

# U.S. Climate Vulnerability Index: Integrating, visualizing, and prioritizing cumulative impacts of climate change, health, and environment

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# Acknowledgments

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- NIH T32 ES026568 (TAMU Regulatory Sciences in Toxicology and Environmental Health Training Program)
- EPA STAR RD84004601 (Community Resilience to Industrial Pollutants)

## Community Stakeholders

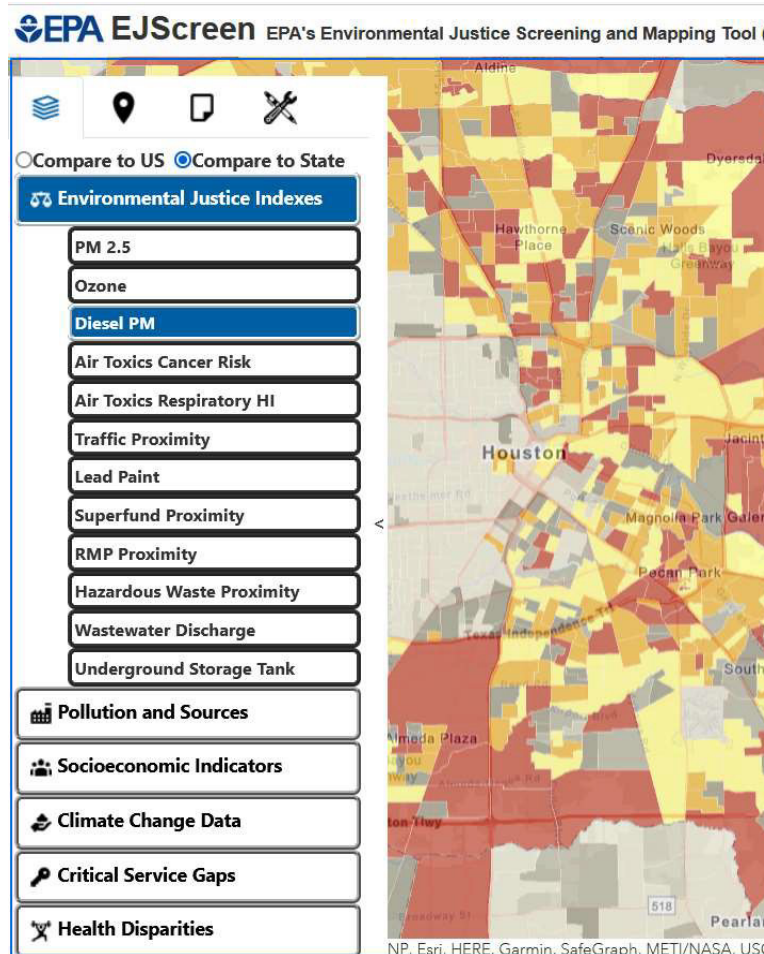
Achieving Community Tasks Successfully (ACTS)  
Coalition of Community Organizations (COCO)  
Sunnyside Community Redevelopment  
Organization (SCRO)  
Will County Community Partners  
Lewis University  
South Bronx United  
Michigan United

## Other Partners and Collaborators

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Harris County Long-Term  
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Workgroup  
Houston Food Bank  
Houston Galveston Area  
Council GIS data repository  
Rice University Urban Data  
Platform  
Houston Chronicle

# Examples of Current Environmental Justice (EJ) Screening Approaches



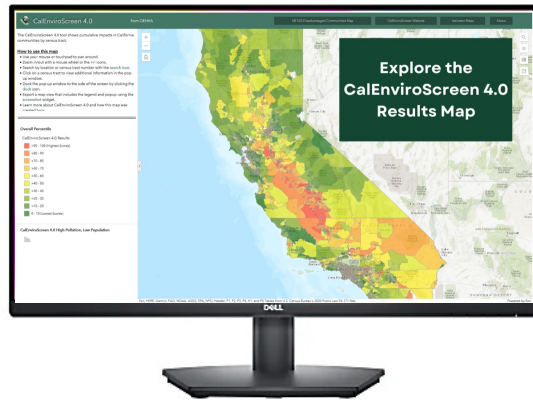
## EPA's EJ Screen

Analogous to a Tapas menu... you can pick and choose what indicators and indices you'd like to look use. By design, lacks cumulative index or score.



