Communities.” CT.gov. Accessed July 5, 2022.

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the statewide annual median household income; racial/ethnic minorities comprise at least 40% of the population; 25% of households lack English language proficiency; or racial/ethnic minorities comprise 25% of the population, and the annual median household income of the corresponding municipality does not exceed 150% of the statewide annual median household income.¹⁷

In sum, California is the only state that uses environmental and socioeconomic dimensions to identify EJ areas. Several states, such as Illinois and Connecticut, have environmental and socioeconomic screening tools available only as separate map layers instead of a cumulative score and are not a decision-making tool as applied in California. Furthermore, the unit of analysis is inconsistent across the selected ten states. The geographic levels vary significantly between census-based geographies and administrative boundaries. Similarly, states have different thresholds for socioeconomic EJ criteria. For example, Connecticut defines low-income populations as those living below 200% of the federal poverty level, whereas Minnesota uses a 185% below the federal poverty level threshold. While some states compare EJ areas and rank them to determine EJ status, others compare BG characteristics to the state level. Combined with a one-dimensional approach, these inconsistencies can potentially conceal environmental burden disparities.

THE CASE FOR ENVIRONMENTAL INCLUSION IN EJ AREA IDENTIFICATION

Identifying EJ areas using the one-dimensional approach yields a broad spectrum. For example, in Chicago, the Illinois EPA EJ Start map renders a CT with a median household income (MHI) of \$142,000 (CT 8088) and a CT with an MHI of \$38,000 (CT 6006) as an EJ area. The one-dimensional approach overlooks environmentally overburdened areas and undermines the need to prioritize them for relief measures. In addition, the lack of granularity fosters risk in allocating environmental improvement resources to low priority EJ areas (CT 8088).

EJ areas should meet the EJ duality requirement to advance EO 14008 priorities by examining social disparity (SD) and environmental burden (ED) dimensions. To achieve the EJ duality requirement, we employ a coincidence matrix as an assessment tool and an approach to identify EJ areas.¹⁸ In doing so, we can more precisely identify socially vulnerable communities that are disproportionately impacted by environmental burdens.

¹⁷ State of Massachusetts. “Environmental Justice Populations in Massachusetts.” Mass.gov. Accessed July 5, 2022. <<https://www.mass.gov/info-details/environmental-justice-populations-in-massachusetts>>

¹⁸ H. G. Lewis & M. Brown (2001) A generalized confusion matrix for assessing area estimates from remotely sensed data, *International Journal of Remote Sensing*, 22:16, 3223-3235, DOI: 10.1080/01431160152558332

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To demonstrate the issues raised by implementing the one-dimensional classification compared to a two-dimensional approach, we use Massachusetts’s¹⁹ three basic threshold criteria to classify the BGs in Chicago (Table 1).²⁰ We obtained socioeconomic-variables from the American Community Survey (ACS) 2015-2019 5-year-estimates tables.²¹ For this demonstration, we used the number of toxic release inventory (TRI) reporting facilities²² at the BG level as an EB indicator. We use BG as the geographic level because it is the smallest unit for socioeconomic data from the ACS and provides better precision than CT in identifying high-priority areas.²³ In this simplified two-dimensional assessment, the coincidence matrix renders 54.56% of BGs as EJ areas using Massachusetts’s threshold criteria; none encompass any TRIs (i.e., SD/non-EB areas). According to both approaches, only 34.75% of the BGs are classified appropriately as non-SD/non-EB areas and 7.21% as SD/EB areas. It is noteworthy that 3.47% of BGs do not have an EJ designation, despite containing TRIs (i.e., non-SD/EB areas), which does not meet the EO 14008 mission to prioritize overburdened communities. Other EB indicators, such as brownfield locations and rail hubs, generated similar results (not shown). This assessment underscores the limitations within the one-dimensional approach for implementing and evaluating EJ policies.

[Table 1 about here]

Calibrating the SD and EB dimensions is a significant two-dimensional approach requirement. Additional analyses are thus necessary to identify more variables and matrix dimensions for optimal results; this work is currently underway by the authors. We construct another coincidence matrix for demonstration purposes using only one SD variable: the percent of MHI for Chicago households (in a reversed order from high to low with min-max scaling). We use TRIs as the EB indicator.

The two-dimensional approach showed that only 10.7% of BGs satisfy the EJ duality requirement (i.e., red-highlighted cells) (Table 2). The proposed two-dimensional method identifies EJ BGs, by offering a more holistic identification scheme than the one-dimensional approach by using SD and EB dimensions calculated at a relative scale. More importantly, this approach prioritizes relief measures aiming to overcome “the

¹⁹ MassGIS Data: 2020 Environmental Justice Populations. <<https://www.mass.gov/info-details/massgis-data-2020-environmental-justice-populations#summary-tables>>. MassGIS (Bureau of Geographic Information). June 2021.

