Lecture 14: Environmental Justice Analysis

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Econ 4075

EJ Analysis Roadmap

1. Why is there inequality of pollution exposure for minority and low-income populations?
   - Contextual background, common explanations

2. How can we determine if environmental policies will worsen environmental or wealth inequality for minority and low-income populations?

   - Foundations
   - Analytic Considerations
   - Example EJ Analysis
   - Retrospective Studies of EJ Analyses

Part 1: Foundations

Environmental Justice Analysis as a Priority

Executive orders:

- Executive order 12898
- Executive order 14008
  - Signed January 2021

SECURING ENVIRONMENTAL JUSTICE AND SPURRING ECONOMIC OPPORTUNITY

Sec. 219. Policy. To secure an equitable economic future, the United States must ensure that environmental and economic justice are key considerations in how we govern. That means investing and building a clean energy economy that creates well-paying union jobs, turning disadvantaged communities — historically marginalized and overburdened — into healthy, thriving communities, and undertaking robust actions to mitigate climate change while preparing for the impacts of climate change across rural, urban, and Tribal areas. **Agencies shall make achieving environmental justice part of their missions by developing programs, policies, and activities to address the disproportionately high and adverse human health, environmental, climate-related and other cumulative impacts on disadvantaged communities, as well as the accompanying economic challenges of such impacts.** It is therefore the policy of my Administration to secure environmental justice and spur economic opportunity for disadvantaged communities that have been historically marginalized and overburdened by pollution and underinvestment in housing, transportation, water and wastewater infrastructure, and health care.

Justice40 Initiative

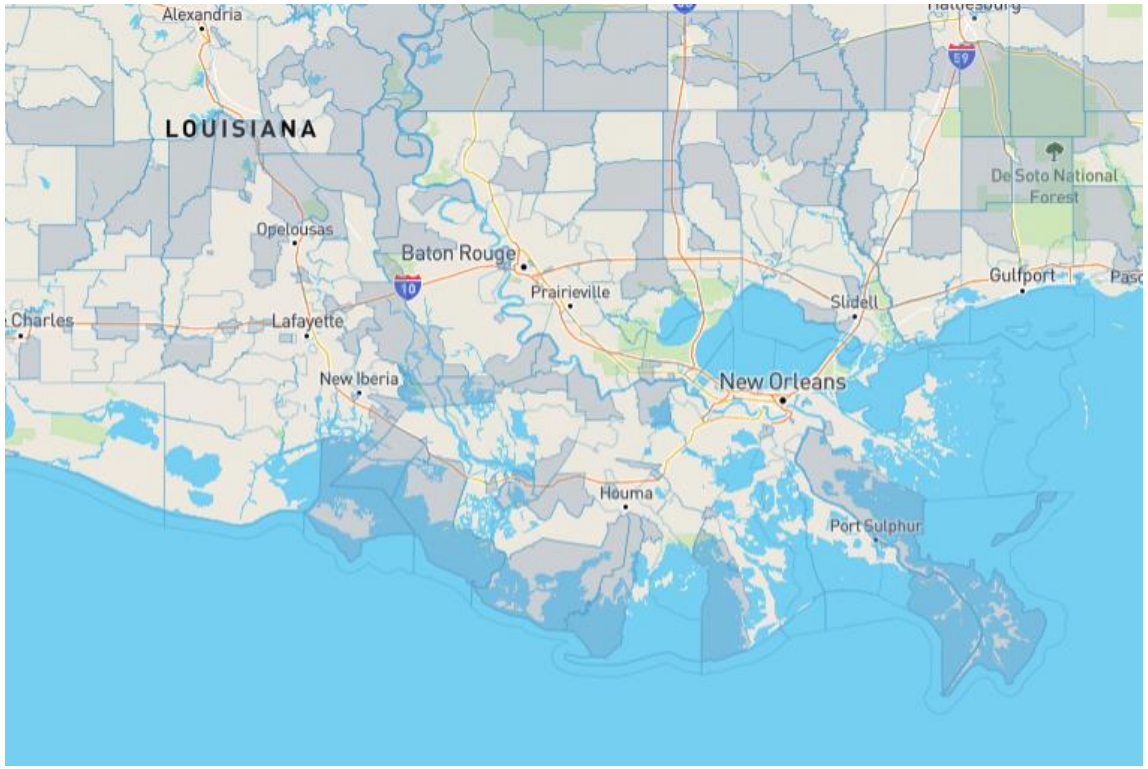


Figure: Disadvantaged communities in Southern Louisiana according to CEJST (link to tool).

What is the Justice40 Initiative?

For the first time in our nation's history, the Federal Government has made it a goal that 40 percent of the overall benefits of certain Federal investments flow to disadvantaged communities that are marginalized, underserved, and overburdened by pollution. President Biden made this historic commitment when he signed Executive Order 14008 within days of taking office.

What is an EJ Analysis?

An EJ analysis documents baseline conditions such as pre-existing exposure, cumulative impacts, and distribution of health impacts over population groups with heightened socioeconomic vulnerability.

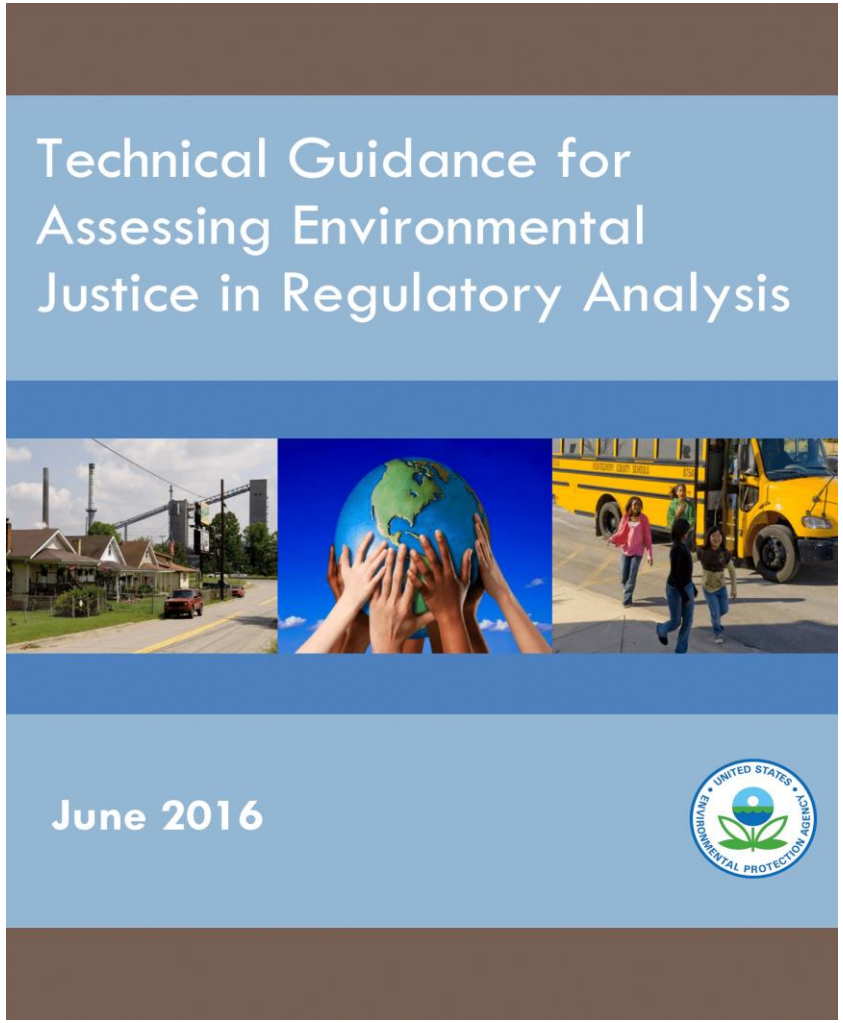
An EJ analysis is distinct from distributional analysis:

- Distributional analysis is an evaluation of incidence of benefits or costs by different members of society (often income quintiles)

Guidelines for EJ Analysis

EPA's *Technical Guidance for EJ Analysis*:

- Underwent extensive internal review by all program offices, public comment, and peer review by EPA's Science Advisory Board.
- Finalized in 2016 but never properly implemented.
- Outlines approaches for risk assessors and economists to evaluate EJ concerns for significant policy actions
  - ➢ 2022 Strategic Goal to have EJ Analyses in at least 80% of significant policy actions.



Goals of EJ Analysis

An EJ Analysis seeks to answer three questions:

1) Is there evidence of potential EJ concerns in the baseline for population groups of concern?
2) Do the regulatory option(s) under consideration affect the potential EJ concern?
3) Do the regulatory option(s) under consideration exacerbate or mitigate EJ concerns relative to the baseline?

Key Terms: Potential EJ Concern

Procedural Justice

2.1 Potential EJ Concern and Disproportionate Impacts

A *potential EJ concern* is defined as "the actual or potential lack of fair treatment or meaningful involvement of minority populations, low-income populations, tribes, and indigenous peoples in the development, implementation and enforcement of environmental laws, regulations and policies" (U.S. EPA, 2015a). For analytic purposes, this concept refers more specifically to "disproportionate impacts on minority populations, low-income populations, and/or indigenous peoples that may exist prior to or that may be created by the proposed regulatory action" (U.S. EPA, 2015a).[8]

Distributive Justice

Key Terms: Vulnerability

"A matrix of **physical, chemical, biological, social, and cultural factors** that result in certain communities and subpopulations being **more susceptible** to environmental factors because of greater exposure to such factors or a compromised ability to cope with and/or recover from such exposure."

Source: WHO (2006). Principles for Evaluating Health Risks in Children.