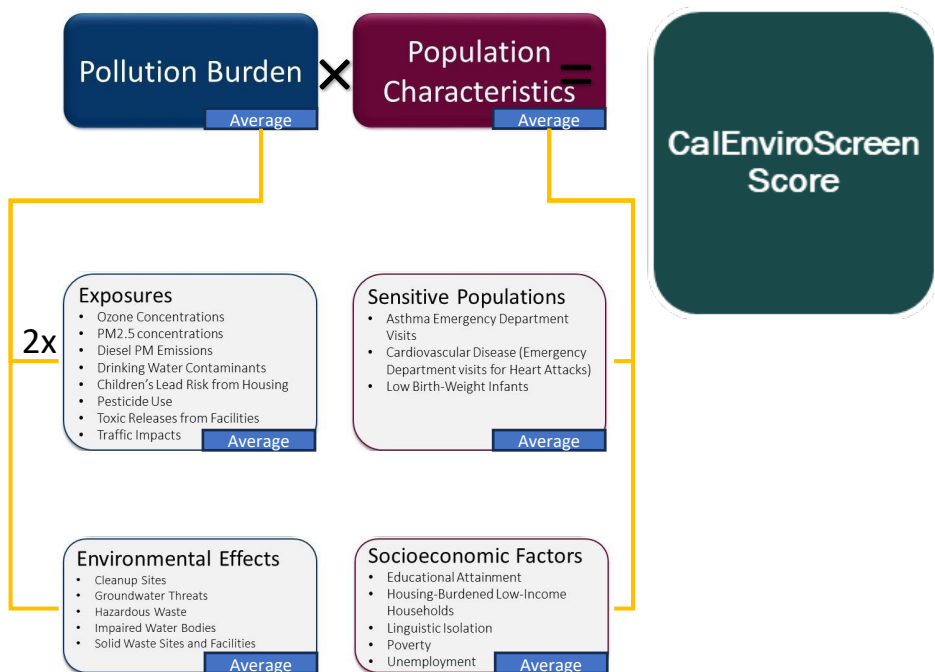


# Examples of Current EJ Screening



## CalEnviroScreen (now version 4.0)

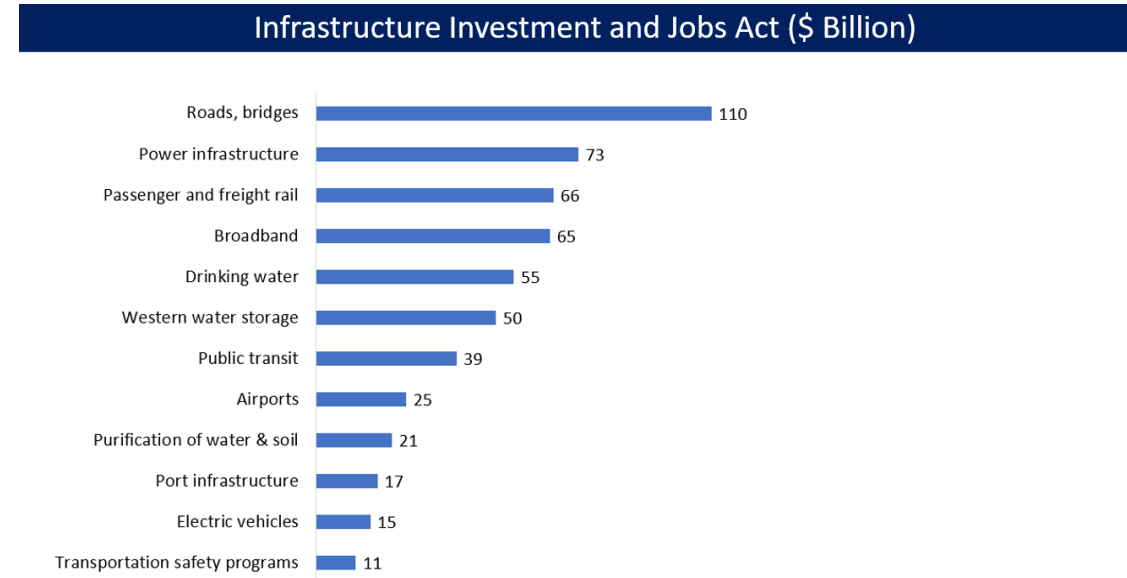
Analogous to making soup – you know what went into it, but not necessarily what ingredients were most important.





# Challenges Moving from EJ Screening to Climate and Environmental Action and Mitigation

- Existing focus has been on chemical pollution, but recent initiatives are broader in scope
- Existing approaches have difficulty “zooming in and out” from the individual indicators to cumulative impacts
- Identifying key stressors needed to identify key interventions and ultimately improve people’s lives



# There is a critical need for a tool that

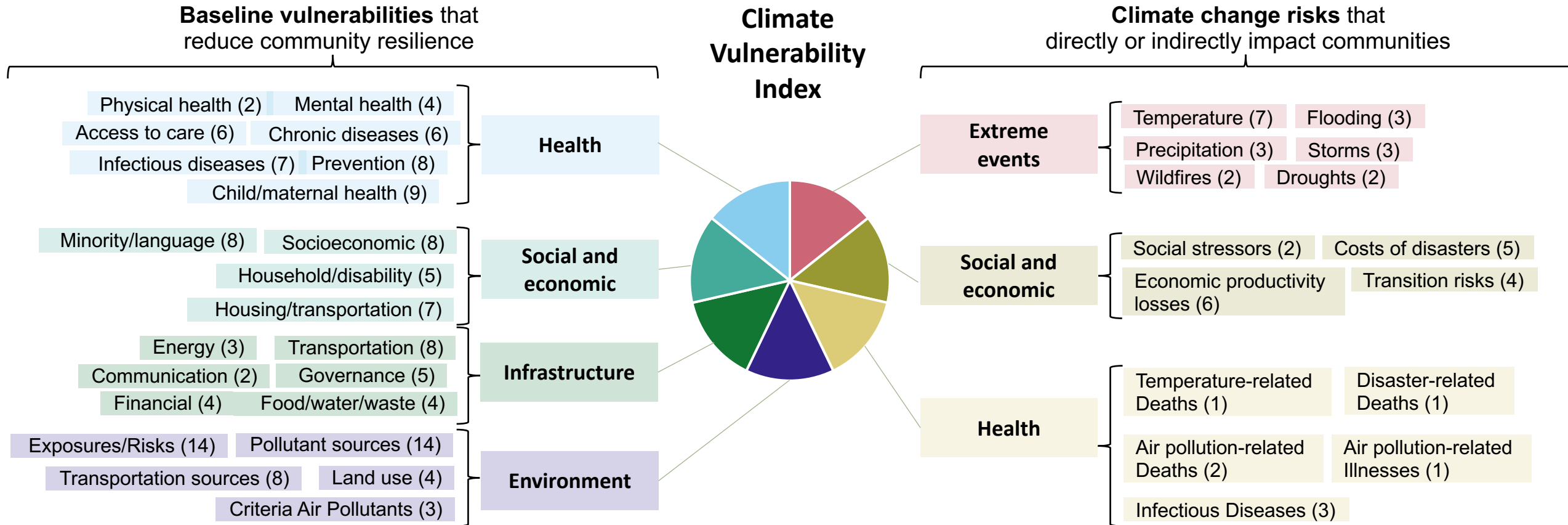
- Equips policymakers with data to effectively prioritize resources and interventions.
- Facilitates a clear roadmap for planners, local governments, federal agencies, research teams, and others to take targeted action.
- Gives community-based organizations access to local data that can help them take advantage of grant opportunities for reducing disparities in their communities.