²⁰We removed BGs that lack demographic data. In addition, we excluded BGs constituting the O’Hare International Airport area due to their lack of urban characteristics.

²¹American Community Survey (ACS) 2015-2019 5-year estimates tables. <<https://www.census.gov/programs-surveys/acs>>.

²²U.S. EPA. Toxics Release Inventory (TRI) Program. TRI Data and Tools. <<https://www.epa.gov/toxics-release-inventory-tri-program/tri-data-and-tools>>.

²³ Flax-Hatch, J., Srabanti, S., Miranda, F., Sambanis, A., & Cailas, M. (2021). Visualizing environmental justice issues in urban areas with a community input approach. UC Santa Barbara: Center for Spatial Studies. <<http://dx.doi.org/10.25436/E2Z30J>> Retrieved from <<https://escholarship.org/uc/item/81g5n0tq>>

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reality of overburdened communities, which means that it is often easier to site the eighth facility in a community that already has seven than in a community that has none.”²⁴ Using Chicago as an example, the BGs with the most critical SD and EB are those with the lowest MHI and the highest TRI numbers (e.g., one of the 12 BGs that are the most socioeconomically vulnerable encompasses 15 TRIs; see Table 2). Therefore, the 1,428 BGs with the lowest EB and highest SD level (i.e., orange highlighted cells) should also be included in a long-term plan to prevent siting environmental burdens due to their socioeconomic vulnerability.

[Table 2 about here]

This demonstration shows how policymakers may exacerbate environmental injustice in overburdened communities through a one-dimensional approach. Although the two-dimensional method needs fine tuning (e.g., selecting the variables defining the EJ duality requirement and constructing the coincidence matrix’s dimensions), this method meets the EJ duality requirement and establishes a prioritization scale (e.g., red-highlighted cells in Table 2).

CONCLUSION

Our review of ten states’ EJ frameworks and area identification practices suggest that the one-dimensional classification method can yield a broad range of areas that may not be environmentally overburdened. Consequently, this approach lacks the precision to prioritize environmentally overburdened communities. The socioeconomic disparities and environmental burdens are fundamental components in EJ and must be simultaneously considered when identifying potential EJ areas. To meet the EJ duality requirement, we propose the two-dimensional approach and an assessment tool based on a coincidence matrix. We use Chicago as a case study to show how the one-dimensional classification can conceal environmentally overburdened communities that need relief measures. Therefore, incorporating the community-level SD and EB characteristics in EJ area identification is imperative to achieve EJ priorities efficiently and equitably.

Declaration of Conflicting Interests

The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

²⁴ U.S. EPA. Draft FY 2022-2026 EPA Strategic Plan. October 1, 2021. Accessed. June 16, 2022. < <https://www.epa.gov/system/files/documents/2021-10/fy-2022-2026-epa-draft-strategic-plan.pdf>>.

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Table 1. Assessment of the one-dimensional binary classification of EJ block groups (BG) in Chicago					
SD dimension EB dimension			Binary classification of BGs based on SD criteria		
			0	1	Total
Binary classification of BGs based on TRIs	0	Count	670	1,052	1,722
		% Total	34.75%	54.56%	89.31%
	1	Count	67	139	206
		% Total	3.47%	7.21%	10.68%
	Total count		737	1,191	1,928
Notes:					
SD refers to the variables describing socioeconomic disparities and EB to those describing environmental burden.					
SD criteria	BGs with 39.5% or more minority population, 24.5% or more Limited English, and less than or equal to 65.49% MHI are designated as 1. All other 0.				
EB criterion	BGs encompassing more than 1 TRI facilities are designated as 1. All other 0.				

Assessment of one-dimensional binary classification of EJ block groups (BG) in Chicago
204x210mm (120 x 120 DPI)

Table 2. Application of a two dinesional approach for classification of EJ block groups (BG) in Chicago						
SD dimension EB dimension		BG classification based on socioeconomic disparity (SD) criterion				
		≤ 20%	20.1% to 40%	40.1% to 60%	> 60%	Total
BG classification based on environmental burden (EB) criterion	0 (no TRIs)	13	54	227	1,428	1,722
	% Total	0.67	2.81	11.77	74.07	89.31%
	1 or 2	1	7	17	137	162
	% Total	0.05	0.36	0.88	7.11	8.40%
	3, 4, or 5	0	3	2	23	28
	% Total	0.0	0.16	0.10	1.19	1.45%
	> 5	0	1	3	12	16
	% Total	0.0	0.05	0.15	0.62	0.83%
	Total count	14	65	249	1,600	1,928
	% Total	0.73%	3.37%	12.91%	82.99%	100%
Notes:						
SD criterion		The percent median household income (MHI) in reverse order for Chicago (highest 20% to lowest 60%). BGs without reported MHI where excluded.				
EB criterion		BGs encompassing TRI facilities starting with those having none.				

Application of a two dimensional approach for classification of EJ block groups (BG) in Chicago

222x220mm (120 x 120 DPI)