VIRGINIA

11	CLIMATE DISASTER DECLARATIONS
KING AND QUEEN	COUNTY WITH THE HIGHEST DISASTER OCCURENCES
7	COUNTIES WITH FIVE OR MORE DISASTERS
102	SUPERFUND SITES
RICHMOND CITY	HIGHEST COMPOUNDING RISKS
$417 MILLION	FEMA + HUD POST-DISASTER FUNDING
8.5 MILLION	POPULATION TOTAL
$49	PER CAPITA SPENDING ON CLIMATE DISASTERS
$6.2 BILLION	OF CLIMATE INFRASTRUCTURE COULD BE SUPPORTED THROUGH A SMALL INSURANCE SURCHARGE

INDEPENDENT CITIES

1. Alexandria City
2. Bristol City
3. Buena Vista City
4. Charlottesville City
5. Chesapeake City
6. Colonial Heights City
7. Covington City
8. Danville City
9. Emporia City
10. Fairfax City

11. Falls Church City
12. Franklin City
13. Fredericksburg City
14. Galax City
15. Hampton City
16. Harrisonburg City
17. Hopewell City
18. Lexington City
19. Lynchburg City
20. Manassas City

21. Manassas Park City
22. Martinsville City
23. Newport News City
24. Norfolk City
25. Norton City
26. Petersburg City
27. Poquoson City
28. Portsmouth City
29. Radford City
30. Richmond City

31. Roanoke City
32. Salem City
33. Staunton City
34. Suffolk City
35. Virginia Beach City
36. Waynesboro City
37. Williamsburg City
38. Winchester City

DISASTER OCCURRENCES 2011–2021
FEDERALLY DECLARED CLIMATE DISASTERS BY COUNTY

11

disaster declarations

One hundred twenty-four out of 133 counties and independent cities have had a recent disaster.

King and Queen County has had the higest number of recent disasters in Virginia: 6 disasters.
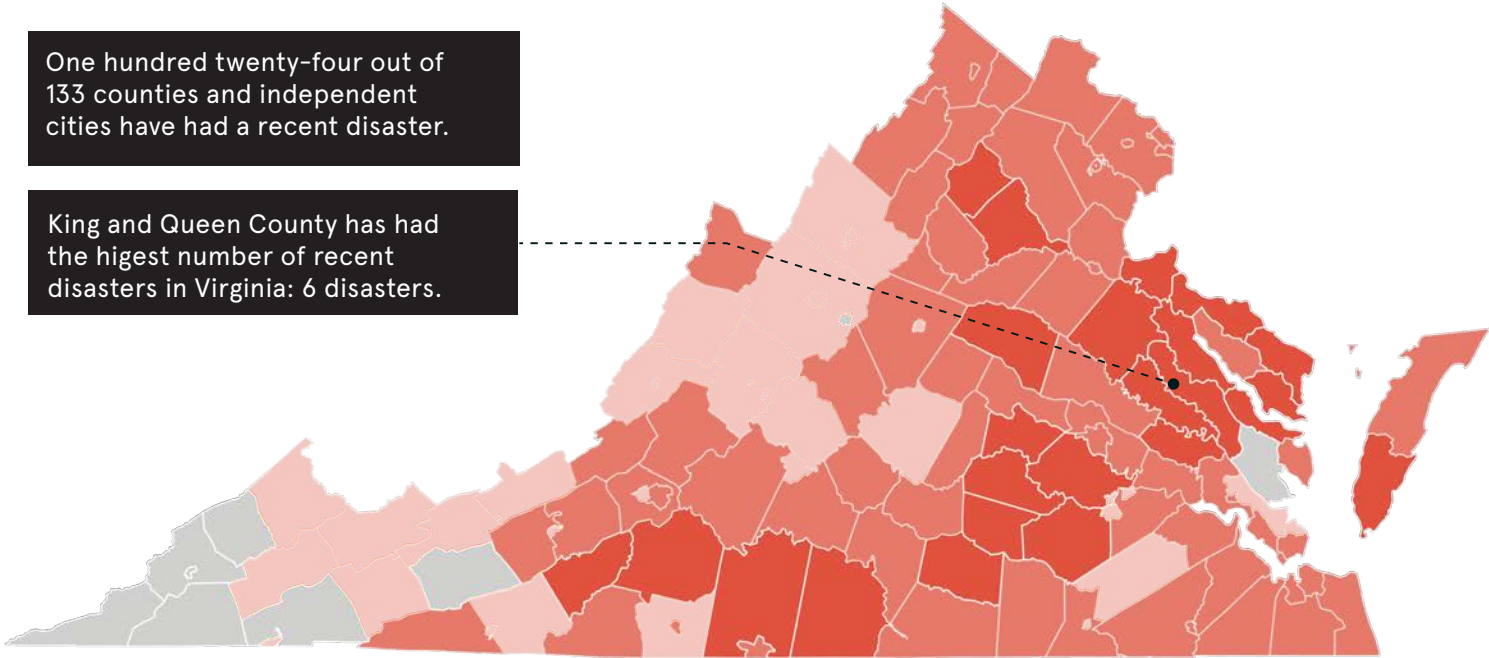
Number of Disaster Events

Major Disaster Declarations (2011-2021)

- 0 occurences
- 1 occurrence
- 2-3 occurences
- 4-6 occurrences
- 7-9 occurrences
- 10+ occurrences

Source: FEMA 2021
Maps courtesy of iParametrics

FEDERAL ASSISTANCE 2011–2021
POST-DISASTER PUBLIC ASSISTANCE AND HAZARD MITIGATION FUNDS OBLIGATED BY COUNTY FOR CLIMATE DISASTERS