# Climate Vulnerability Index

- **Overall Goal:** Identify local climate vulnerabilities on a national scale through a data-driven, GIS-based mapping tool integrating cumulative impacts of climate change, health, and environment
- **Anticipated Outcomes:**
  - Improve our understanding of the intersection between baseline vulnerabilities and climate change risks
  - Disentangle factors contributing most to vulnerability and inequity
  - Empower vulnerable communities and policymakers to develop effective action plans for today and tomorrow



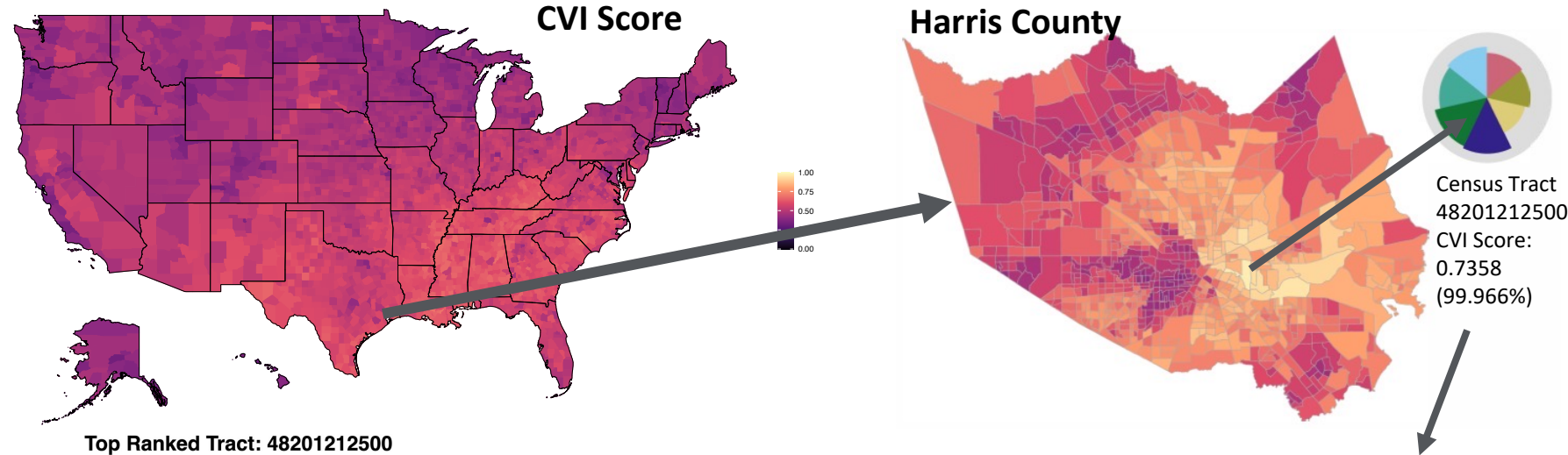
# Pulling in 184 sets of data, the CVI creates a comprehensive vulnerability score and ranks more than 70,000 U.S. census tracts.



Tee Lewis PG\*, Chiu WA\*, Nasser E, Proville J, Barone A, Danforth C, Kim B, Prozzi J, Craft E. Characterizing vulnerabilities to climate change across the United States. Environ Int. 2023 Feb;172:107772. doi: <https://doi.org/10.1016/j.envint.2023.107772> PMID: [36731185](https://pubmed.ncbi.nlm.nih.gov/36731185/)

\*Equally contributing first authors

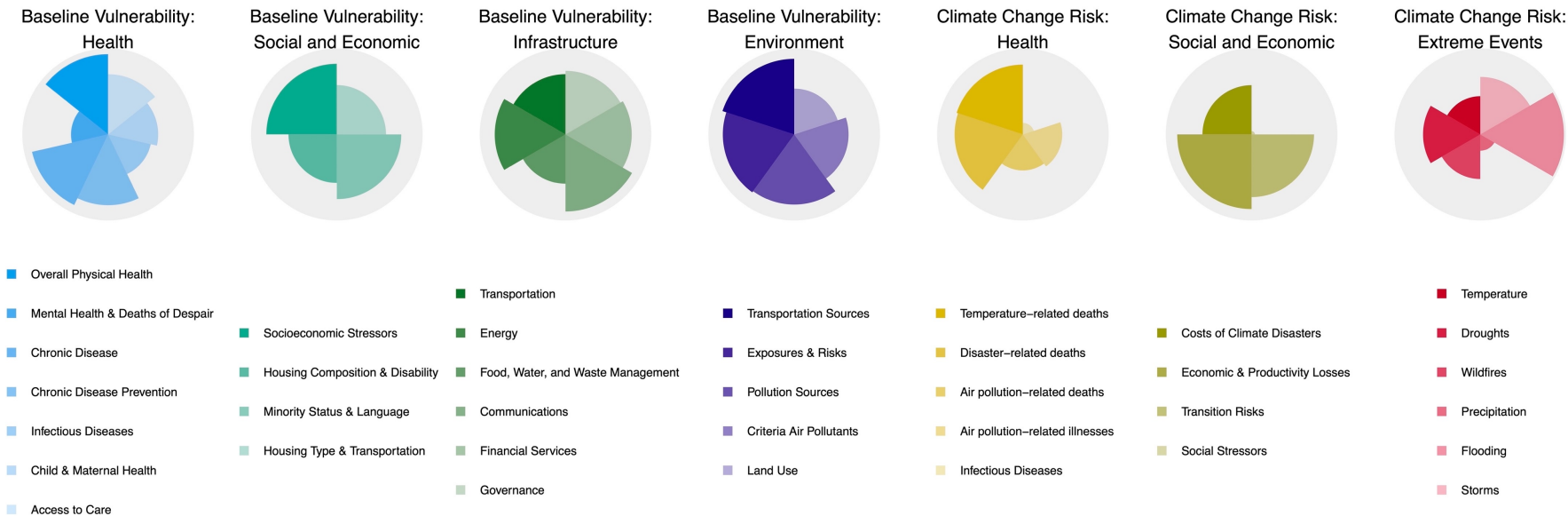
# Zooming from national to local scale



Top Ranked Tract: 48201212500

## Top ranked tract within Harris County:

- Ranked 26th nationwide
- Known EJ community (Cluster B) with multiple Baseline Vulnerabilities
- Key climate risks include flooding, economic/productivity, temperature, and disasters