Key Terms: Groups of Concern

Groups of Concern

- People of color: American Indian or Alaska Native, Asian, Black, Native Hawaiian and Pacific Islander, and Hispanic
- Characteristics associated with vulnerability: low income, over age 65, under 5, women of child-bearing age, linguistic isolation, low educational attainment, subsistence fishers

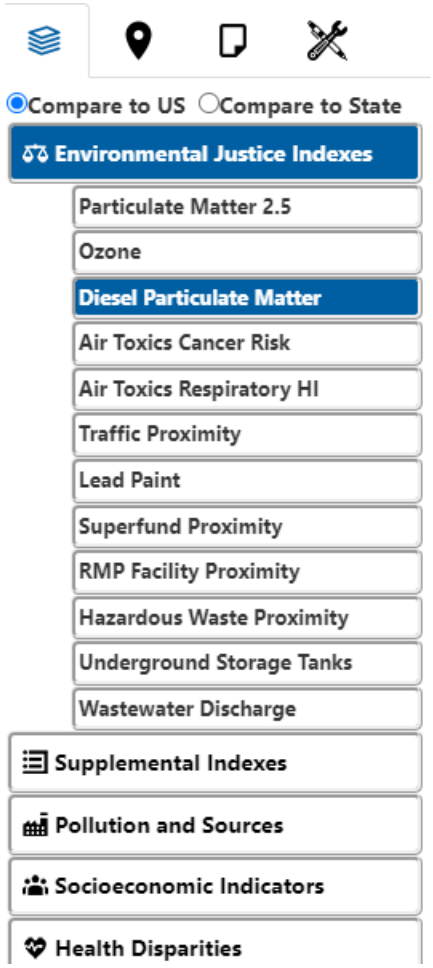
Steps to an EJ Analysis

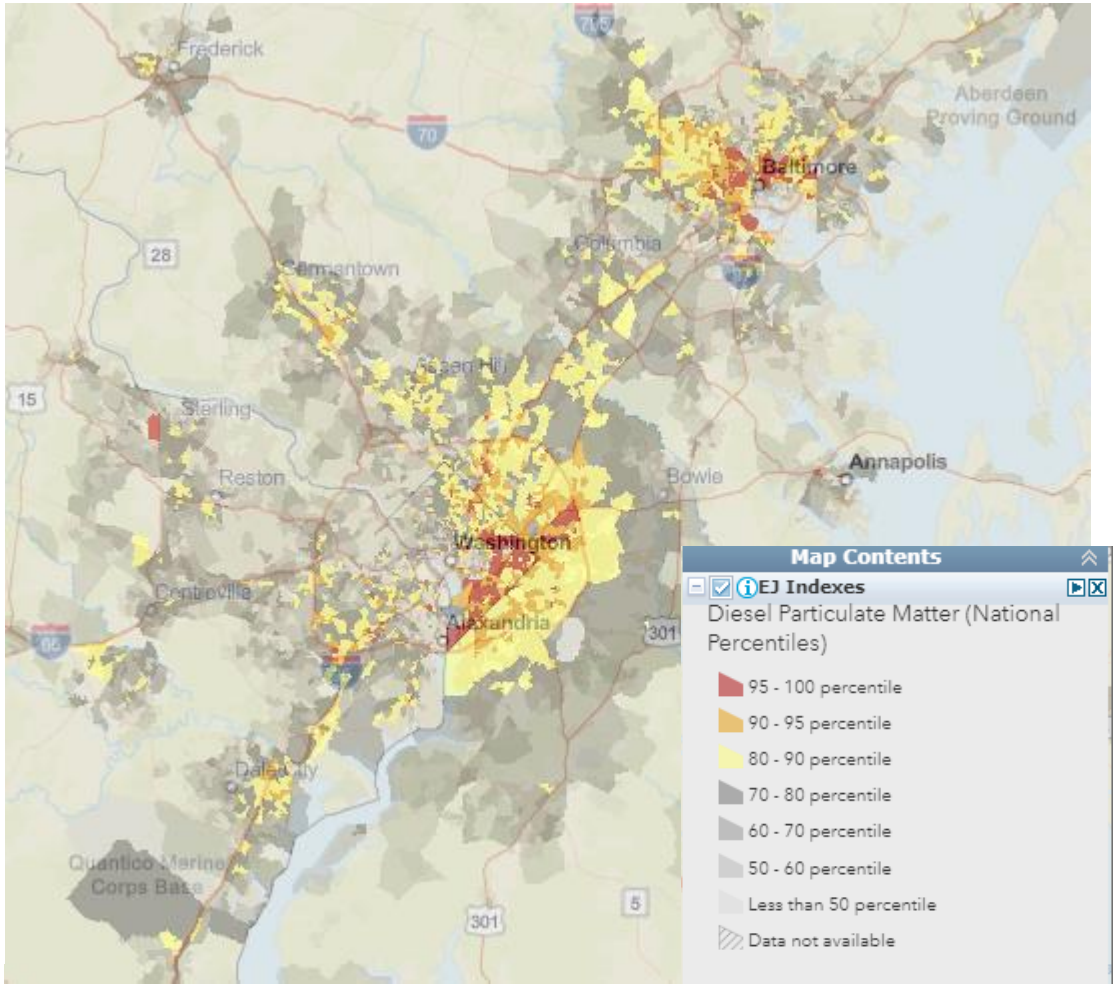
Early **screening assessment**:

1. Review availability of data and analytic methods
2. Evaluate literature and stakeholder input
3. Identify indicators of potential EJ concerns
   - Proximity, potential for hotspots, number of sources, nature and amounts of pollutants already impacting relevant populations, unique exposure pathways, unique vulnerabilities, etc.

EJSCREEN version 2.0

- Nationally consistent environmental and demographic data in maps
- Block-group level data
- State/national levels and percentiles as basis of comparison
- Allows custom buffers, threshold maps, batch analyses
- Indices to highlight the intersection between environmental and socioeconomic factors

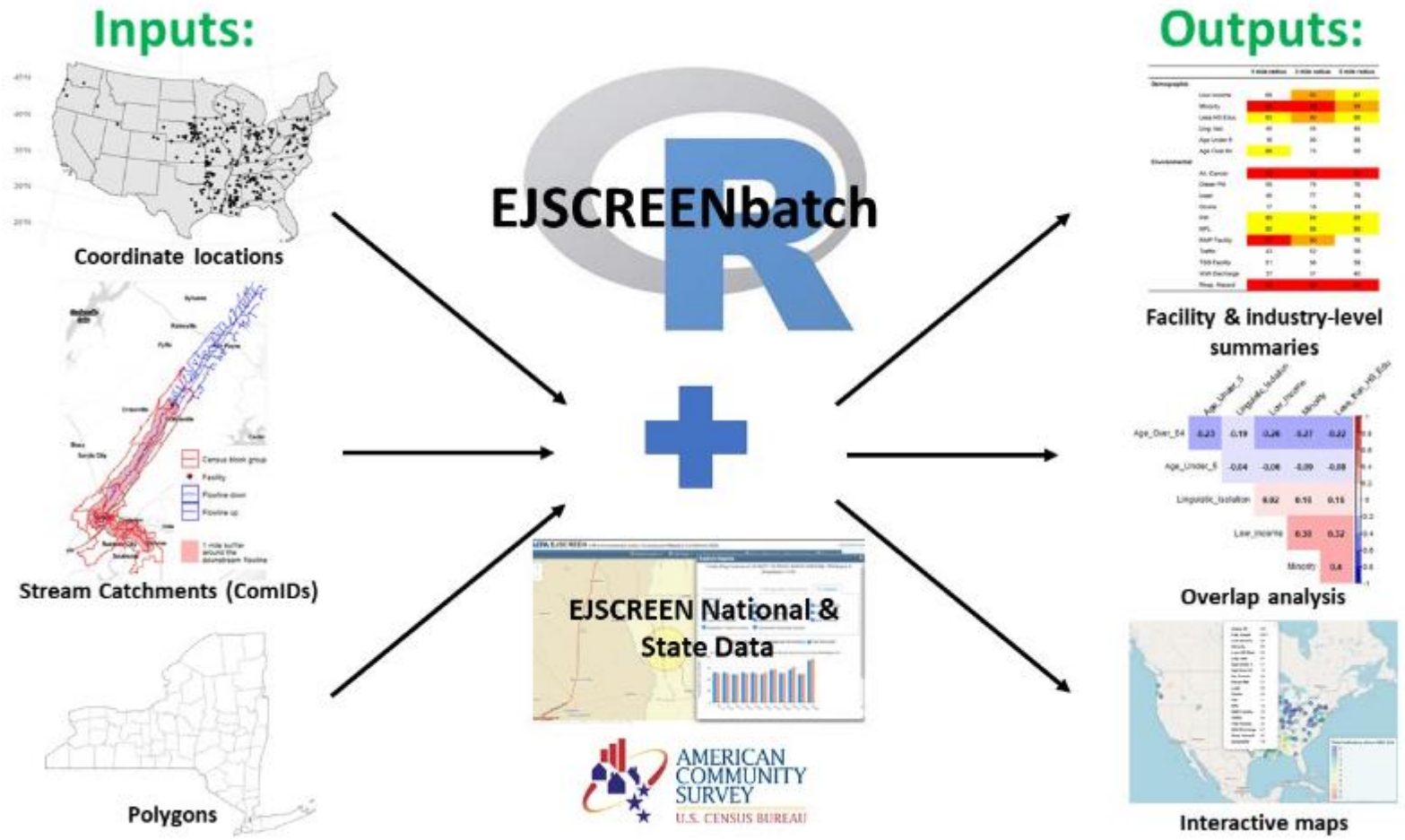




EJSCREENbatch

EJSCREENbatch is an open-source processing tool that allows inputting many locations and fetching aggregate EJSCREEN information and other demographic information.

- Github repo.



EJSCREENbatch: Example of 3M Plant in Cordova, Illinois

The 3M Specialty Film and Media Products Plant manufactures PFAS. According to NPDES DMR reports, it released:

- 26,000 kg of 10 unique PFAS, especially PFBA, over the period from 2018-2021.

A buffer approach for all tracts within 20-miles around the facility and a 180-mile distance downstream includes 282 CBGs with a population of 290,000.