$417M

post-disaster assistance

Louisa County has received the most post-disaster federal funding in the state: $42 million primarily for severe winter storms.
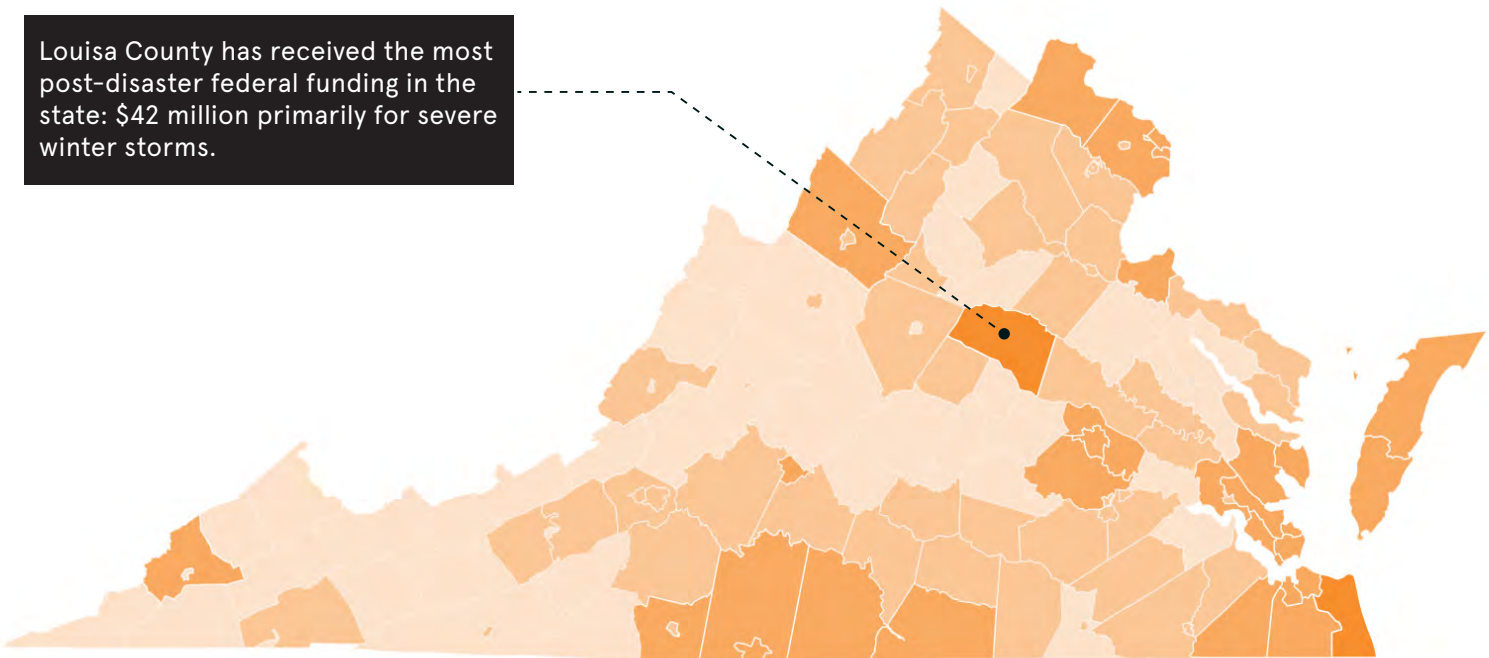
Public Assistance and Hazard Mitigation

Federal Share Obligated (2011-2021)

- $0 to $100K
- $100K to $1M
- $1M to $10M
- $10M to $50M
- $50M to $100M
- $100M to $1B
- $1B to $9B

Source: FEMA 2021
Maps courtesy of iParametrics

$297M FEMA obligations

$120M HUD CDBG-DR Funds

$417M FEMA + HUD assistance

$49 per capita cost

SOCIAL VULNERABILITY INDEX 2011–2021

AREAS OF GREATEST SOCIAL VULNERABILITY

New Kent County has had five disaster declarations and an increase in population over 10%.
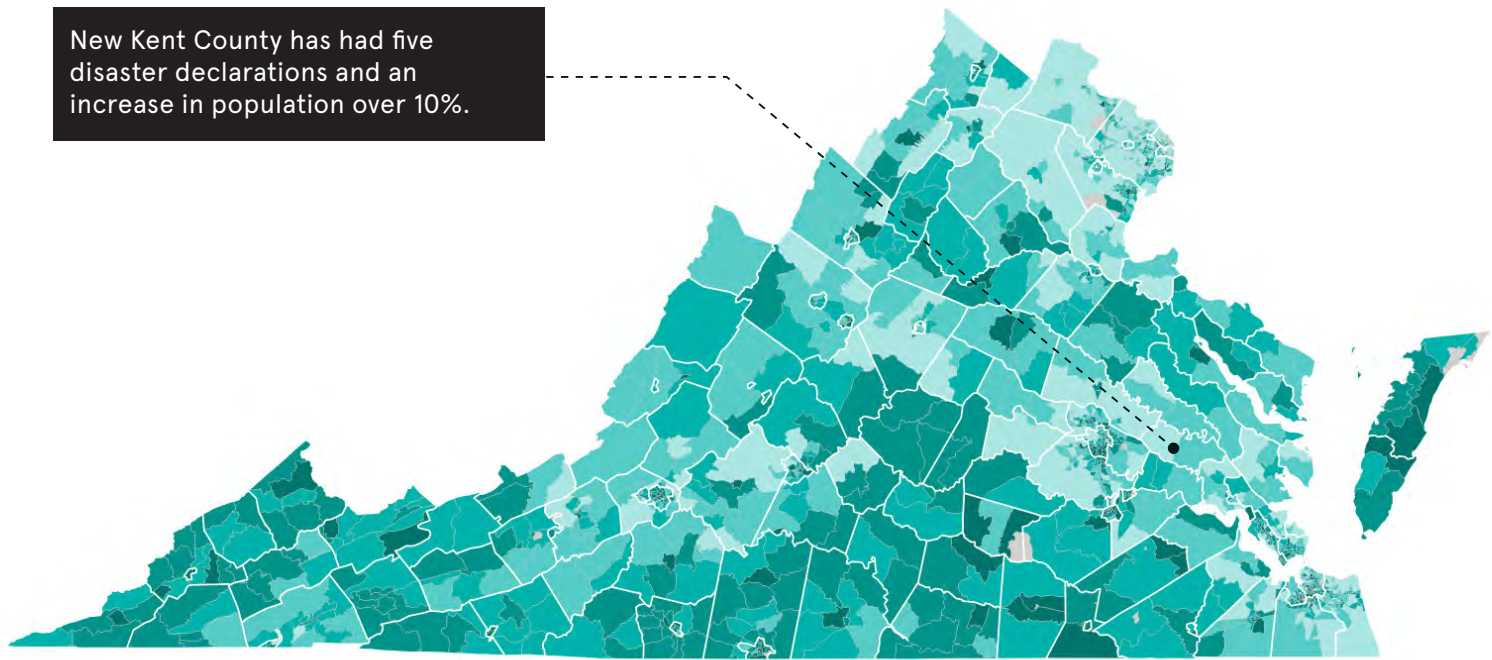
Social Vulnerability Index

CDC (2018)