# From a paper to a tool that facilitates action

Environment International 172 (2023) 107772

Contents lists available at ScienceDirect  
Environment International

journal homepage: [www.elsevier.com/locate/envint](http://www.elsevier.com/locate/envint)



Full length article

## Characterizing vulnerabilities to climate change across the United States

P. Grace Tee Lewis<sup>a,1</sup>, Weihseh A. Chiu<sup>b,1,\*</sup>, Ellu Nasser<sup>a</sup>, Jeremy Proville<sup>a</sup>, Aurora Barone<sup>a</sup>, Cloelle Danforth<sup>a</sup>, Bumsik Kim<sup>c</sup>, Jolanda Prozzi<sup>c</sup>, Elena Craft<sup>a</sup>

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### ABSTRACT

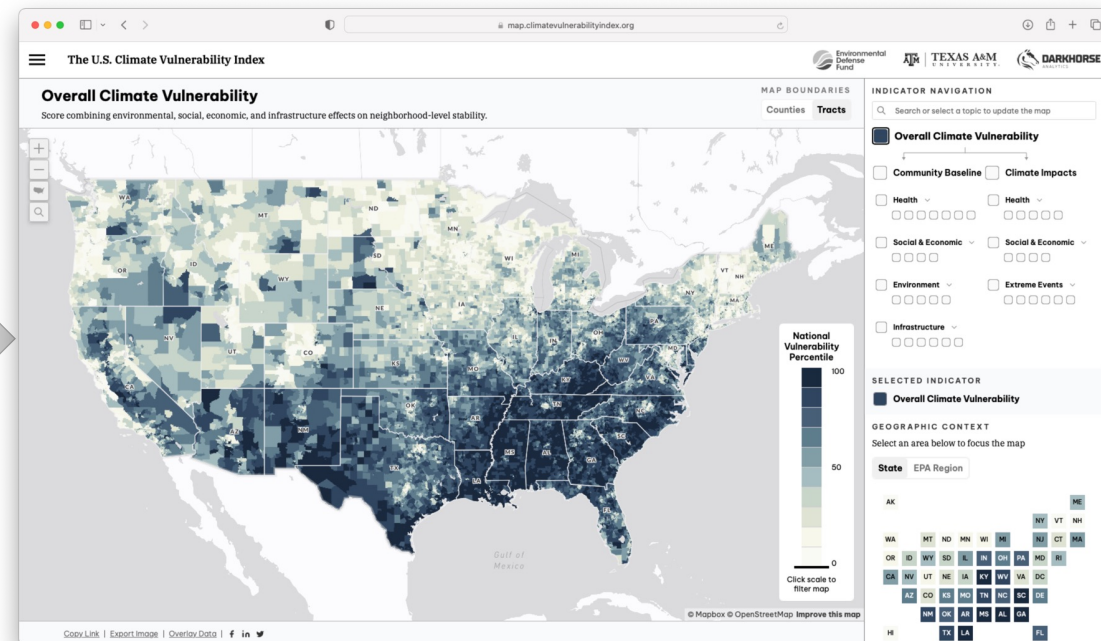
Climate change will cause a range of related risks, including increases in infectious and chronic disease, intensified social and economic stresses, and more frequent extreme weather events. Vulnerable groups will be disproportionately affected due to greater exposure to climate risks and lower ability to prepare, adapt, and recover from their effects. Better understanding of the intersection of vulnerability and climate change risks is required to identify the most important drivers of future climate risks and effectively build resilience and deploy targeted adaptation efforts. Incorporating community stakeholder input, we identified and integrated available public health, social, economic, environmental, and climate data in the United States (U.S.), comprising 184 indicators, to develop a Climate Vulnerability Index (CVI) composed of four baseline vulnerabilities (health, social/economic, infrastructure, and environment) and three climate change risks (health, social/economic, extreme events). We find that the vulnerability to and risks from climate change are highly heterogeneous across the U.S. at the census tract scale, and geospatially cluster into complementary areas with similar climate risks but differing baseline vulnerabilities. Our results therefore demonstrate that not only are climate change risks both broadly and variably distributed across the U.S., but also that existing disparities are often further exacerbated by climate change. The CVI thus lays a data-driven, scientific foundation for future research on the intersection of climate change risks with health and other inequalities, while also identifying health impacts of climate change as the greatest research gap. Moreover, given U.S. government initiatives surrounding climate and equity, the CVI can be instrumental in empowering communities and policymakers to better prioritize resources and target interventions, providing a template for addressing local-scale climate and environmental justice globally.

### 1. Introduction

With growing evidence that national efforts to mitigate climate pollution in the U.S. and other countries will fail to meet the International Panel on Climate Change (IPCC) climate target of limiting warming to 1.5°C above pre-industrial levels, there is increased interest in understanding where investments in resilience and adaptation strategies may be deployed to curb the most serious and impactful harms (Iturbide et al., 2021; World Health Organization 2021). Furthermore, given existing long-standing disparities experienced by vulnerable communities across the United States and worldwide, there is a critical need for increased understanding of the nexus of vulnerability and climate change risks in order to ensure that adaptation efforts are

targeted to those most in need.