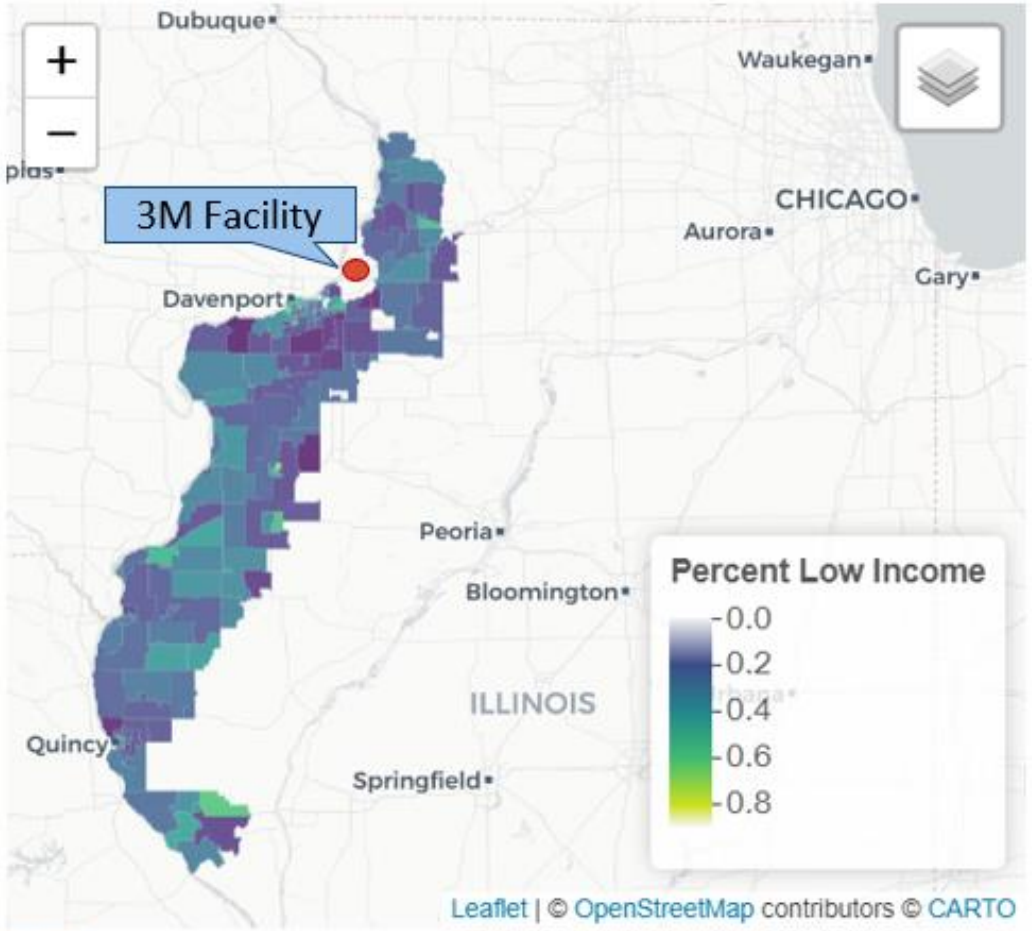


Figure: Illinois CBGs within 20 miles of the 3M Facility and within 20 miles of a 180-mile downstream trace.

EJSCREENbatch: Example of 3M Plant in Cordova, Illinois

Service Boundaries can be used to screen across the 95 census block groups served by water systems with PFAS detections.

EJSCREEN Indicator	Average (Detect = 1)	Average (Detect =0)	State Average	National Average
Pct. Minority	33.5	27.1	28.7	31.4
Pct. Low Income	30.6	9.5	38.6	39.9
Pct. Linguistic Isolation	2.5	0.6	4.8	5.4
PM 2.5	9.3	9.1	9.9	8.7
Traffic Proximity	470.7	163.1	752.0	705.0
Pct pre-1960 Housing	56.5	44.7	39.9	27.2
Population	111,517	179,598		

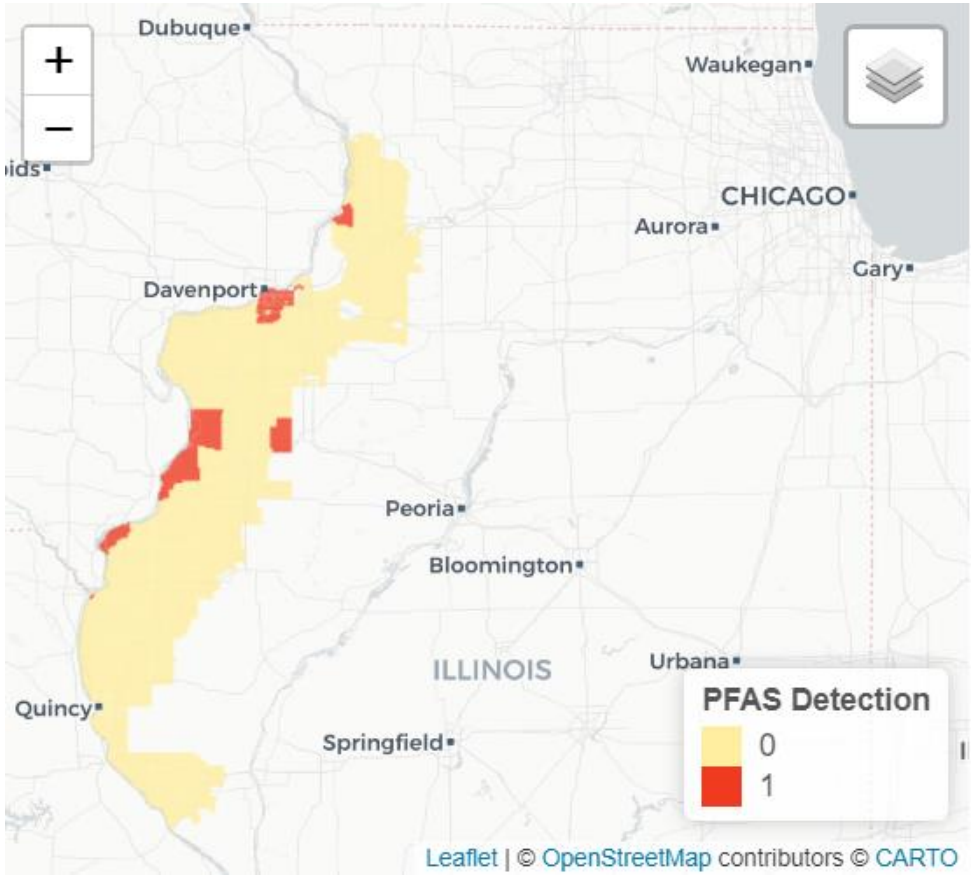


Figure: Illinois CBGs with a detection any of 12 PFAS from 2016-2021. Data source: Illinois Drinking Water Watch website

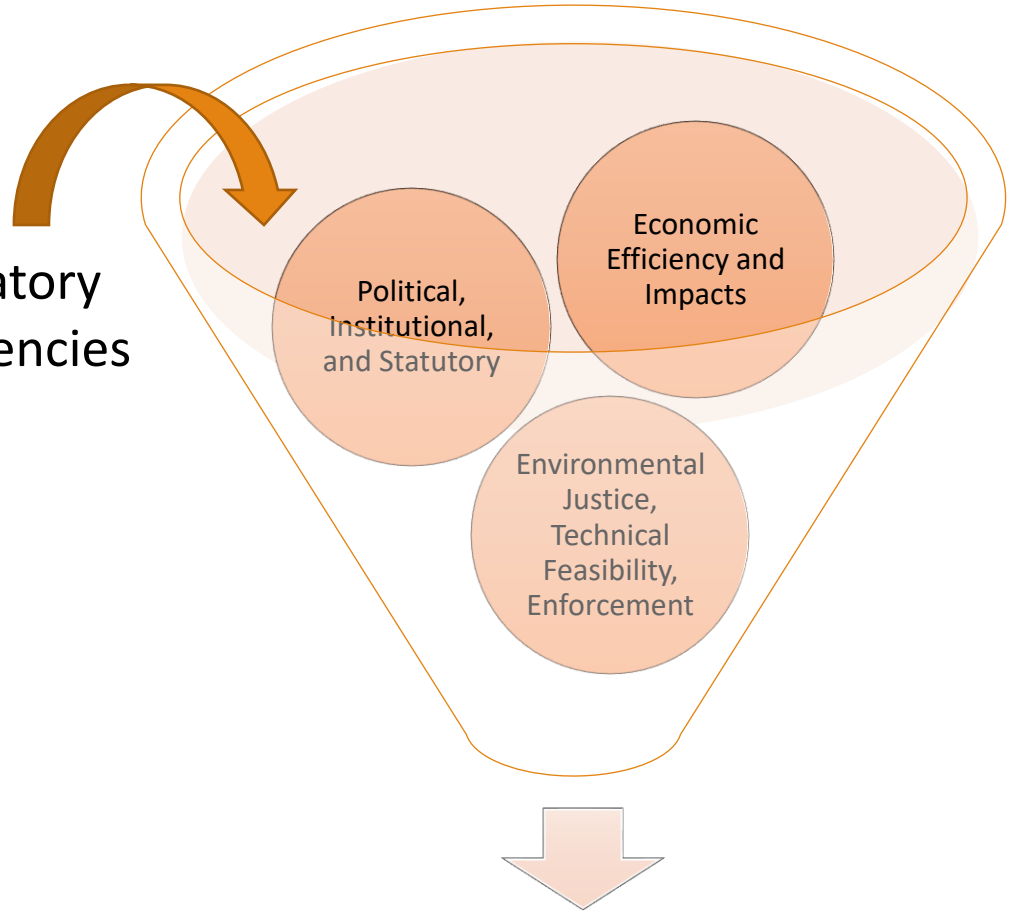
Other Steps in an EJ Analysis

4. More in-depth assessment if warranted and where possible:
    - Select relevant geographic scope, scale, and comparison groups
    - Capacity for more nuanced approaches dictated in part by ability to build from risk and benefits assessments
5. Pre-proposal community engagement:
    - Recent examples: oil & gas NPSPS, steam electric ELG, PFAS NPDWR

How EJ Analysis Informs Regulatory Design

- Political Factors
- Statutory Instruction
- Institutional Feasibility
- Benefits and Costs (Economic Efficiency)
- Environmental Justice
- Economic Impacts (Distribution)
- Technical Feasibility
- Enforceability
- Ethics
- Sustainability

Possible Regulatory Designs/Stringencies



Preferred Alternative(s)

Part 2: Analytic Considerations

Common Pitfalls in Assessing EJ Concerns

Studies may miss or mis-characterize EJ concerns because of their analytic methods:

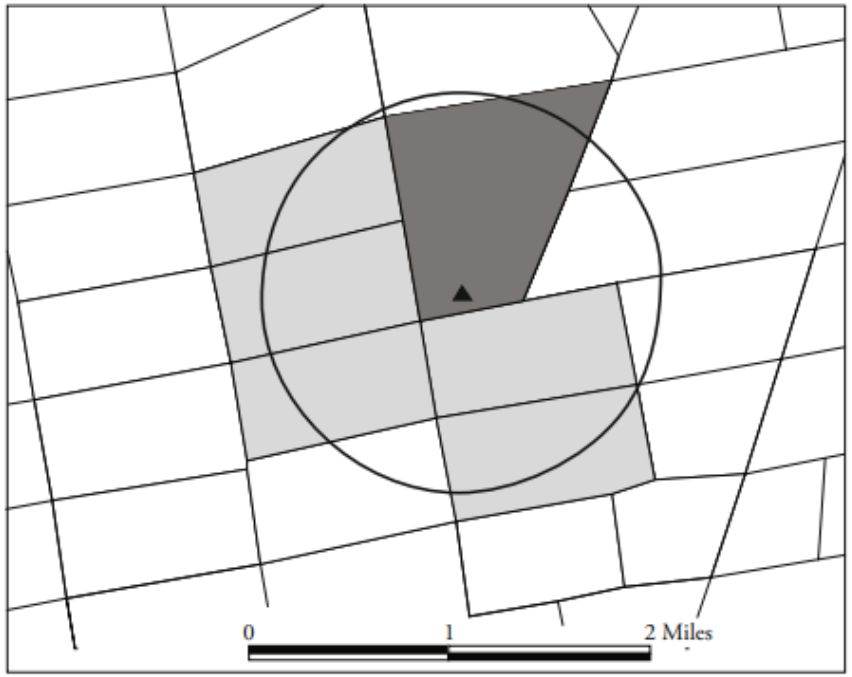
- Defining the comparison group
- Controlling (or not controlling) for other variables and multicollinearity
- Transboundary pollution and measurement error
- Unit-hazard coincidence vs. distance measures
- Defining the unit of analysis and the **ecological fallacy**

Mohai and Saha (2006)

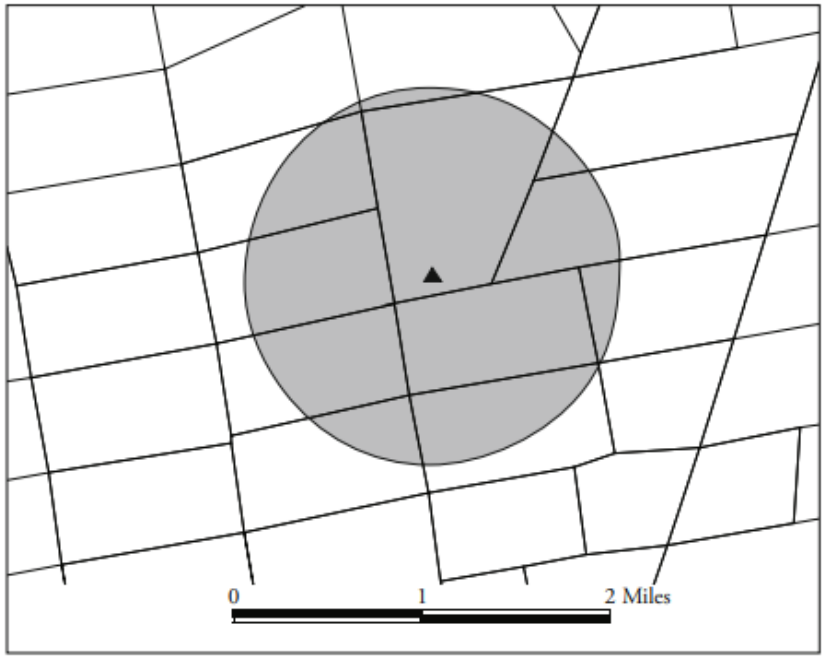
Unit-hazard coincidence considers the demographics of one pre-determined boundary.

Distance-based measures consider demographics within a specified distance, often by areal apportionment.

a. 50% areal containment using a one-mile radius



b. Areal apportionment using a one-mile radius



Mohai and Saha (2006)

Race and income are more likely to be correlated with pollution when using distance-based measures rather than unit-hazard coincidence.

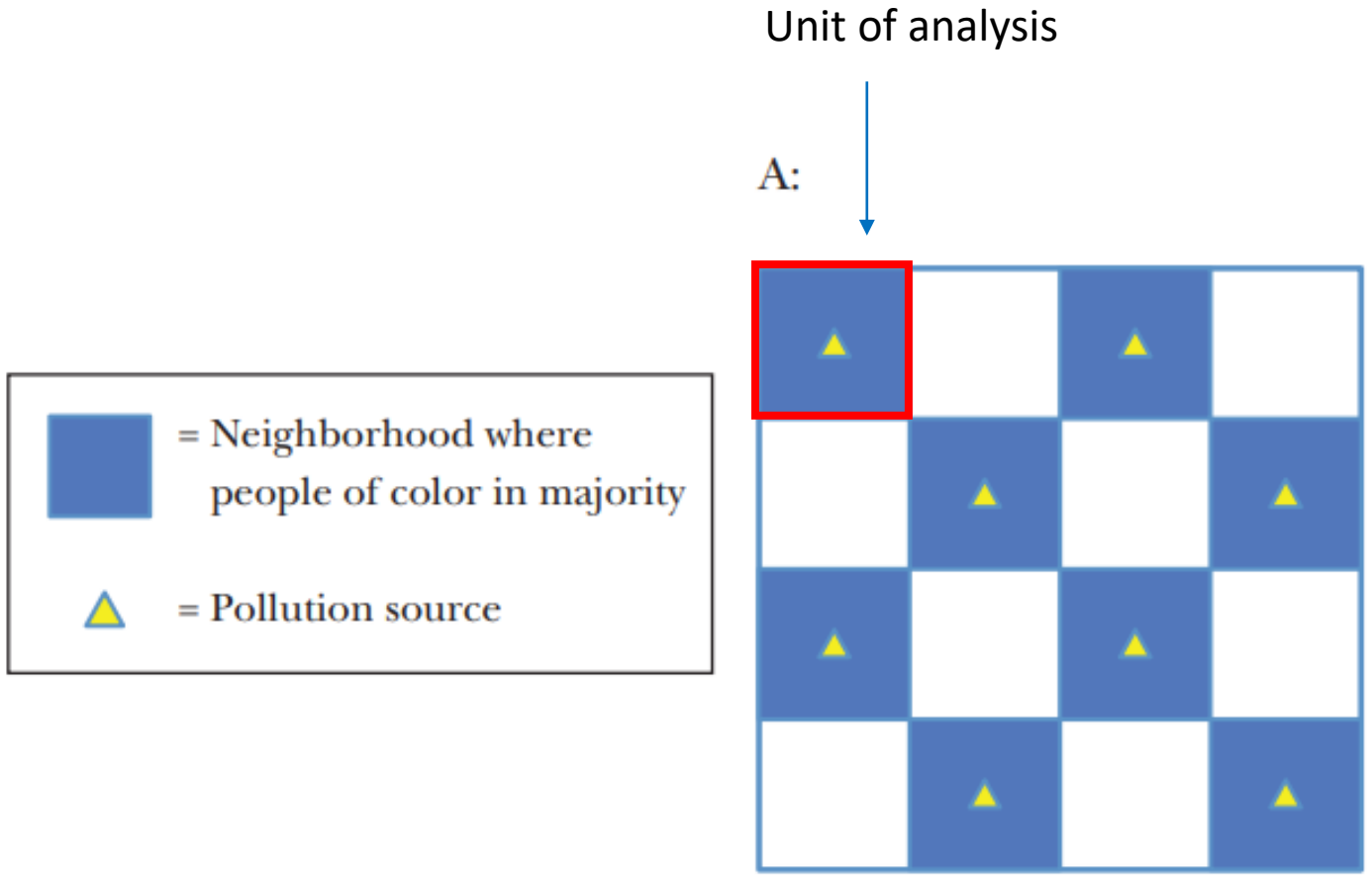
Table 3. Logistic Regression Results Comparing Unit-Hazard Coincidence and 50% Areal Containment Methods

	Unit-Hazard Coincidence		50% Areal Containment (1-Mile Radius)		50% Areal Containment (3-Mile Radius)	
Variable	Coefficient (1)	Significance (2)	Coefficient (3)	Significance (4)	Coefficient (5)	Significance (6)
% African American	–.003	.986	.698	.000	1.522	.000
% Hispanic	.431	.066	1.482	.000	1.960	.000
Mean household income ($1,000s)	.012	.000	–.025	.000	–.015	.000
Mean property value ($1,000s)	–.002	.058	.005	.000	.004	.000
% With a college degree	.338	.673	–1.704	.012	–.409	.046
% Employed in executive, managerial, and professional occupations	–3.215	.002	–.872	.282	.010	.970
% Employed in precision production or labor occupations	2.323	.000	1.787	.000	.073	.684
Constant	–5.052	.000	–4.197	.000	–2.220	.000
–2 Log-Likelihood	6,010.2		8,077.3		40,995.556	
Model chi-square	153.743	.000	548.233	.000	2786.536	.000
Sample size	59,050		59,050		59,050	