- No Value
- 0.0 – 0.2
- 0.2 – 0.4
- 0.4 – 0.6
- 0.6 – 0.8
- 0.8 – 1.0

Source: CDC/ATSDR 2018 Social Vulnerability Index
Maps courtesy of iParametrics

ENERGY RELIABILITY 2011–2021

COUNTIES AT GREATEST RISK OF POWER OUTAGES

Seven counties in Virginia have populations with high social vulnerability and low energy reliability.
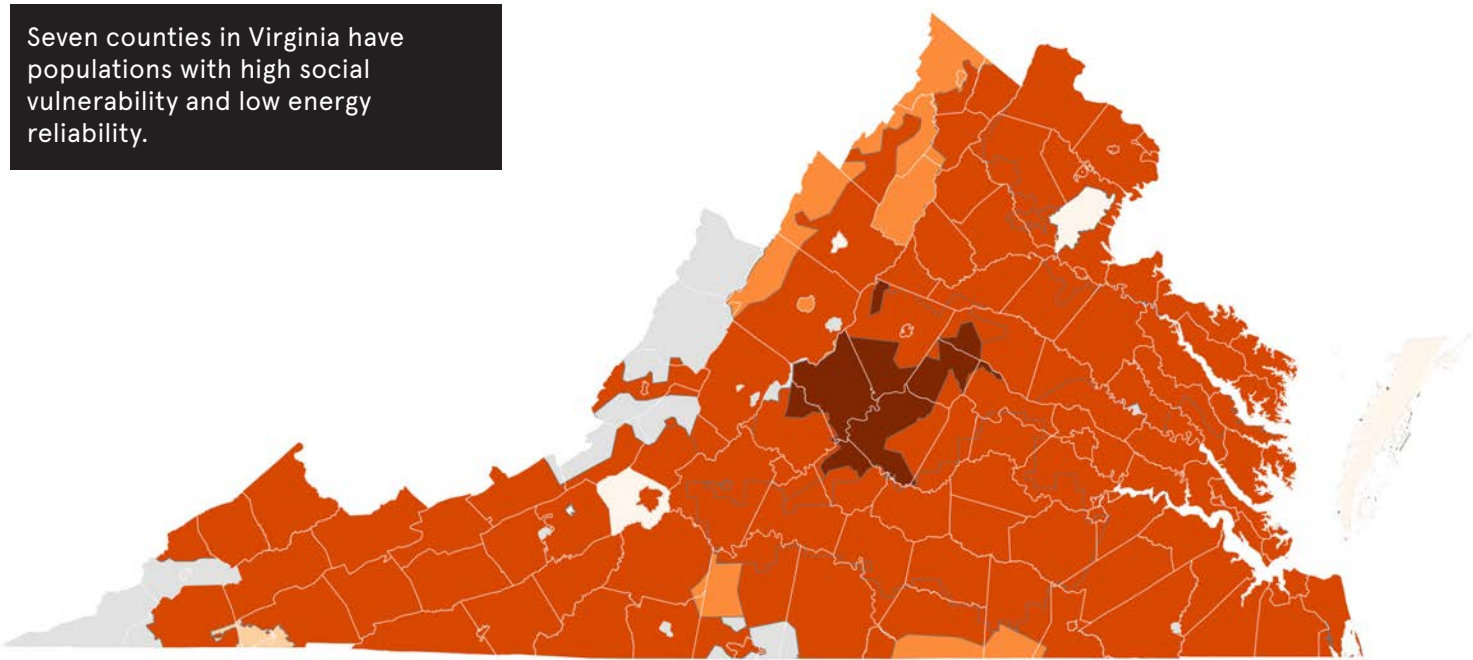
Aggregated Annual Electric Outage Duration
Including major events – SAIDI_W_MED

- missing electric outage data
- 0 – 60 minutes
- 60 – 120 minutes
- 120 – 240 minutes
- 240 – 456 minutes
- 456– 7,700 minutes

Source: U.S. Energy Information Administration
Maps courtesy of APTIM

COMPOUNDING RISKS: A FRAMEWORK FOR FUTURE INVESTMENT

Richmond City has a high risk of climate disasters, high population density, high population increase, high poverty, high health risks, and will experience sea level rise.

Areas with the greatest return on investment due to physical and social risk

- High Compounding Risks
- Low Compounding Risks
- 🟡 Superfund Sites
- 🟦 Wastewater Discharge Sites
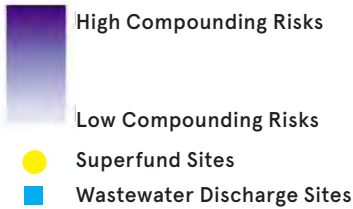
U.S. counties were analyzed for social benefits using the following parameters: NOAA Sea Level Rise (Source: Sea Level Rise and Coastal Flooding Impacts (noaa.gov)); Population Density (Source: 2020 Census Demographic Data Map Viewer); Population Change (Source: 2020 Census Demographic Data Map Viewer); Poverty (Source: 2020 Census Demographic Data Map Viewer); Cardiovascular Diseases (Source: US Data | GHDx (healthdata.org)); Neoplasms (Source: US Data | GHDx (healthdata.org)); Diabetes, urogenital, blood, and endocrine diseases (Source: US Data | GHDx (healthdata.org)); FEMA Natural Hazard risk (Source: Map | National Risk Index (fema.gov))t | Map courtesy of APTIM.

County Name	High Population Density	High Percent of Population Change	High Poverty Rate	High Health Risk	Types of High Climate Risk	Sea Level	Total Risk Count
Accomack					1		4
Albemarle							0
Alexandria							1
Alleghany							0
Amelia							0
Amherst							0
Appomattox							0
Arlington							1
Augusta							0
Bath					1		2
Bedford County							0
Bland							0
Botetourt							0
Bristol							0
Brunswick							0
Buchanan							0
Buckingham							0
Buena Vista							0
Campbell							0
Caroline							0
Carroll							0
Charles City							1
Charlotte							0
Charlottesville							0
Chesapeake							1
Chesterfield							1
Clarke							0
Colonial Heights							1
Covington							0
Craig							0
Culpeper							0
Cumberland					1		1
Danville					2		4
Dickenson							0
Dinwiddie							0
Emporia							0
Essex							1
Fairfax City							0
Fairfax County							1
Falls Church							0
Fauquier							0
Floyd							0
Fluvanna							0
Franklin City							1
Franklin County							0
Frederick							0
Fredericksburg							0
Galax							0
Giles					1		2