To fill this critical gap, we have integrated existing public health, social, economic, environmental, and climate data at the U.S. census tract level, comprising almost two hundred indicators, to develop a Climate Vulnerability Index (CVI). The CVI integrates baseline vulnerabilities that reduce resilience (health, social/economic, infrastructure, and environment) and climate change risks that may adversely affect individuals and communities (health, social/economic, extreme events). Together, these data illustrate the most ambitious attempt to date to provide a cumulative and quantitative assessment of specific vulnerabilities, risks, and disparities related to climate change. The ultimate objective of the CVI is to provide a robust scientific foundation for characterizing the geographic distribution of health, social,



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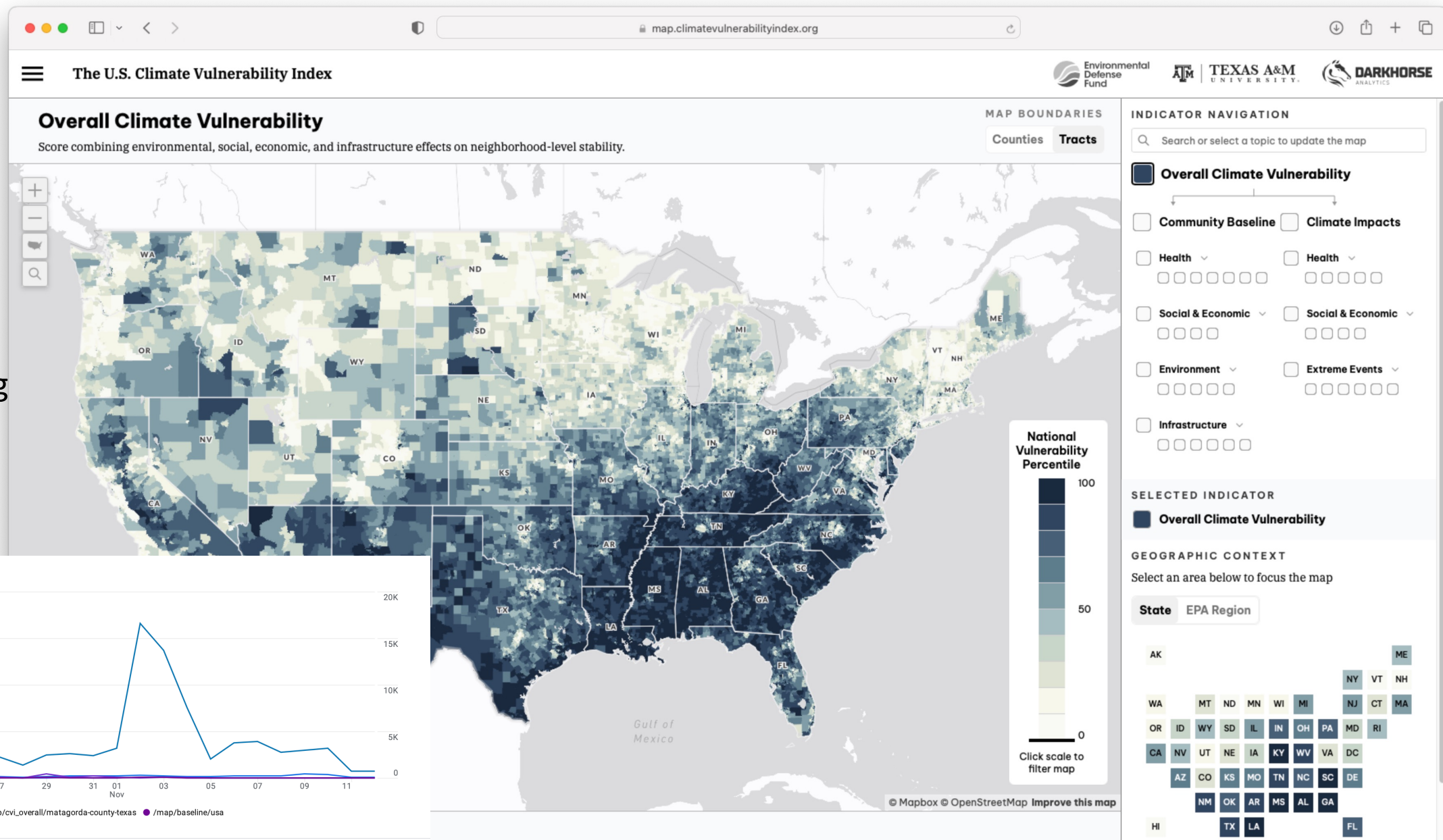
0160-4120/© 2023 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

<https://ClimateVulnerabilityIndex.org>

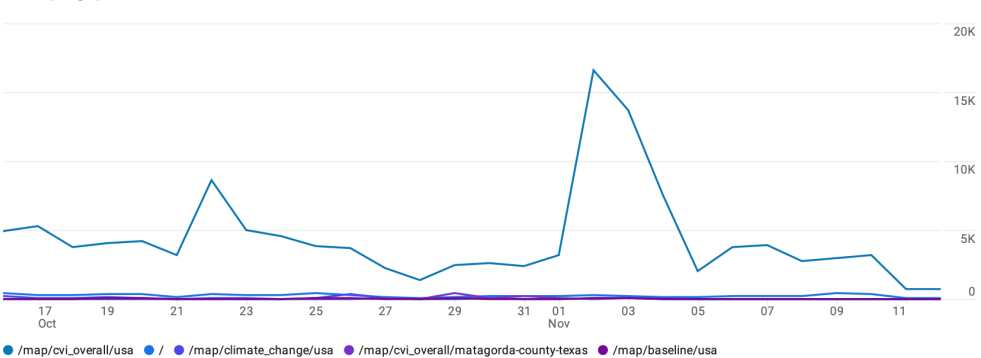


## Overall CVI:

- Highest the Southeast and Southwest
- Lowest in the Northeast, upper Mid-West, and along the West Coast