Ecological Fallacy

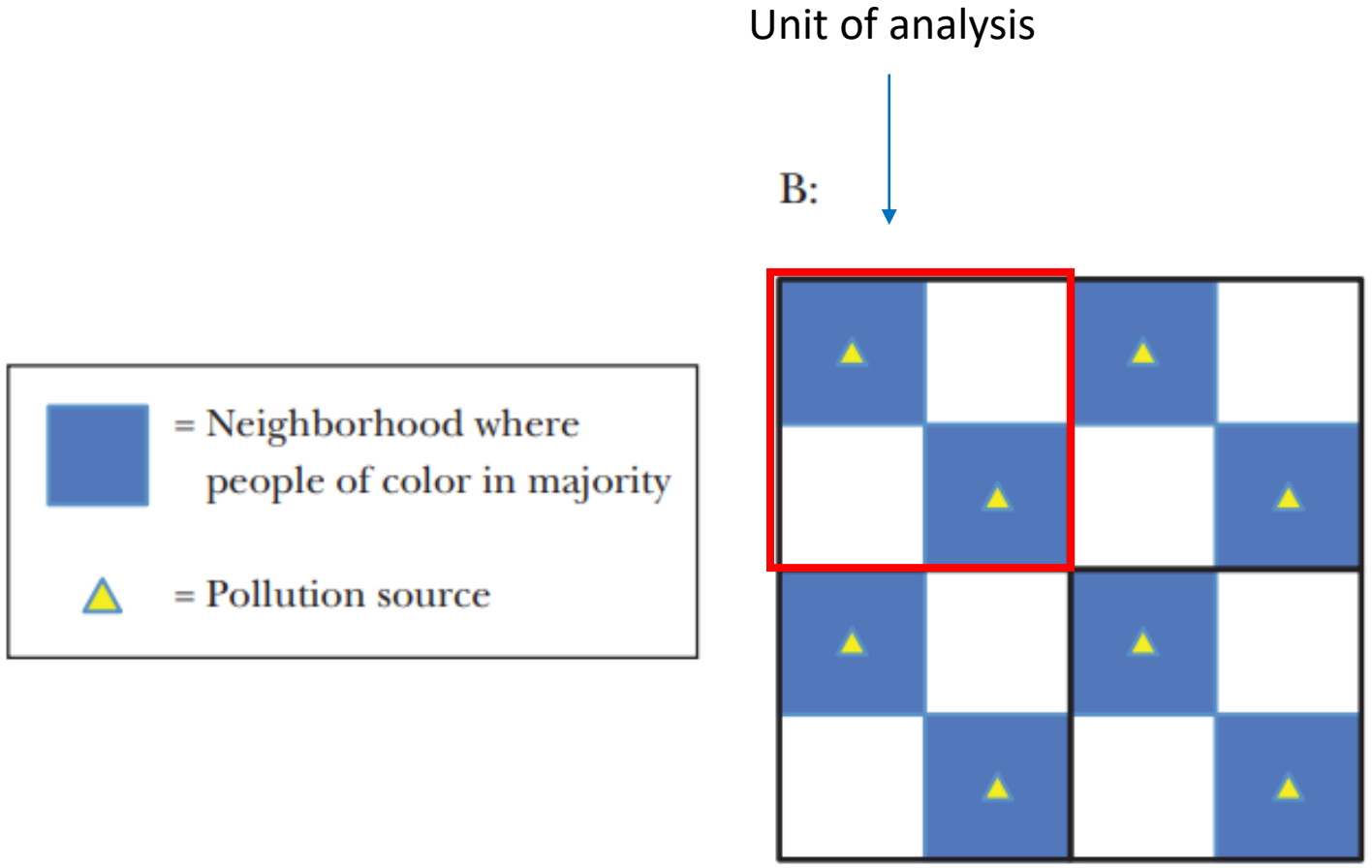
Ecological fallacy: Incorrectly drawing conclusions about individual exposures from group exposures.

In figure A, Pollution sources are perfectly correlated with neighborhoods where people of color are the majority.



Ecological Fallacy

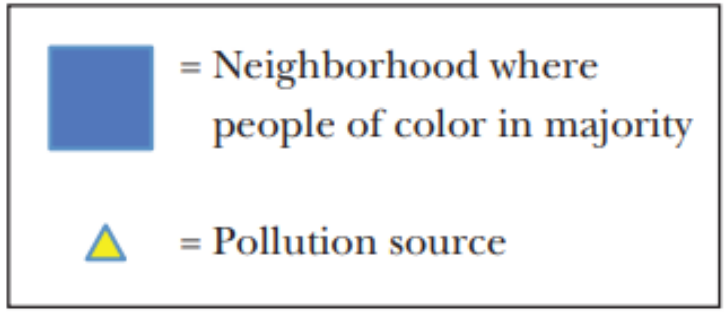
Using a larger group for analysis in figure B, there is no correlation between pollution sources and minority neighborhoods.



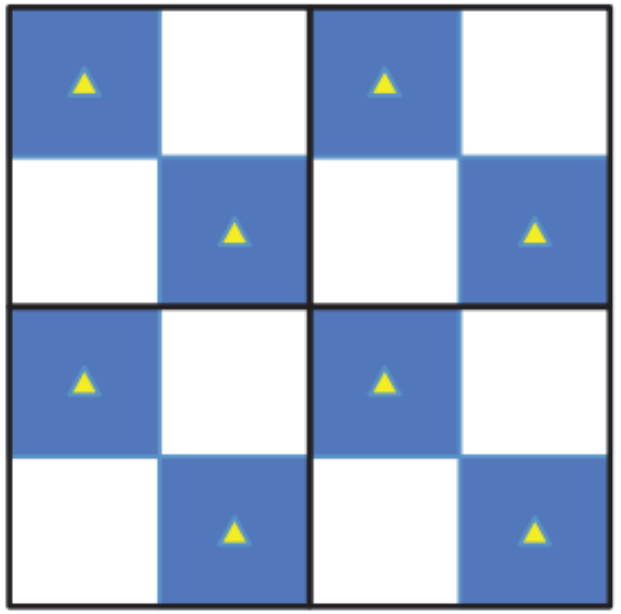
Ecological Fallacy

Aggregation can mask inequality of pollution exposure with greater residential segregation.

Baden, Noonan, and Turaga (2007) show using smaller level of analysis increases correlation between NPL sites and demographics.



B:



Part 3: Example EJ Analysis

AIM Act

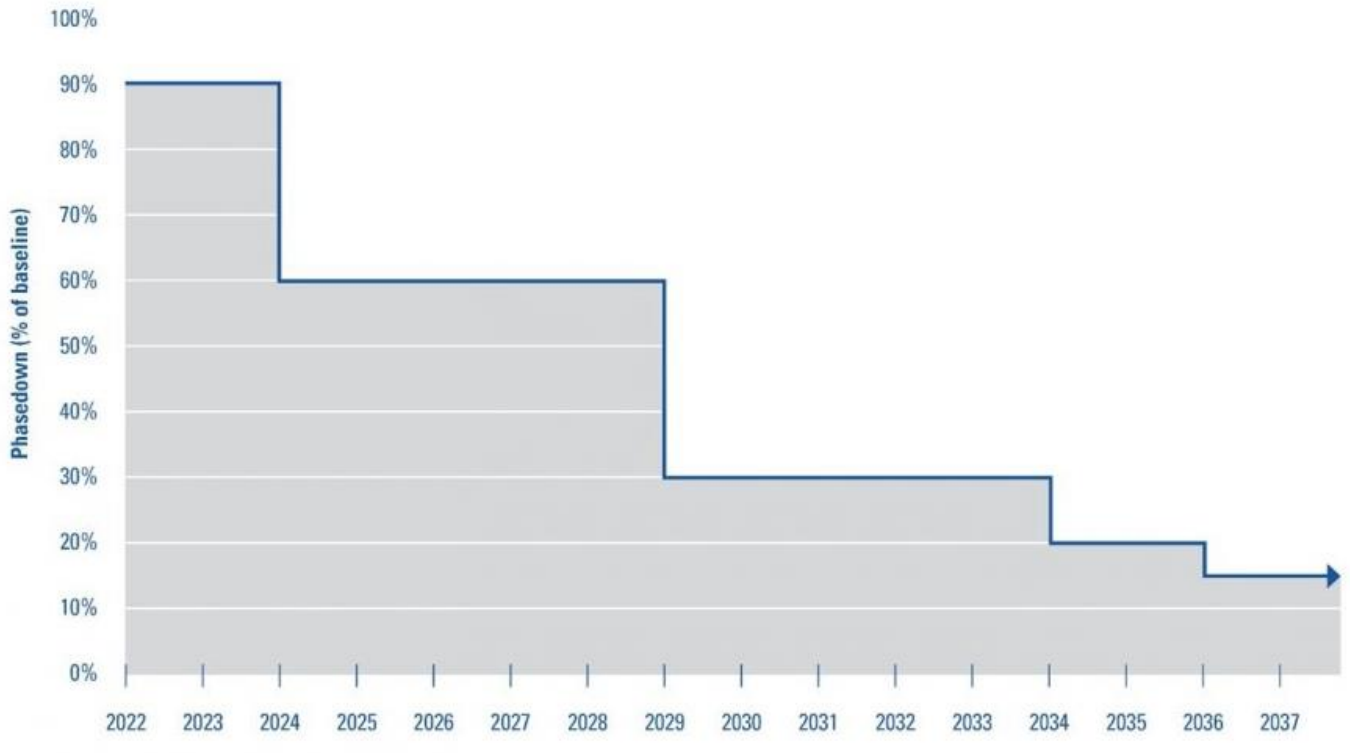
American Innovation and Manufacturing (AIM) Act to incentivize less use of hydroflourocarbons (HFCs), June 2022 version.

- HFCs developed to replace ozone depleting substances
- HFCs used in refrigeration, air conditioning, aerosols, fire suppression, and foam blowing sectors.
- HFCs have global warming potential (GWP) hundreds to thousands of times greater than carbon dioxide

AIM Act

American Innovation and Manufacturing (AIM) Act to phase down use of hydroflourocarbons (HFCs):

- Phase down schedule is based on allowances that can be traded.



AIM Act EJ Concerns

- No local effects from direct exposure to HFCs
- Potential EJ concerns about feedstocks, catalysts and byproducts of HFC production.
  - HFCs rely on toxic chemicals for production (e.g., carbon tetrachloride, hydrochloric acid, vinyl chloride, trichloroethylene (TCE), hydrogen fluoride)
- Some lower GWP HFC alternatives also rely on toxic chemicals.