County Name	High Population Density	High Percent of Population Change	High Poverty Rate	High Health Risk	Types of High Climate Risk	Sea Level	Total Risk Count
Gloucester							1
Goochland							0
Grayson							0
Greene							0
Greensville							0
Halifax							0
Hampton							1
Hanover							0
Harrisonburg							0
Henrico							1
Henry							0
Highland							0
Hopewell							1
Isle of Wight							1
James City							1
King and Queen							1
King George							1
King William							1
Lancaster							1
Lee					1		3
Lexington							0
Loudoun							0
Louisa							0
Lunenburg							0
Lynchburg							0
Madison							0
Manassas							0
Manassas Park							0
Martinsville							0
Mathews							1
Mecklenburg							0
Middlesex							1
Montgomery							0
Nelson							0
New Kent							1
Newport News							1
Norfolk							1
Northampton							1
Northumberland							1
Norton					1		3
Nottoway					1		3
Orange							0
Page							0
Patrick							0
Petersburg							1
Pittsylvania							0
Poquoson							0
Portsmouth							1
Powhatan							0
Prince Edward							0
Prince George							1

County Name	High Population Density	High Percent of Population Change	High Poverty Rate	High Health Risk	Types of High Climate Risk	Sea Level	Total Risk Count
Prince William							1
Pulaski							0
Radford							0
Rappahannock							0
Richmond City						1	6
Richmond County							1
Roanoke City						1	4
Roanoke County							0
Rockbridge							0
Rockingham							0
Russell							0
Salem							0
Scott							0
Shenandoah							0
Smyth							0
Southampton							1
Spotsylvania							0
Stafford							1
Staunton							0
Suffolk							1
Surry							1
Sussex							1
Tazewell							0
Virginia Beach							1
Warren							0
Washington							0
Waynesboro							0
Westmoreland							1
Williamsburg							1
Winchester							0
Wise							0
Wythe							0
York							1

TOTAL: 11 DISASTERS
FEMA PA + HM: $297 M
HUD CDBG-DR: $120 M
FEMA + HUD ASSISTANCE: $417 M

Disaster legend (PA = Public Assistance, HM = Hazard Mitigation):
- **2011** — 4024: Hurricane Irene · 4042: Earthquake · 4045: The Remnants of Tropical Storm Lee
- **2012** — 4072: Severe Storms and Straight-Line Winds · 4092: Hurricane Sandy
- **2016** — 4262: Severe Winter Storm and Snowstorm · 4291: Hurricane Matthew
- **2018** — 4401: Hurricane Florence · 4411: Tropical Storm Michael
- **2021** — 4602: Severe Winter Storms · 4628: Flooding, Landslides, and Mudslides