### Views by Page path and screen class over time



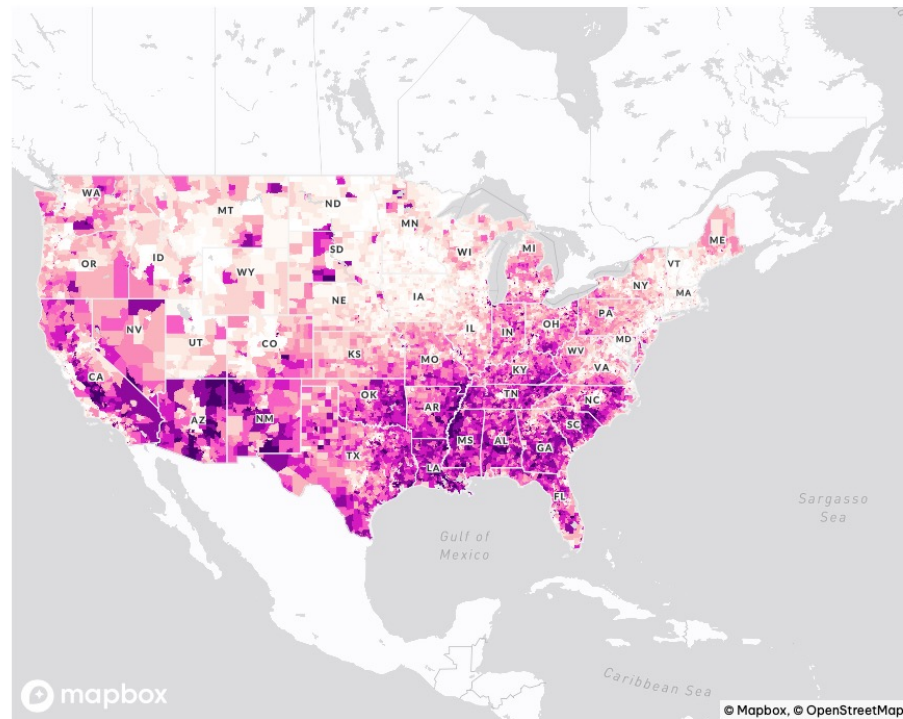
	Page path and screen class	+ ↓ Views 140,100 <small>100% of total</small>	Users 17,189 <small>100% of total</small>	Views per user 8.15 <small>Avg 0%</small>
1	/map/cvi_overall/usa	123,163	14,116	8.73

<https://ClimateVulnerabilityIndex.org>

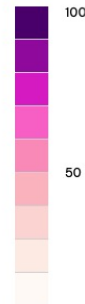
# Baseline Vulnerabilities have more localized patterns than Climate Impacts

## Community Baseline

The long-standing inequities shaping resilience to climate impacts.



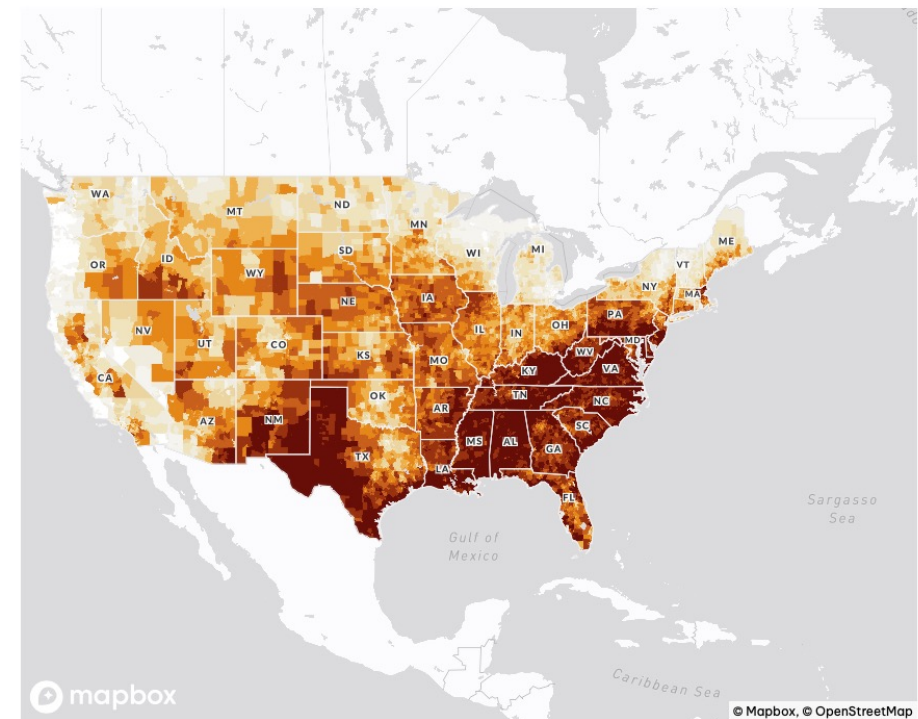
National  
Vulnerability  
Percentile



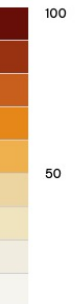
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Click scale to  
filter map

## Climate Impacts

How a community is vulnerable to environmental and economic disruptions.