AIM Act EJ Analysis

Key Elements:

- Describe possible health effects of feedstock chemicals and potential risk of exposure for workers
- Present profile of toxic releases associated with HFC production at each facility overall and by chemical
- Proximity analysis to examine nearby community characteristics and cumulative risk of exposure
- Summarize recent compliance and enforcement history of HFC facilities

Health Effects of Byproducts or Feedstocks of HFC Production

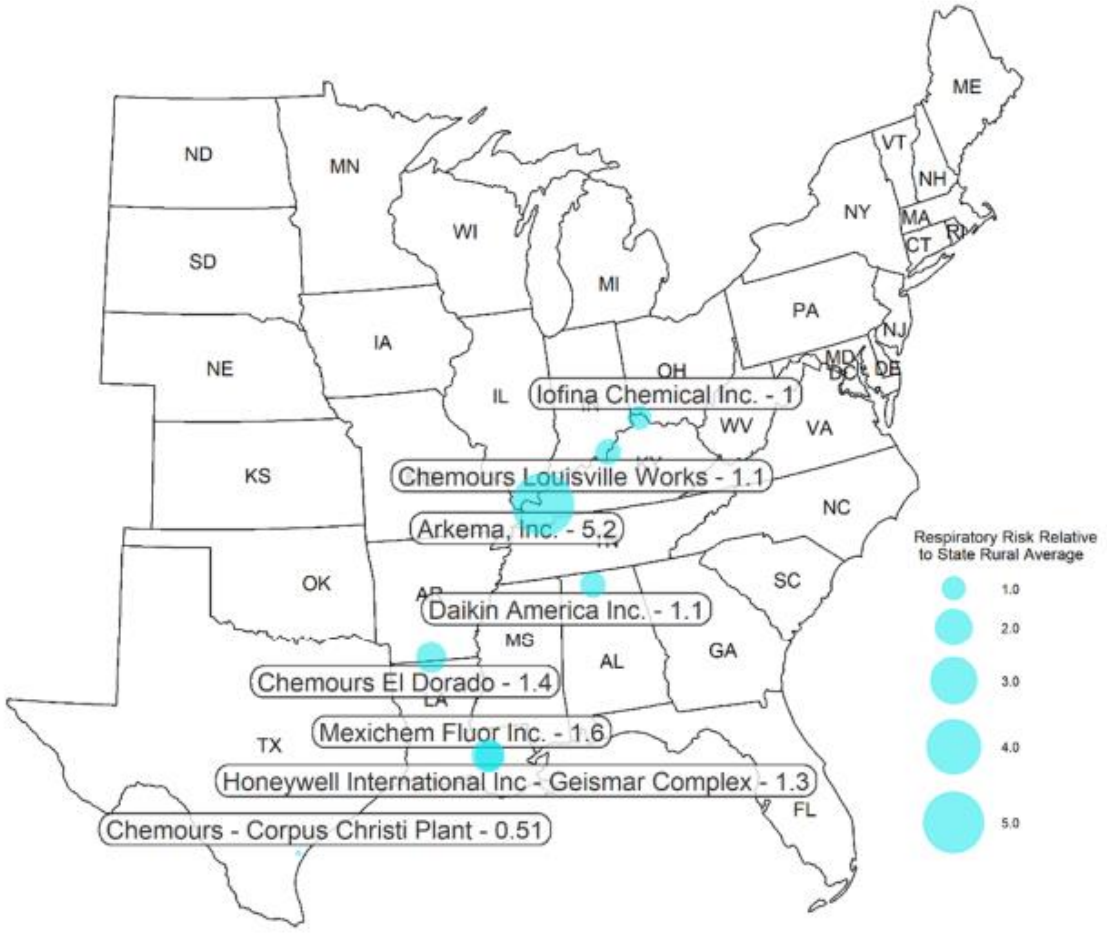
HFC production uses chemical feedstocks and catalysts or produces byproducts that are toxic and/or may lead to serious health impacts for local communities and workers.

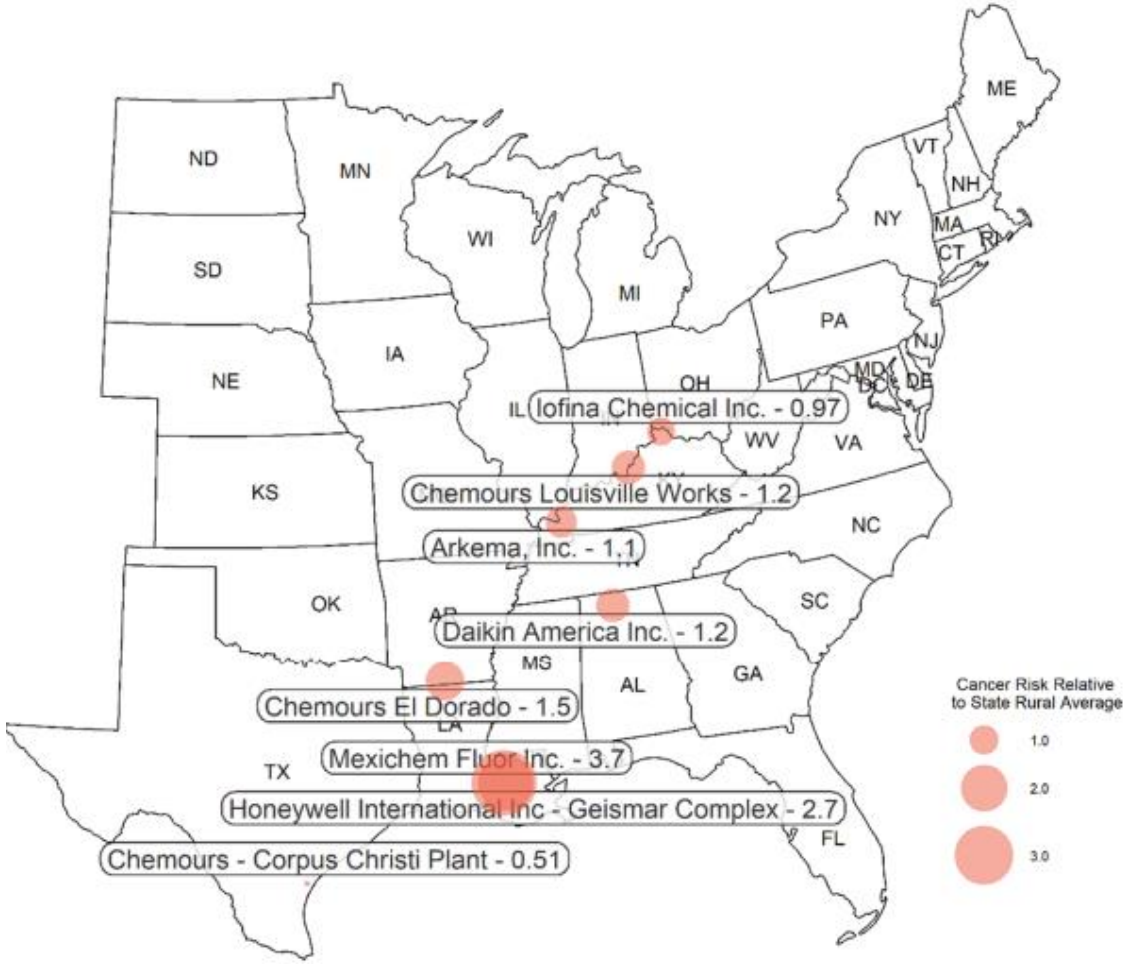
Chemical Name	Health Effects
Antimony Compounds	Metabolic, Other Systemic
Carbon tetrachloride	Cancer, Developmental, Hepatic, Reproductive
Chlorine	Ocular, Respiratory
Chloroform (trichloromethane)	Cancer, Developmental, Hepatic, Renal, Respiratory
Chromium Compounds	Cancer, Gastrointestinal, Hematological, Respiratory
Cobalt Compounds	Cancer, Hematological, Respiratory
1,1-Dichloroethane	No information available
1,2-Dichloroethane	Cancer, Hepatic, Renal
Hydrochloric acid	Respiratory
Hydrogen fluoride	Ocular, Respiratory
Methylene chloride (Dichloromethane)	Cancer, Hematological, Hepatic, Neurological
Nickel Compounds	Body Weight, Cancer, Hematological, Immunological, Respiratory
Tetrachloroethylene (Perchloroethylene)	Body Weight, Cancer, Developmental, Hepatic, Neurological, Ocular, Renal, Respiratory
1,1,1-Trichloroethane	Body Weight, Hepatic, Neurological
Trichloroethylene	Cancer, Cardiovascular, Developmental, Immunological, Neurological, Ocular
Vinyl chloride	Cancer, Developmental, Hepatic, Neurological, Ocular, Respiratory
Vinylidene chloride (1,1-dichloroethylene)	Hepatic, Other Systemic

Evaluation of 8 HFC Facilities

Facility name	City	State	Number of Employees	2019 HFC Emissions (MT CO2e)	Air releases of toxic HFC production chemicals	Water releases of toxic HFC production chemicals	Offsite transfers of toxic HFC production chemicals
Arkema, Inc.	Calvert City	Kentucky	200	843,010	58,043	456	501
Chemours - Corpus Christi Plant	Gregory	Texas	250	17,240	34,876		
Chemours El Dorado	El Dorado	Arkansas	21	66,990	9,868		
Chemours Louisville	Louisville	Kentucky	127	3,707,770	3,724		196
Daikin America	Decatur	Alabama	200	5,297	3,313	22	30
Honeywell - Geismar Complex	Geismar	Louisiana	250	413,584	51,282	499	62,543
Iofina Chemical Inc.	Covington	Kentucky	100	NR			
Mexichem Fluor Inc.	Saint Gabriel	Louisiana	67	18,331	4,369	28	73

Evaluation of 8 HFC Facilities





Community Profile Analysis of 8 HFC Facilities

Proximity analysis characterized communities near 8 HFC facilities.

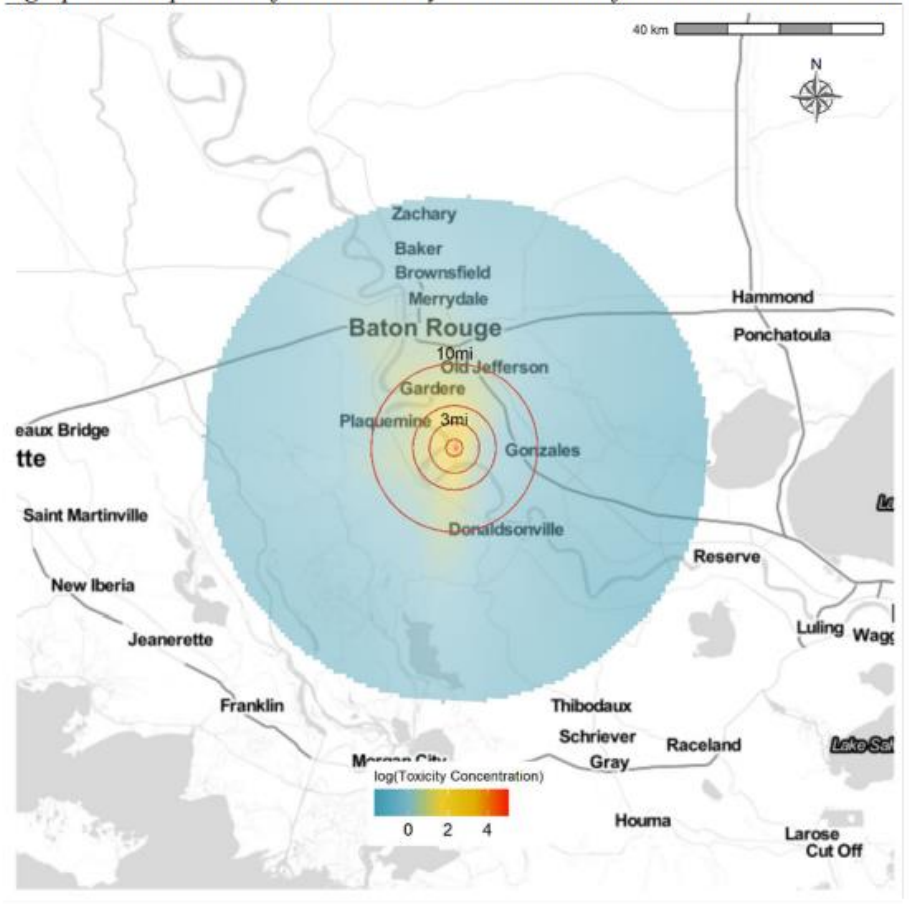
- 1-, 3-, 5- and 10-mile buffers
- Overall and for each facility
- Very high NATA cancer risks around LA facilities
- Not only due to HFC production