County Name	# Disasters 2011-2021	Total FEMA Obligations	4024 PA	4024 HM	4042 PA	4042 HM	4045 PA	4045 HM	4072 PA	4072 HM	4092 PA	4092 HM	4262 PA	4262 HM	4291 PA	4291 HM	4401 PA	4401 HM	4411 PA	4411 HM	4602 PA	4602 HM	4628 PA	4628 HM
Statewide	11	$152,652,978	$25,886,467	$419,805	$911,708	$780,207	$3,081,170	$43,343	$13,190,973	$139,811			$7,128,579	$72,642	$35,508,302	$509,050	$1,652,768	$262,589	$31,863,913	$416,896	$22,409,621	$640,225	$7,934,909	$0
Accomack County	2	$2,258,521	$318,792	$691,447																				
Albemarle County	3	$267,255			$0	$0			$204,093	$0					$63,161	$0								
Alleghany County	1	$169,255							$169,255															
Amelia County	4	$30,515	$0	$0					$0	$0									$30,515	$0	$0	$0		
Amherst County	1	$31,450							$31,450															
Appomattox County	3	$0																	$0	$0	$0	$0		
Arlington County	3	$2,736,651							$433,668	$0	$490,904	$0	$1,812,079	$0										
Augusta County	1	$86,938							$86,938	$0														
Bath County	1	$75,657							$75,657															
Bedford County	2	$117,126							$117,126	$0											$0			
Bland County	1	$0							$0															
Botetourt County	2	$78,573							$78,573								$0	$0						
Brunswick County	3	$432,219	$143,671	$0															$229,897	$0	$58,651	$0		
Buchanan County	1	$0																					$0	$0
Buckingham County	1	$1,597							$1,597	$0														
Campbell County	3	$0							$0	$0											$0	$0		
Caroline County	4	$16,207	$13,138	$0			$3,070	$0					$0	$0							$0	$0		
Carroll County	1	$18,346							$18,346															
Charles City County	2	$69,206	$69,206	$0													$0	$0						
Charlotte County	3	$185,999							$0	$0									$109,958	$0	$76,041	$0		
Chesterfield County	4	$1,849,316	$918,048	$0													$232,849	$0	$581,224	$0	$117,194	$0		
Clarke County	3	$40,944							$10,660	$0			$30,284	$0										
Craig County	3	$19,431							$14,114	$0	$0	$0					$5,318	$0						
Culpeper County	4	$863,946			$676,664	$0			$30,392	$0	$0	$0	$156,889	$0										
Cumberland County	3	$3,279							$0	$0									$3,279	$0	$0	$0		
Dickenson County	0	$0																						
Dinwiddie County	4	$397,819	$229,889	$0					$0	$0									$0	$0	$167,929	$0		
Essex County	5	$84,467	$84,467	$0			$0	$0	$0										$0	$0	$0	$0		
Fairfax County	2	$4,095,119					$1,043,677	$0					$3,051,442	$0										
Fauquier County	3	$631,372							$56,093	$0	$94,978	$0	$480,301	$0										
Floyd County	4	$0							$0	$0							$0	$0	$0	$0	$0	$0		
Fluvanna County	3	$135,477			$0	$135,477			$0	$0														
Franklin County	4	$402,145							$38,844	$0							$36,896	$0	$194,403	$116,250	$15,752	$0		
Frederick County	3	$113,575							$0	$0	$3,048	$0	$110,526	$0										
Giles County	1	$29,591							$29,591	$0														
Gloucester County	0	$0																						
Goochland County	2	$0			$0	$0															$0	$0		
Grayson County	2	$22,024															$18,381	$0	$3,643	$0				
Greene County	3	$104,554							$18,508	$72,199	$3,961	$0	$9,885	$0										
Greensville County	2	$84,437	$84,437	$0					$0	$0														
Halifax County	4	$2,155,618							$0	$0							$9,841	$1,838,605	$285,213	$0	$21,960	$0		
Hanover County	2	$262,379	$262,379	$0																	$0	$0		
Henrico County	2	$5,094,044	$3,853,562	$0									$1,240,482	$0										
Henry County	1	$346,894															$346,894	$0						
Highland County	2	$44,289							$43,257	$0	$1,032	$0												
Isle of Wight County	2	$461,874	$273,770	$0											$169,398	$0	$18,706	$0						
James City County	2	$2,300,674	$2,102,017	$73,500																	$125,157	$0		
King and Queen County	6	$47,721	$47,721	$0			$0	$0	$0										$0	$0	$0	$0		
King George County	4	$1,351,583	$63,953	$0	$0	$0	$50,536	$0					$30,902	$1,206,193										
King William County	4	$64,966	$64,966	$0																				
Lancaster County	5	$43,744	$27,289	$0					$0	$0							$5,583	$0	$10,872	$0	$0	$0		
Lee County	0	$0																						
Loudoun County	2	$1,717,496									$361,479	$0	$1,356,017	$0										
Louisa County	4	$41,939,619			$41,898,081	$0			$0	$0			$41,538	$0										
Lunenburg County	5	$164,681	$8,302	$0					$0	$0							$0	$0	$28,208	$0	$128,171	$0		
Madison County	3	$2,448							$2,448	$0	$0	$0	$0	$0										
Mathews County	3	$1,358,665	$28,030	$0							$0	$1,330,635					$0	$0						
Mecklenburg County	3	$1,147,094	$641,682	$0													$50,328	$0	$96,350	$104,250	$254,484	$0		
Middlesex County	4	$39,954	$34,220	$0							$5,734	$0												
Montgomery County	3	$202,464							$202,464	$0											$0	$0		
Nelson County	3	$5,109							$5,109	$0	$0	$0					$0	$0						
New Kent County	5	$945,658	$839,632	$0					$32,286	$0			$13,872	$0					$59,868	$0				
Northampton County	4	$585,408	$74,893	$0	$6,001	$0							$314,514	$100,000										
Northumberland County	5	$146,471	$88,883	$0									$9,543	$0			$0	$0	$48,045	$0	$0	$0		
Nottoway County	5	$856,463	$22,206	$0					$2,197	$0							$0	$0	$34,883	$0	$797,177	$0		
Orange County	2	$0			$0	$0			$0	$0														
Page County	2	$118,504							$36,702	$0			$81,802	$0										
Patrick County	3	$0							$0	$0							$0	$0			$0	$0		
Pittsylvania County	4	$3,166,185							$17,843	$0							$0	$0	$2,807,003	$129,212	$212,127	$0		
Powhatan County	4	$37,433	$5,183	$0															$32,250	$0				
Prince Edward County	3	$421,123							$0	$0									$298,971	$0	$122,152	$0		
Prince George County	2	$383,406	$383,406	$0																	$0	$0		
Prince William County	3	$631,266					$124,318	$0			$135,551	$0	$371,397	$0										
Pulaski County	2	$125,522							$39,140	$0							$12,431	$73,950						
Rappahannock County	4	$9,090							$0	$0	$0	$0							$0	$9,090				
Richmond County	2	$94,956	$94,956	$0																	$0	$0		
Roanoke County	2	$516,688							$255,691	$0									$260,997	$0				
Rockbridge County	1	$24,674							$24,674	$0														
Rockingham County	1	$1,738,188							$1,641,497	$96,691														
Russell County	1	$0															$0	$0						
Scott County	0	$0																						
Shenandoah County	3	$113,937							$27,629	$0			$86,308	$0										
Smyth County	1	$9,024							$9,024	$0														
Southampton County	2	$131,188	$131,188	$0											$0	$0								
Spotsylvania County	2	$107,843			$26,970	$0							$80,873	$0										
Stafford County	2	$447,315							$194,816	$0			$252,499	$0										
Surry County	2	$81,808	$67,180	$0							$14,628	$0												
Sussex County	1	$110,395	$110,395	$0																				
Tazewell County	1	$56,733							$56,733	$0														
Warren County	3	$200,948							$8,020	$0	$0	$0	$192,929	$0										
Washington County	0	$0																						
Westmoreland County	4	$216,989	$181,179	$0			$35,809	$0			$0	$0							$0	$0				
Wise County	0	$0																						
Wythe County	0	$0																						
York County	1	$2,514,288	$1,177,135	$1,337,153																				
Alexandria city	3	$2,078,159	$315,188	$0			$796,819	$0					$966,152	$0										
Bristol city	1	$0															$0	$0						
Buena Vista city	1	$27,605							$27,605	$0														
Charlottesville city	1	$40,873							$40,873	$0														
Chesapeake city	2	$5,621,390	$2,648,462	$1,085,411											$1,342,358	$545,159								
Colonial Heights city	1	$481,025	$481,025	$0																				
Covington city	1	$90,123							$90,123	$0														
Danville city	3	$8,939,681							$291,267	$0									$141,377	$0	$7,837,008	$0	$670,029	$0
Emporia city	1	$230,618	$190,741	$39,877																				
Fairfax city	2	$532,548							$168,598	$0	$127,206	$0	$236,744	$0										
Falls Church city	3	$323,517							$187,743	$0	$49,442	$0	$86,332	$0										
Franklin city	3	$430,451	$282,100	$39,528													$95,382	$0	$13,441	$0				
Fredericksburg city	3	$235,632			$31,047	$0			$56,067	$0			$148,518	$0										
Galax city	1	$409,659																			$409,659	$0		
Hampton city	3	$3,548,926	$1,135,074	$1,395,112											$680,497	$0	$246,036	$92,206						
Harrisonburg city	1	$203,141							$203,141	$0														
Hopewell city	1	$160,843	$160,843	$0																				
Lexington city	1	$184,155							$184,155	$0														
Lynchburg city	1	$1,757,502							$1,693,395	$64,107														
Manassas city	2	$279,614											$252,910	$0	$26,704	$0								
Manassas Park city	2	$166,204							$10,454	$0			$155,750	$0										
Martinsville city	2	$678,183															$0	$0	$364,155	$261,394				
Newport News city	3	$2,847,582	$2,395,751	$0							$343,357	$0			$0	$0	$108,474	$0						
Norfolk city	2	$4,966,416	$2,484,441	$514,487											$1,967,488	$0								
Norton city	0	$0																						
Petersburg city	1	$341,582	$341,582	$0																				
Poquoson city	1	$205,979	$183,131	$22,848																				
Portsmouth city	2	$2,907,226	$764,162	$0											$2,143,064	$0								
Radford city	1	$86,550							$86,550	$0														
Richmond city	2	$2,136,321	$1,963,028	$0													$173,293	$0						
Roanoke city	2	$543,007							$543,007	$0									$0	$0				
Salem city	1	$133,655							$133,655	$0														
Staunton city	1	$106,643							$106,643	$0														
Suffolk city	1	$1,790,677	$1,122,162	$0											$668,514	$0								
Virginia Beach city	2	$11,805,489	$4,697,217	$117,110											$6,896,501	$94,661								
Waynesboro city	0	$0																						
Williamsburg city	2	$231,376	$231,376	$0													$0	$0						
Winchester city	2	$865,900							$589,320	$0			$276,579	$0										
Total FEMA Allocation		$296,037,057	$57,728,529	$5,736,278	$43,550,471	$915,684	$5,135,398	$43,343	$21,670,638	$372,808	$10,459,122	$1,503,277	$46,994,294	$1,715,243	$15,615,970	$902,409	$33,083,762	$2,421,657	$36,261,177	$1,350,421	$10,576,577	$0	$0	$0