National  
Vulnerability  
Percentile

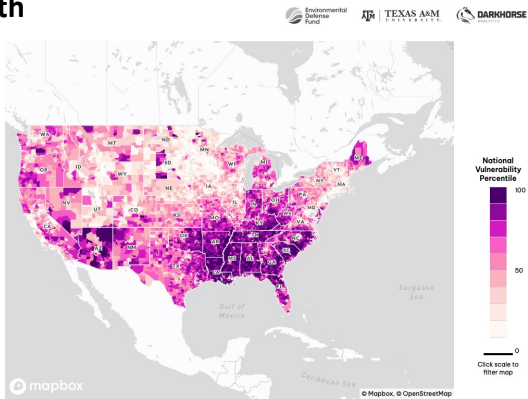


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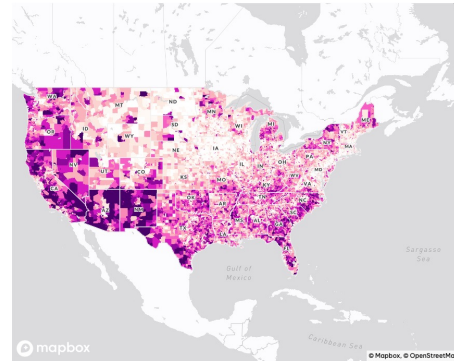
# Each Domain has its own geographic pattern

## Baseline Vulnerabilities

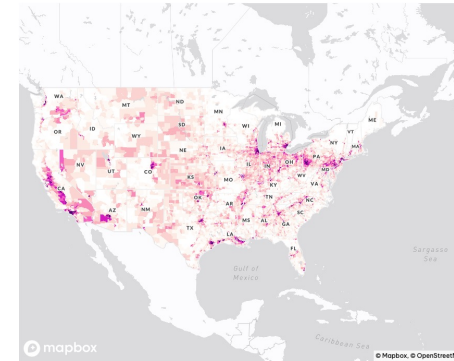
Health



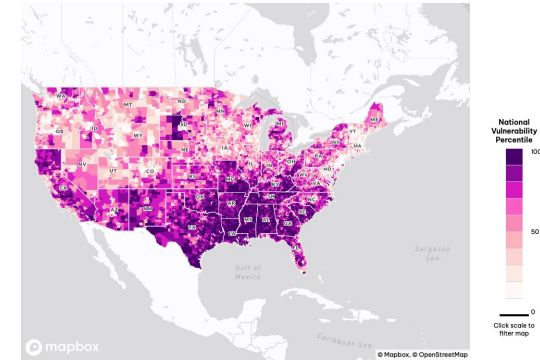
Social & Economic



Environment

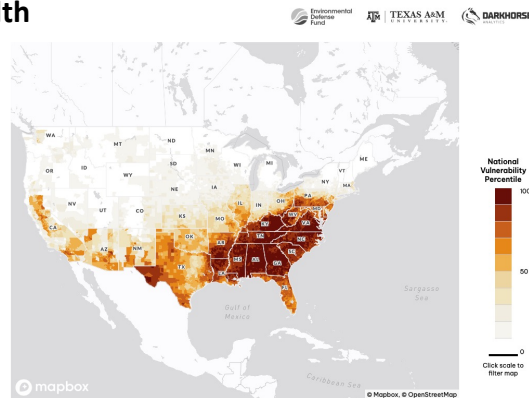


Infrastructure

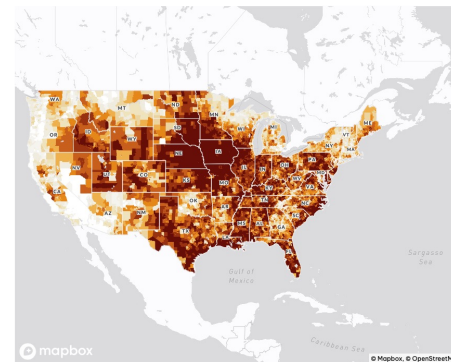


## Climate Impacts

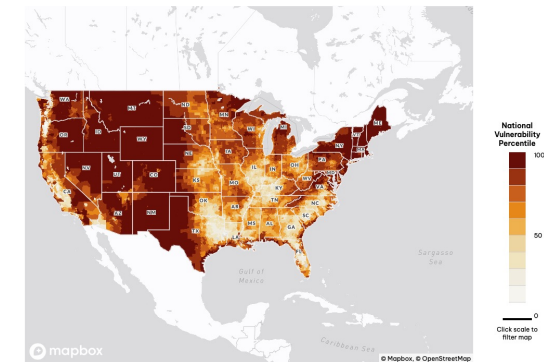
Health



Social & Economic



Extreme Events





# Connecting to Policy and Action

- IRA, IJA, and CHIPS allocates hundreds of billions of dollars to address both baseline vulnerabilities and climate change risks
- CVI facilitates matching community needs to funding opportunities

Vulnerability or Risk Category Improved	Climate vulnerability and risk-related funding in major recent legislative efforts						
	Inflation Reduction Act, 2022		Infrastructure Investment and Jobs Act, 2021		CHIPS Act, 2022		Combined
	billion \$	% of bill total	billion \$	% of bill total	billion \$	% of bill total	billion \$
<b>Total Baseline</b>	188.9	43%	418.9	48%	33.0	13%	640.8
- Health	0.9	0%	21.6	3%		0%	22.6
- Social & economic	43.9	10%	20.4	2%	16.1	6%	80.4
- Infrastructure	105.3	24%	344.4	40%	16.7	7%	466.4
- Environment	38.7	9%	32.5	4%	0.2	0%	71.4
<b>Total Climate Change (may overlap with Baseline)</b>	369.0	84%	152.5	18%	13.7	6%	535.2
<b>Total (Entire Bill)</b>	437.0		863.9		248.1		1,549.0

# Matching Vulnerabilities and Impacts to Resources

- EDF and Columbia Law School developed a comprehensive [list of current and forthcoming IRA related resources](#)
- We matched these resources along with those in the IIA, and Justice 40 to the indicators and domains in the CVI in order to help communities plan, prepare, and adapt to climate change.