	Overall National Average	Rural Areas National Average	Within 1 mile of HFC production facility	Within 3 miles of HFC production facility
% White (race)	72	84	80	65
% Black or African American (race)	13	7.5	16	30
% Other (race)	15	8.2	3.7	4.5
% Hispanic (ethnic origin)	18	10	7.5	6.7
Median Household Income (1k 2019$)	71	67	76	62
% Below Poverty Line	7.3	6.8	5.8	8
% Below Half the Poverty Line	5.8	5.1	6	6.9
Total Cancer Risk (per million)	32	28	53	47
Total Respiratory Risk (hazard quotient)	0.44	0.38	0.66	0.56

Facility Emissions Transport Modelling

Modelled pollution transport modelling for specific facilities with the highest respiratory hazard (link to Regulatory Impact Analysis).

Figure 6-2: Geographical dispersion of RSEI Toxicity Concentration for Mexichem Fluor – Saint Gabriel, LA



AIM Act EJ Analysis Conclusions

Conclusions:

- Baseline cancer and respiratory risks from air toxics are generally higher close to an HFC production facility
- Higher percentages of low-income and Black individuals live near HFC production facilities compared with the overall average at the national level.
- Potential changes in toxic emissions might be unevenly distributed in ways that impact low-income and minority communities differentially.
- Predicting these effects *ex ante* is difficult due to limited information on where and in what quantities specific substitutes will be produced.

Part 4: Retrospective Studies of EJ Analysis

Some Perspective

In general, federal agencies have not conducted meaningful EJ analyses.

- Cecot and Hahn (2022) analyze 189 regulatory impact assessments from 2003-2021.
- 17% of regulatory analyses discuss EJ and equity.
- 28 of 34 analyses that discussed equity or EJ were EPA analyses.

Table 1 Regulatory impact analyses summary scorecard results

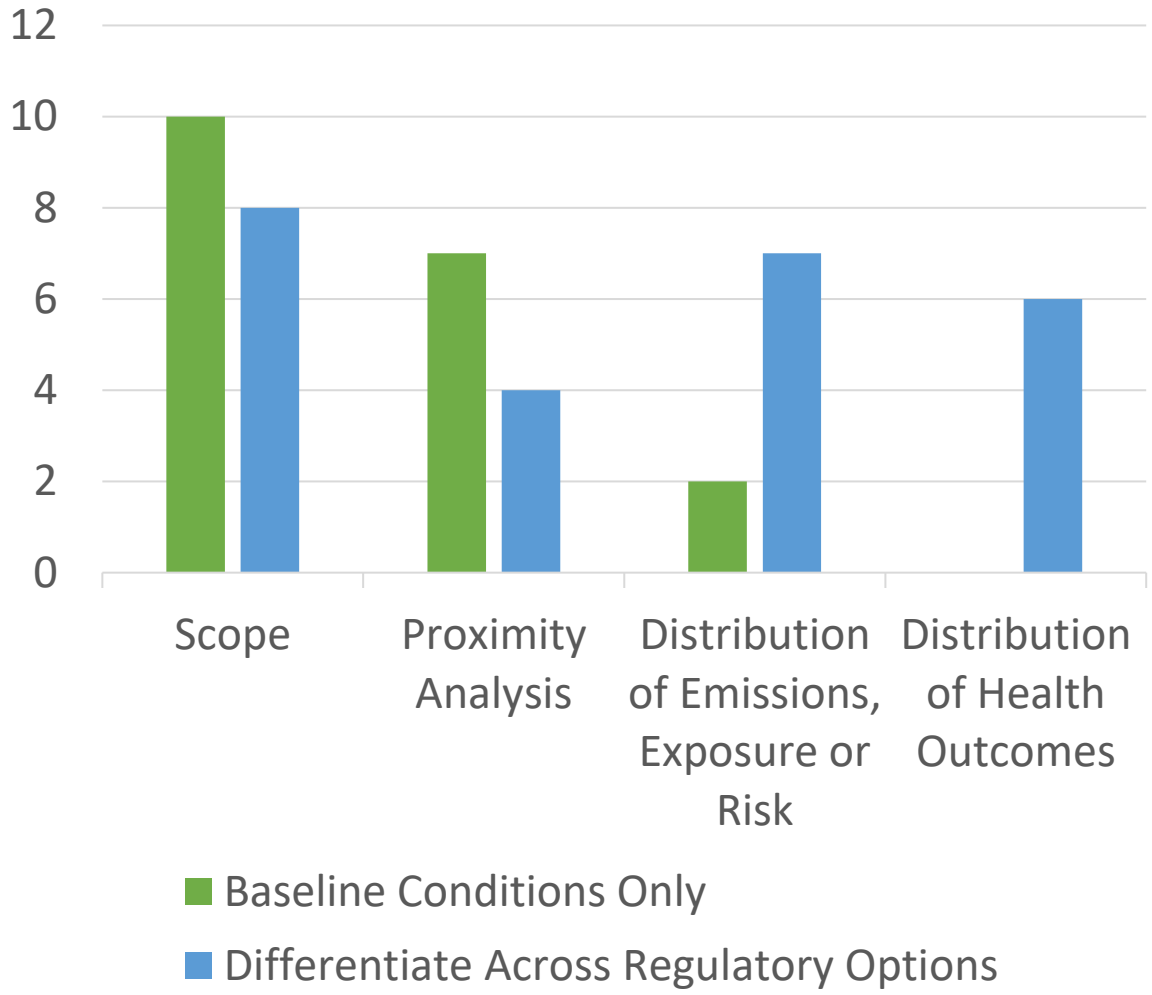
Summary	Total RIAs	Discussion of equity/EJ	Some benefits by group	Some costs by group
By Presidential Administration				
Trump	31	4	7	5
Obama	115	22	30	29
G.W. Bush	43	8	3	4
By Agency				
Environmental Protection Agency	61	28	11	10
Dept. of Transportation	34	1	2	2
Dept. of Energy	32	3	24	7
Dept. of Health and Human Services	25	2	1	5
Dept. of Labor	12	0	0	4
Dept. of Agriculture	8	0	0	3
Dept. of Justice	6	0	0	4
Dept. of Homeland Security	6	0	0	0
Dept. of Interior	2	0	2	2
Dept. of Housing and Urban Development	1	0	0	1
Treasury	1	0	0	0
Defense	1	0	0	0
Total (Oct 2003–Jan 2021)	189	34	40	38

Quantitative EPA EJ Analyses 2012-2021

- EPA inventory of EJ analyses for *economically significant* final rules, Jan 2012 – Jan 2021.
- More than half quantitatively evaluated potential EJ concerns
  - Majority only characterize baseline
  - Often rely on proximity analysis

Years	Total Final Rules	Total with EJ Analysis	Total with Quantitative EJ Analysis	Percent with Quantitative EJ Analysis
2012-14	11	6	5	45%
2015-17	12	11	7	58%
2018-21	11	9	6	55%
Total	**34**	**26**	**18**	**53%**

Quantitative EJ Analyses 2012-2021



Andarge et al. (2023)

Abstract: Since President Clinton's Executive Order 12898, federal agencies have been required to conduct environmental justice (EJ) analyses of federal rules and regulations. More recently, the Biden Administration instituted several efforts to reform regulatory review and promote a more equitable distribution of environmental benefits and burdens. This paper seeks to understand how prior guidelines have been implemented in federal regulatory reviews related to the Clean Water Act and provide a baseline for future studies of the distributional effects of clean water regulations. We reviewed 18 regulatory impact assessments relating to the Clean Water Act conducted since 1992. Only five of these studies conducted a quantitative analysis of distributional impacts and none of the 18 assessments found disproportionately adverse effects on low-income or minority communities. Anticipating that future regulatory review will require more comprehensive distributional analyses, we combine national data on the location of regulated point sources with demographic characteristics to determine the baseline distribution of water pollution facilities. Overall, we find that discharge locations tend to be located in areas with higher poverty rates, higher White population shares, and less education. We find that rurality partly explains this pattern. We conclude with a discussion of the policy implications of these analyses.

Andarge et al. (2023)

Overview:

- Summarize 18 EJ analyses in rules relating to the Clean Water Act since 1992.
- Combine national information on wastewater discharge locations (“outfalls”) with demographic information to assess potential EJ concerns.
- Provide new tools for assessing environmental justice concerns in the form of pseudo Lorenz curves.

Andarge et al. (2023)

Review of 18 prior EJ analyses:

- Only five conducted a quantitative EJ analysis.
- Many rules argued that because the rule improves environmental conditions, no EJ analysis is necessary.
- Analyses typically only look at % low income and % minority.
- No EJ analysis found disproportionately high or adverse human health or environmental effects on minority or low-income populations.

8.9 Environmental Justice

Executive Order 12898 establishes a Federal policy for incorporating environmental justice into Federal agency missions by directing agencies to identify and address disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations. The Executive Order requires the Agency to consider environmental justice issues in the rulemaking and to consult with Environmental Justice (EJ) stakeholders.

The Agency has considered environmental justice related issues concerning the potential impacts of this regulation and has determined that there are no substantial disproportionate effects. Because the Arsenic Rule applies to all community water systems, the majority of the population, including minority and low-income populations will benefit from the additional health protection.

EJ analysis in the 2001 arsenic drinking water rule.

Andarge et al. (2023)

Assess how outfall locations may impact various communities. Communities near outfalls are more likely to have a greater share of the population that is:

- Non-Hispanic White
- Below the poverty line
- Less than college degree education
- Most outfalls are in rural regions
  - ➢ Suggest importance of separating rural and national analyses.