DISASTER OCCURRENCES 2011-2021

	TOTAL DISASTERS		TOTAL DISASTERS
California	25	Virginia	11
Mississippi	22	Florida	11
Oklahoma	22	Georgia	11
Iowa	21	Minnesota	11
Tennessee	20	Connecticut	10
Louisiana	18	Hawaii	10
Alabama	17	Maryland	10
Texas	17	New Mexico	10
Vermont	17	Wisconsin	10
West Virginia	17	Idaho	9
Arkansas	16	Massachusetts	9
Kentucky	16	Pennsylvania	9
New Hampshire	16	South Carolina	8
New York	16	Colorado	7
Washington	16	Utah	7
Alaska	15	Maine	6
North Carolina	15	Michigan	6
Nebraska	14	Ohio	6
Missouri	13	Arizona	6
Kansas	13	Delaware	5
New Jersey	13	Illinois	5
North Dakota	13	Indiana	4
South Dakota	13	Rhode Island	4
Montana	12	Wyoming	4
Oregon	12	Nevada	3

FEMA AND HUD COST PER CAPITA 2011-2021

	PER CAPITA		PER CAPITA
Louisiana	$1,736	New Mexico	$97
New York	$1,348	Arkansas	$81
New Jersey	$815	Massachusetts	$73
North Dakota	$738	Georgia	$64
Vermont	$593	Montana	$63
Texas	$518	Kansas	$60
West Virginia	$481	New Hampshire	$55
Alaska	$401	Rhode Island	$53
Florida	$390	Minnesota	$49
Nebraska	$390	Pennsylvania	$49
South Carolina	$289	Virginia	$49
Alabama	$275	Maryland	$39
South Dakota	$269	Washington	$36
North Carolina	$243	Wyoming	$32
Hawaii	$229	Idaho	$32
Iowa	$228	Wisconsin	$27
Oklahoma	$215	Illinois	$24
Oregon	$210	Michigan	$23
Missouri	$162	Ohio	$19
Mississippi	$159	Maine	$18
California	$157	Delaware	$14
Connecticut	$149	Utah	$11
Colorado	$141	Nevada	$11
Kentucky	$105	Indiana	$7
Tennessee	$97	Arizona	$2

MAPPING THE IMPACT

DATA VISUALIZATION TOOLS

It is evident the U.S. is already paying a steep price for this challenge. Rebuild by Design partnered with APTIM and iParametrics to create the following visual tools to demonstrate how climate events have affected each state. The set of six maps depicts which areas have been hit the hardest by recent climate events, where recovery funds are focused, where those individuals with high social vulnerabilities live, and which areas have the least energy reliability.

The U.S. needs to change the way it is making funding decisions. Where we make priority investments is equally important to what we invest in. Returns on investments (ROI) in the form of social benefits to communities needs to be part of grant evaluations. The U.S. need to utilize new decision-making frameworks that are forward-looking. The final map in the set includes an example of a new decision-making framework that takes into account current vulnerabilities and future climate risks. This is one example of how physical and social vulnerability indicators could inform where investments in adaptation infrastructure can yield high returns in social benefits to the most impacted communities. Our team recognizes, however, that there are other decision-making frameworks to explore, and further research is needed to understand which indicators should be included in any state-specific model. Given the ever-present constraints on funding availability, the intent of presenting these maps together is to prompt investments that address multiple known vulnerabilities simultaneously within projects, furthering comprehensive climate adaptation planning.

The following data are designed as a tool to help communities understand their risks to make better-informed choices with higher returns on investment, though each state should determine their own framework for investment.

There are always many ways to present these data. For the purposes of this report, we chose to analyze the years 2011-2021. The following six maps and two tables are presented in this format with the following considerations and limitations:

GEOGRAPHIC MAP

The map provides topographic and geographic context for each state and its surrounding areas, indicating whether the state encompasses coastal, riverine, lake, alpine, or desert land.

GEOGRAPHIC MAP. SOURCE: ESRI WORLD IMAGERY BASEMAP

DISASTER DECLARATIONS (RED)

This map shows federally declared climate disasters by county from 2011-2021 – providing a snapshot of the magnitude of climate disasters across the country in recent history. This report only identifies federally declared disasters, as there is no entity that collects and publishes state disaster declarations. It should be noted that the declarations shown in this report do not reflect every climate event that has occurred between 2011-2021; the report instead only shows those which have met the cost threshold for a federal disaster declaration. Therefore, the findings overall underestimate the number of occurrences and the suffering that some communities have experienced.

According to the Stafford Act, as amended in May 2021, a "major disaster" includes "any natural catastrophe (including any hurricane, tornado, storm, high water, winddriven water, tidal wave, tsunami, earthquake, volcanic eruption, landslide, mudslide, snowstorm, or drought), or, regardless of cause, any fire, flood,
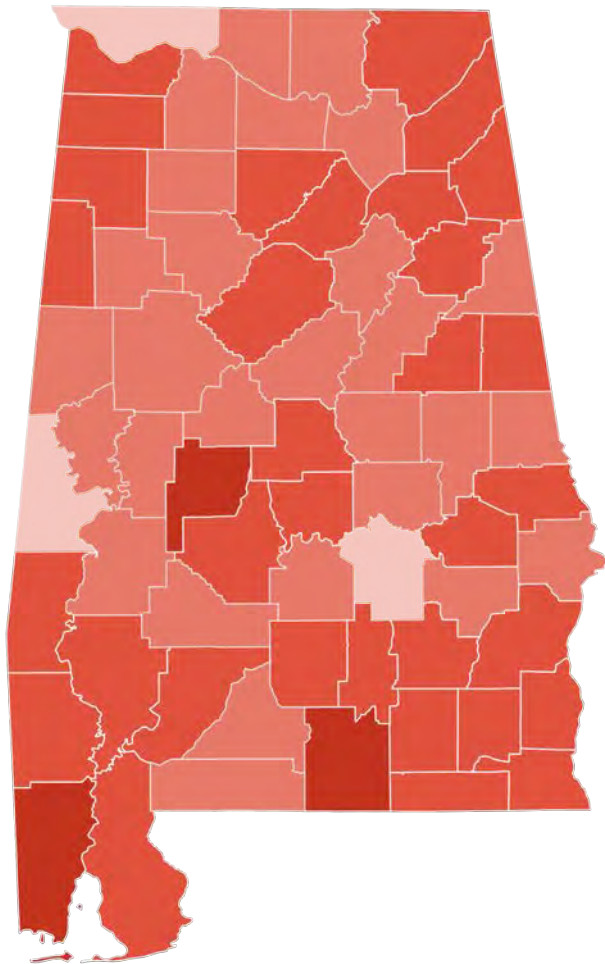
DISASTER DECLARATIONS. SOURCE: FEMA 2021 | MAPS COURTESY OF IPARAMETRICS.