## Matching Vulnerabilities and Impacts to Resources

The passage of the [Inflation Reduction Act \(IRA\)](#) in 2022 and the [Infrastructure Investment and Jobs Act \(IIJA\)](#) in 2021 marks a historic level of federal investment in measures to help the United States meet its goal of reducing U.S. greenhouse gas emissions by 50% or more by 2030 (compared to 2005) levels and improve the infrastructure, health, equity, and resilience of American communities. In addition, the [Justice 40 Initiative](#) is a whole-of-government initiative to ensure that 40% of the overall benefits of certain federal investments flow to disadvantaged communities that are marginalized, underserved, and overburdened by pollution.

Below you will find a comprehensive list of current and forthcoming IRA, IIA, and Justice 40-related resources that can help communities plan, prepare, and adapt to climate change.

## Contents

### [Baseline Vulnerability – Health](#)

1. [Brownfield Grant Funding](#)
2. [Brownfield Job Training Grants](#)
3. [Clean Ports Program](#)
4. [Clean School Bus Program](#)
5. [Clean Water State Revolving Fund](#)
6. [Diesel Emissions Reduction Act Program](#)
7. [Distance Learning and Telemedicine Grants](#)
8. [Drinking Water State Revolving Fund](#)
9. [Environmental and Climate Justice Grants](#)
  - a. [Environmental and Climate Justice \(ECJ\) Grant Program](#)
  - b. [Environmental Justice Thriving Communities Grantmaking \(EJ TCGM\) Program](#)
  - c. [Environmental Justice Collaborative Problem-Solving \(EJCPS\) Cooperative Agreement Program](#)
  - d. [Environmental Justice Government-to-Government \(EJG2G\) Program](#)
10. [Home Energy Rebate Programs](#)
11. [Orphan Well Site Plugging, Remediation, and Restoration Programs](#)
  - a. [Orphaned Well Site Plugging, Remediation, And Restoration Program](#)
  - b. [Federal Orphaned Well Program](#)
  - c. [Orphaned Wells on Tribal Lands](#)
12. [Reduction of Truck Emissions at Port Facilities Program](#)
13. [Renew America's Schools](#)
14. [Renew America's Nonprofits Program](#)
15. [Sanitation Facilities Construction Program](#)
16. [Superfund Hazardous Substance Research and Training Program](#)
17. [Underground Injection Control Grants](#)

### [Baseline Vulnerability – Social & Economic](#)

1. [Affordable Connectivity Program](#)
2. [Building Codes Implementation for Efficiency and Resilience Program](#)
3. [Building Resilient Infrastructure and Communities](#)
4. [Building, Training, and Assessment Centers](#)
5. [Career Skills Training](#)

6. [Clean Energy Production Tax Credit and Clean Electricity Investment Credit](#)
7. [Clean Vehicle Credit](#)
8. [Competitive Grants for Non-Federal Forest Landowners](#)
9. [Discrimination Financial Assistance Program for Farmers, Ranchers, and Forest Landowners](#)
10. [Energy Efficiency and Conservation Block Grant Program](#)
11. [Energy Infrastructure Reinvestment Program](#)
12. [Emergency Food and Shelter Program](#)
13. [Empowering Rural America New ERA Program](#)
14. [Federal Income Tax Credits and Incentives for Energy Efficiency](#)
15. [Federal Emergency Management Agency Public Assistance Program](#)
16. [Flood Mitigation Assistance Grant Program](#)
17. [Green and Resilient Retrofit Program](#)
18. [Hazard Mitigation Assistance Grants](#)
19. [Home Efficiency Rebates](#)
20. [Home Electrification and Appliance Rebates](#)
21. [Home Energy Rebate Programs](#)
22. [Low Income Home Energy Assistance](#)
23. [National Flood Insurance Program](#)
24. [Orphan Well Site Plugging, Remediation, and Restoration Programs](#)
  - a. [Orphaned Well Site Plugging, Remediation, And Restoration Program](#)
  - b. [Federal Orphaned Well Program](#)
  - c. [Orphaned Wells on Tribal Lands](#)
25. [Reconnecting Communities and Neighborhoods Program](#)
  - a. [Neighborhood Access and Equity Grant Program](#)
  - b. [Reconnecting Communities Pilot Program](#)
26. [Residential Clean Energy Credit](#)
27. [Safeguarding Tomorrow Revolving Loan Fund Program](#)
28. [USDA Funds for Financially Distressed Borrowers](#)
29. [Weatherization Assistance Program](#)

...

### [Baseline Vulnerability – Infrastructure](#)

1. [Active Transportation Infrastructure Investment Program](#)
2. [Advanced Battery R&D Consortium](#)
3. [Advanced Energy Manufacturing and Recycling Grant Program](#)
4. [Affordable Connectivity Program](#)
5. [Airport Terminal Program](#)
6. [All Stations Accessibility Program](#)
7. [Battery Manufacturing and Recycling Grants](#)
8. [Battery Material Processing Grants](#)
9. [Bioproduct Pilot Program](#)
10. [Bridge Investment Program](#)
11. [Broadband Equity, Access, and Deployment Program](#)
12. [Building Codes Implementation for Efficiency and Resilience Program](#)
13. [Building, Training, and Assessment Centers](#)
14. [Capital Investment Grants Program](#)
15. [Carbon Capture Demonstration Program](#)
16. [Carbon Dioxide Transportation Infrastructure Finance and Innovation Program](#)
17. [Carbon Reduction Program](#)
18. [Carbon Storage Validation and Testing Program](#)

<https://climatevulnerabilityindex.org/wp-content/uploads/2023/09/CVI-Microsite-Content-Resources.pdf>

# Overall, CVI aims to help communities and policymakers identify

- **Where** mitigation and intervention are most needed
- **What** are most critical factors underlying cumulative vulnerability
- **How** to match vulnerabilities and resources and develop targeted strategies that improve resilience to climate change