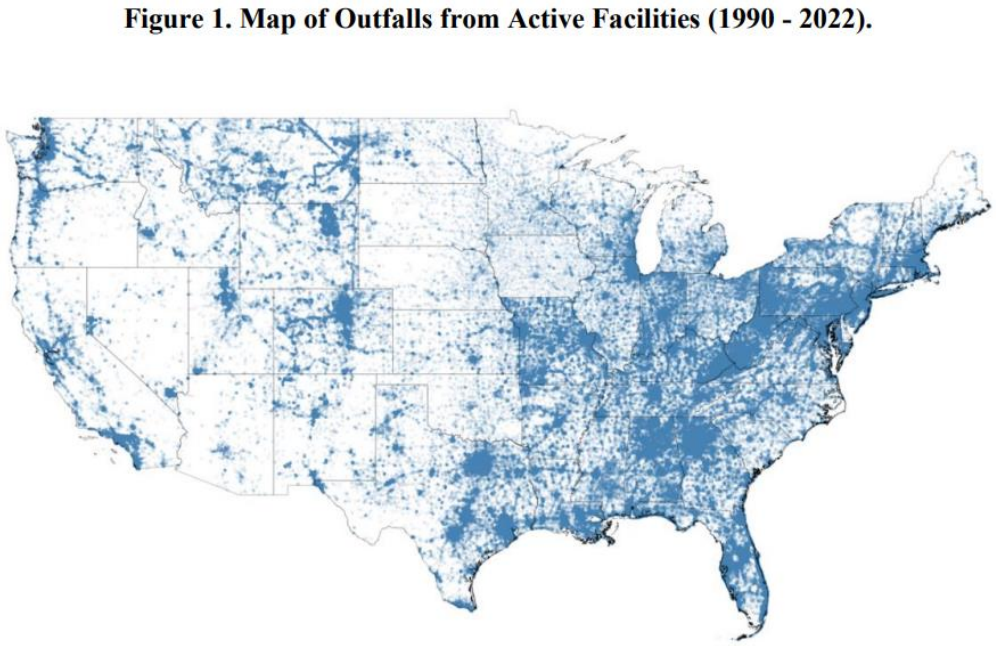
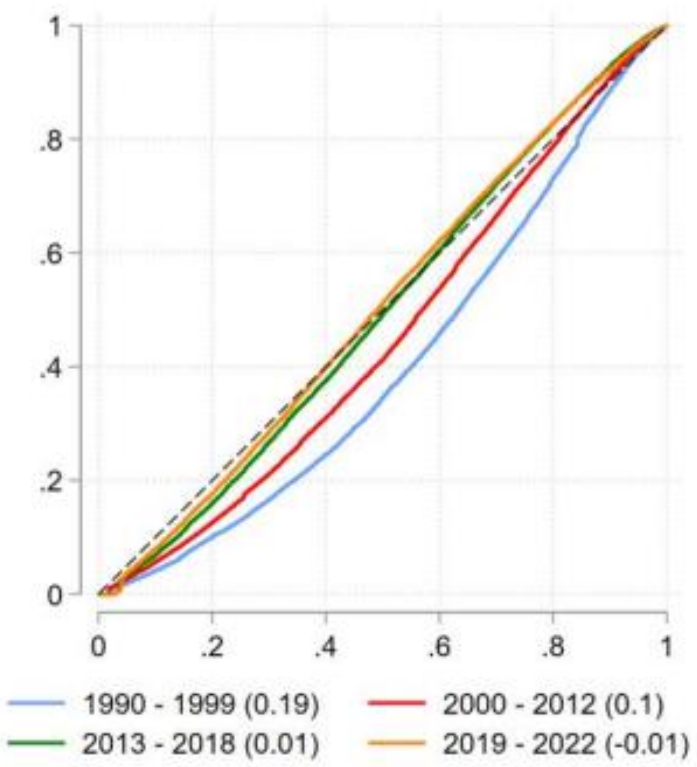


Image: All outfalls included in the analysis.

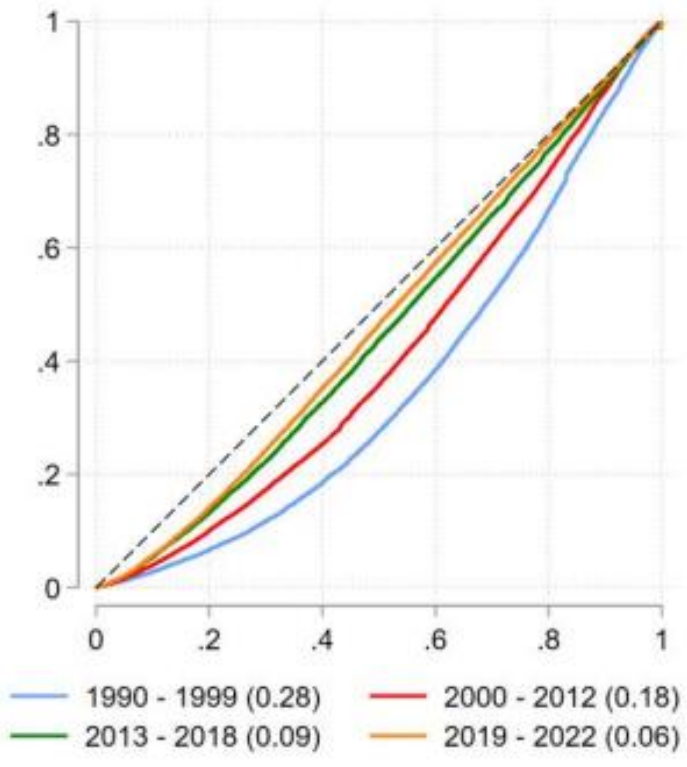
Andarge et al. (2023)

Pseudo-Lorenz curves as a contribution to EJ methods.

Note the Gini coefficient, a measure of inequality, is 2X is the area between 45 degrees and the Lorenz curve.



(b) Share Poverty

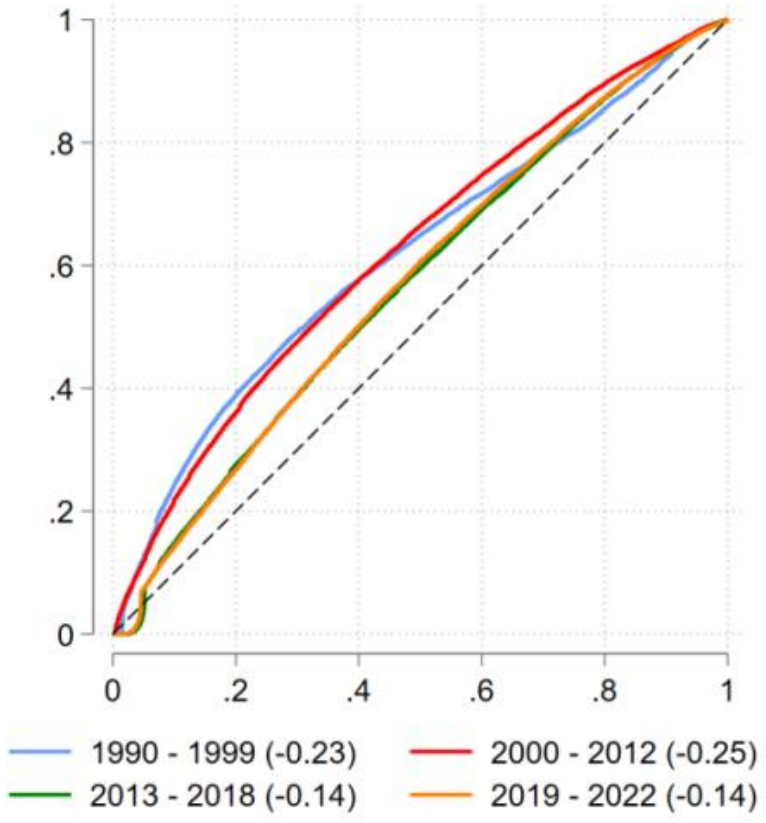


(c) Share Non-College

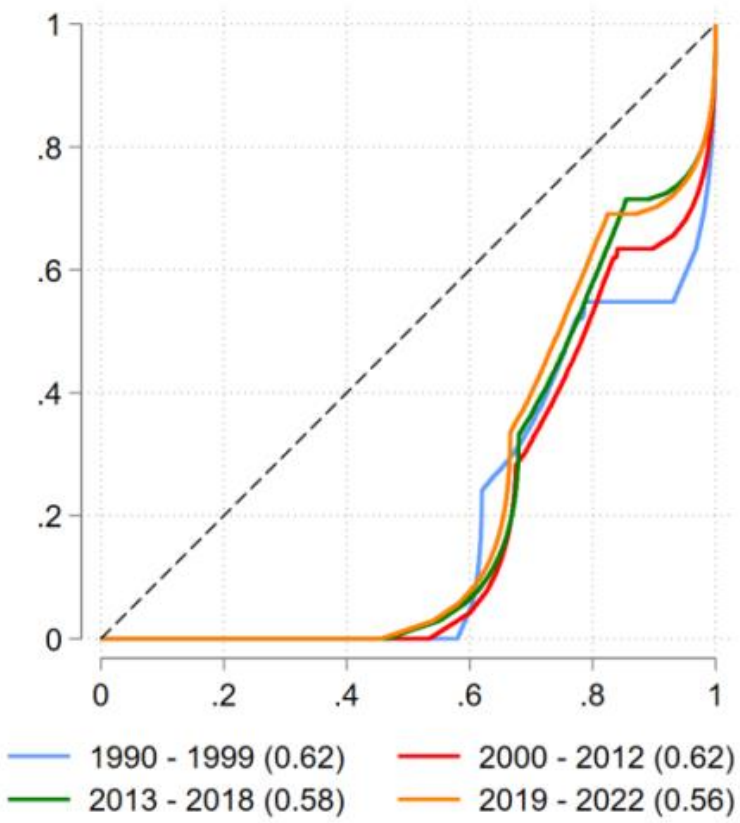
Andarge et al. (2023)

Some odd-looking Lorenz curves.

What's going on here?



(a) Share Non-White



(d) Rural Population Share

Next class

Have a nice weekend. Your **third case study is due October 29th**. It is a simple coding assignment, but some might have issues downloading the requisite R packages. Let me or Yagmur know if you're facing difficulty with the script.

Next Monday Professor Theising will review content for the midterm on Wednesday, October 18th.