or explosion, in any part of the United States, which in the determination of the President causes damage of sufficient severity and magnitude to warrant major disaster assistance under this Act to supplement the efforts and available resources of States, local governments, and disaster relief organizations in alleviating the damage, loss, hardship, or suffering caused thereby."[1]

Importantly, extreme heat waves do not fit the criteria for federal disaster declarations despite being the leading cause of deaths among climate hazards. Likewise, sea level rise is not included in this definition despite the threat it poses to numerous communities, including damage to property, loss of land, and displacement.

It should be noted that while most disaster declarations are due to climate events, there are a few instances of disasters due to other natural hazards, such as earthquakes and volcanic eruptions. Though these events are not increasing in magnitude or frequency due to climate change, the severity of their impact may be connected. As climate impacts degrade household and critical infrastructure, communities may become more vulnerable to other natural hazards. Retrofitting infrastructure after these events often requires the same measures as floods, tornadoes, fires, etc., so these events were included in the report to demonstrate the need to prioritize multi hazard adaptation approaches.

FEDERAL ASSISTANCE (ORANGE)

The map shows the amount of federal dollars allocated to counties through FEMA's Public Assistance and Hazard Mitigation Grant Programs between 2011-2021 which allocates funding to individual counties and statewide. The map does not show where "statewide" allocations were spent within the state, but rather only shows county allocations. However, these statewide allocation amounts are included in the Disaster Declaration table at the end of each chapter and included in the "FEMA Total" provided next to the map. The adjacent table adds HUD's Community Development Block Grant Disaster Recovery funds – which are only available to states after a disaster – to the FEMA Total for an estimate of federal post-disaster spending in each state.
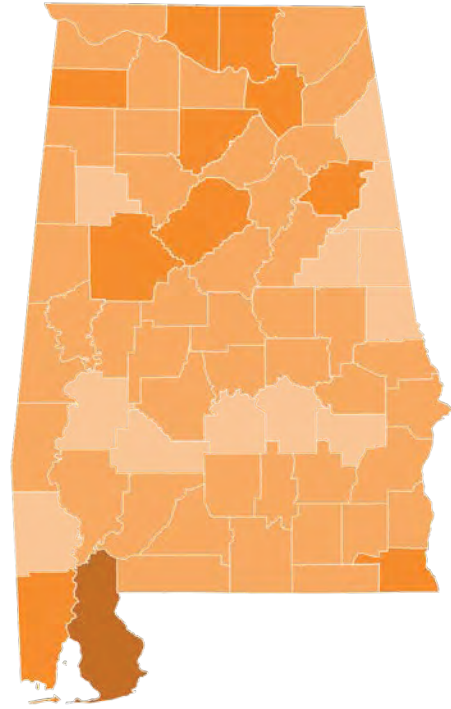
The Disaster Declaration tables provided at the end of each chapter show all federal Disaster Declarations declared between 2011-2021 and the corresponding FEMA obligations associated with those events. **However, in some instances, FEMA continues to obligate funds for years following a declaration. Some states have received funds for events that took place between 2011-2021 after 2021, so the total sum of funds associated with that event are not captured.** All FEMA funds allocated to counties between 2011-2021 are shown in the federal assistance map; however, they do not show up in the Disaster Declaration table if their corresponding event took place prior to 2011. For example, counties in the State of Illinois are still receiving funds from a 1960s storm. The funds obligated to those counties are included in the map, but that event is not included in the Disaster Declaration table at the end of the chapter.

There are additional sources of federal funding made available to governments or individuals in response to disasters, such as the U.S. Army Corp of Engineers (USACE) projects, Small Business Administration (SBA) loans, and private insurance payouts, which are not included in this report because they are harder to uniformly track and/or must be paid back. Therefore, our findings underestimate the total support available to states and individuals post-disaster.

Since disaster aid is allocated to repair physical damage to property, events such as extreme heat, which largely creates physical damage to persons and not property, rarely qualify for federal disaster recovery aid. Additionally, there is only a shallow understanding of the economic impact of social and health-related costs and environmental degradation after a disaster.

SOCIAL VULNERABILITY INDEX (GREEN)

Social vulnerability refers to the potential negative effects on communities caused by external stresses on human well-being. Such stresses include natural or human-caused disasters or disease outbreaks. The factors that determine social vulnerability are directly tied to social determinants of health or the social, economic, and physical factors – such as race, socioeconomic status, and environmental conditions – that influence health. Socially vulnerable populations fare the worst during a disaster and often take longer to recover.[2] The Center for Disease Control/Agency for Toxic Substance and Disease Registry Social Vulnerability Index (CDC/ATSDR SVI) uses 15 U.S. census variables to help local officials identify communities that may need support before, during, or after disasters. The map presents the SVI on a census block level, indicating where the most socially vulnerable populations within each county live. The 15 indicators are grouped into four themes: Socioeconomic Status
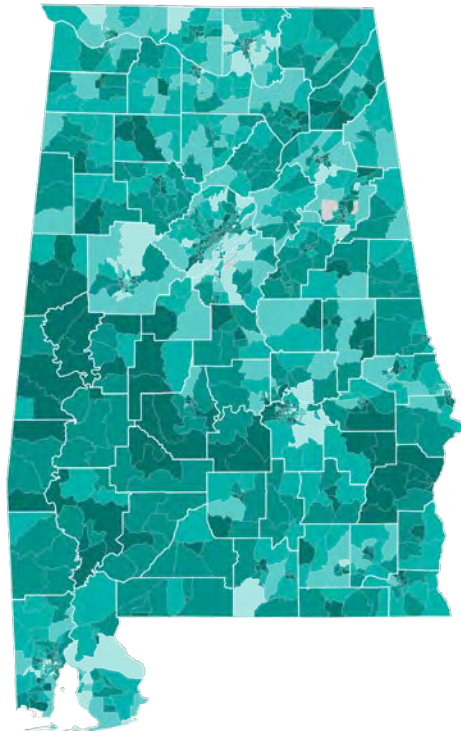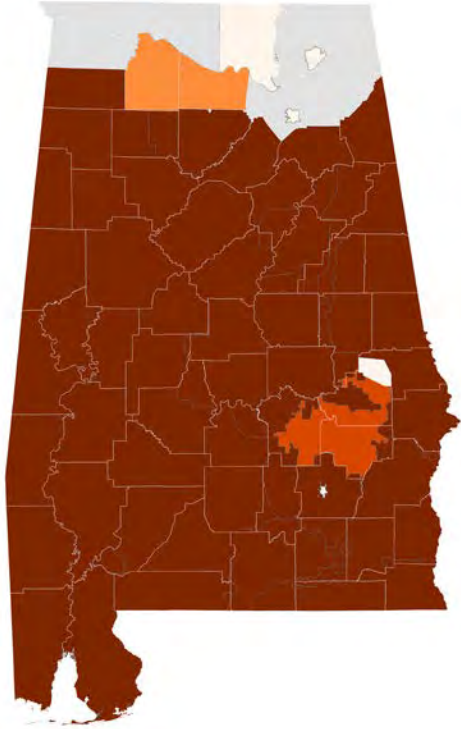
(below poverty, unemployed, income, no high school diploma); Household Composition & Disability (aged 65 or older, aged 17 or younger, older than age 5 with a disability, single-parent households); Minority Status & Language (minority, speak English "less than well"); and Housing Type & Transportation (multi-unit structures, mobile homes, crowding, no vehicle, group quarters).

Social Vulnerability Index data are not being used to make post-disaster assistance funding decisions. HUD only requires Low and Moderate Income for a portion of their funding. FEMA does not consider it in their allocations. To learn more about how vulnerable populations fare during climate events, turn to p. 10.

ENERGY RELIABILITY (BROWN)

Climate events often lead to energy disruptions for hours, days, or weeks. This map shows the annual average interruption time (in minutes) across the different energy utility providers within a state. Regions (or utility territories) in the darkest shade, on average, experience longer energy outages. These data are aggregated by utility territory, not county, meaning more than one provider can serve a county or group of counties.

Viewing the Energy Reliability Map next to the SVI Map, one can begin to infer which regions have the most socially vulnerable residents and are served by the least reliable energy providers. Energy reliability is increasingly becoming related to climate disasters and weather events. Inclusion of these maps is to support evaluation of need for concurrent flood and energy resilience projects. To read more about how energy reliability is calculated, see Appendix A.

COMPOUNDING RISKS (PURPLE)

This map overlays multiple physical and social vulnerability indicators to identify areas where new climate infrastructure would have the greatest return on investment.

This map overlays social inputs – population density, increase in population, and health risks – with physical risk inputs – high risk of climate hazards and sea level rise – to get a more detailed picture of the populations who are most vulnerable to climate events to inform future choices of where new climate infrastructure may have the greatest return on investment through the creation of social benefits.

While other composite maps such as FEMA's National Hazard Risk Index demonstrate climate impact and
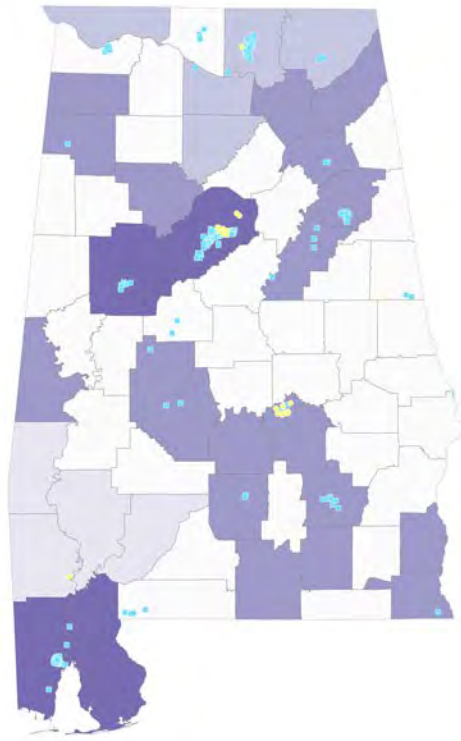
some demographic information, these maps have added additional criteria, such as population density, population increase, poverty rates, and health risks, to focus on the compounding effects. For instance, if a climate event happens in an area where there is already high social vulnerability, that community is likely to suffer more.

This approach provides an example of how to begin creating new frameworks for allocating funding, moving away from funding based on damage estimates from the previous storm. These assumptions should be ground-checked by each state as data do not always give us the full picture. For instance, in some cases, the areas highlighted for "highest compounding risks" may already have numerous funding sources while others, such as rural communities, may not. In other areas, the location where investments need to be directed may be adjacent to the county with the highest need. For example, an adaptation intervention to protect a downstream riverine community may need to be built upstream in a less vulnerable area to stop flooding at its source.

Analyzed Risks Include:

+ **Climate:** sea level rise, multiple climate hazards

+ **Social:** population density, population increase, and poverty

+ **Health:** cardiovascular disease, neoplasms, and other health indicators

COMPOUNDING RISK (TABLE)

Though 10 data sources went into the data for the purple map, the chart shows a simplified view into how the areas of most need were chosen. An array of physical and social challenges were analyzed and then each county was given a score of 0 to 6, with 6 showing areas with the highest potential for returns on investment in the form of social benefits to the county. In order to qualify for a high need of investment, counties needed to have high climate risk. Read more about this approach in Appendix B.

DISASTER OCCURRENCES AND FEMA INVESTMENTS BY COUNTY (TABLE)

The chart provides the raw county-level disaster data used to inform the first two maps. Our team found that sifting through disaster declaration data is often difficult or not available. By making these data public and easily accessible, it is our intent that other organizations, academics, governments, and other decision-makers will continue to make use of and build on this collection.

ENDNOTES

1   Federal Emergency Management Agency, "Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 93-288, as amended," 42 U.S.C. 5121 et seq., and Related Authorities, 2021. [online], www.fema.gov/sites/default/files/documents/fema_stafford_act_2021_vol1.pdf

2   Flanagan, B., Gregory, E., Hallisey, E., Heitgerd, J. & Lewis, B. "A Social Vulnerability Index for Disaster Management. Journal of Homeland Security and Emergency Management," 8(1), 2011. https://doi.org/10.2202/1547-7355.1792

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