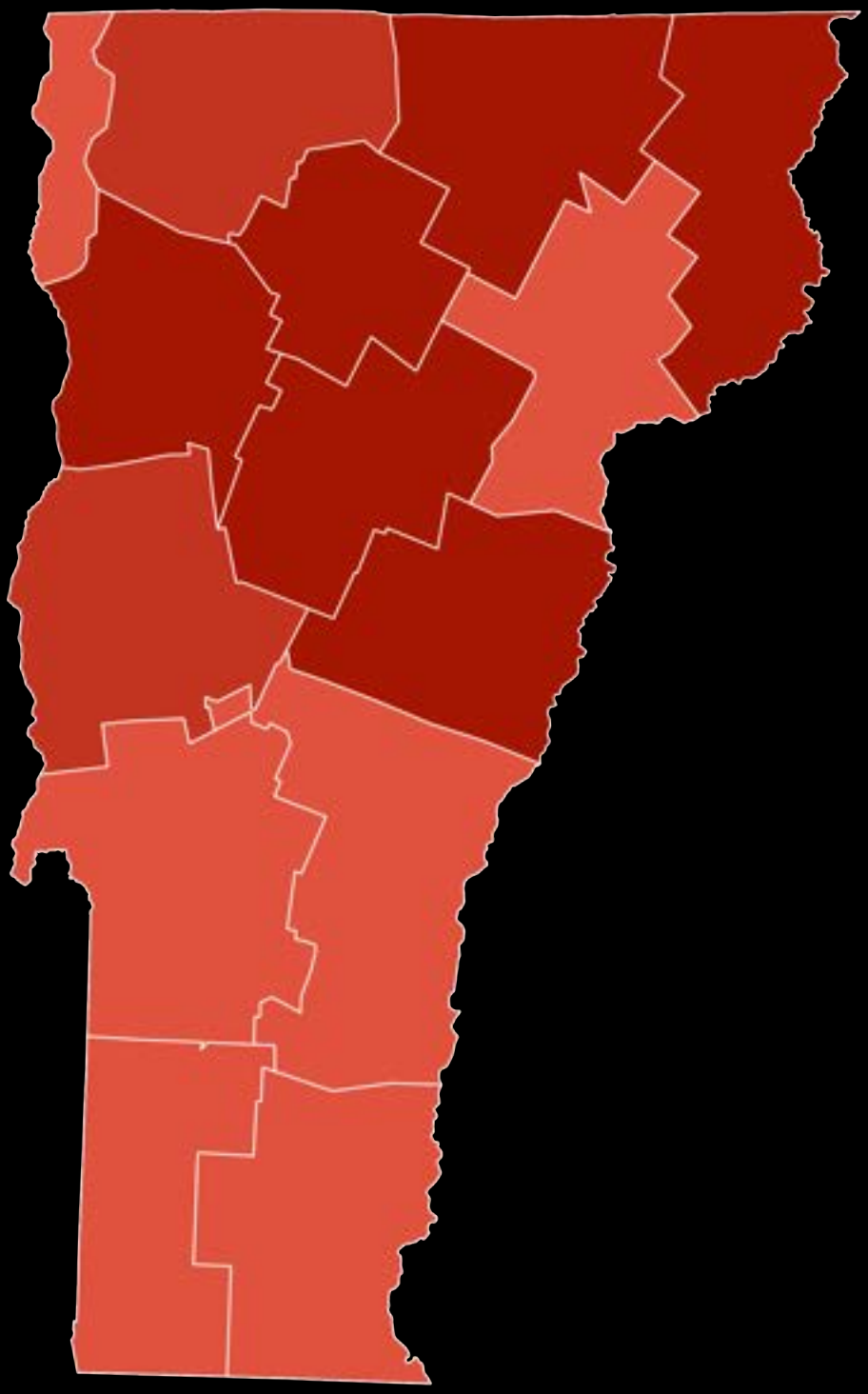
VERMONT

ATLAS OF DISASTER



REBUILD
BY
DESIGN

RALLY FOR THE PLANET

EACH YEAR, THE STREETS OF MONTPELIER, VERMONT ARE FILLED WITH YOUNG ACTIVISTS CHAMPIONING FOR THE ENVIRONMENT AT THE "RALLY FOR THE PLANET."[1]

IMAGE SOURCE: VERMONT YOUTH LOBBY | APRIL 2023

WE WANT TO WORK WITH YOU!

REBUILD BY DESIGN PARTNERS WITH COMMUNITIES TO DESIGN REGIONAL AND LOCAL PROCESSES THAT CREATE AND IMPLEMENT INFRASTRUCTURE POLICY AND PROJECTS TO PREPARE COMMUNITIES FOR THE WORLD'S MOST PRESSING PROBLEMS.

WE RESEARCH, DEVELOP POLICY, AND EDUCATE THE NEXT GENERATION OF RESILIENCE PRACTITIONERS. DO YOU HAVE A VEXING CHALLENGE THAT NEEDS CREATIVE PROBLEM SOLVING? CONTACT US AT INFO@REBUILDBYDESIGN.ORG

EXECUTIVE SUMMARY

Climate change is here, and Vermonters are calling for action. Residents of the Green Mountain State have borne the impacts of severe floods, tropical storms, and winter storms. In July 2023, two days of extreme heavy rainfall overtopped rivers, washed homes and cars away, caused landslides, and damaged over 4,000 homes and 800 businesses, upending thousands of lives and causing at least two fatalities.

The following pages utilize 2011-2021 county-level data to capture the reality that Vermonters are living through – totaling 17 federally declared disasters. To give Vermonters a full understanding of their experience with extreme weather, this report demonstrates the frequency of federal disaster declarations across counties, where post-disaster support has been allocated, where the most socially vulnerable populations reside, and the state's energy reliability by utility area. It also provides county-level disaster data within General Assembly and Senate district boundaries, so legislators and their constituents can work together to advocate for the adaptation needs of their communities.

Since the disaster data was analyzed, two more major disasters have hit Vermont. In December 2022, a major winter storm struck Vermont, causing widespread power outages and leaving many Vermonters without utilities over the holidays. A few months later, the aforementioned July 2023 rainstorms wrought havoc on towns across the state, disproportionately impacting low-income residents along the Winooski River. Early estimates found that the average loss to businesses is $180,000 each.* The complete toll to Vermonters and a full picture of the devastation is still being determined. Additionally, in May 2023, a major freeze halted life across the state, disrupting crop production and taking a devastating economic toll on Vermont's agriculture industry. Though this event did not receive a federal major disaster declaration, it did receive a US Department of Agriculture disaster declaration, unlocking relief programs for impacted farmers, ranchers, communities, and businesses.

Adaptation cannot be planned without mitigation. Though Vermont has taken steps to reduce greenhouse gas emissions and outlined a path toward climate resilience, the state has far to go to ensure its physical and social infrastructure is ready to withstand a future with more frequent and intense storms due to climate change, and more urgency is needed to cut carbon emissions and slow the rate of global warming.

Vermont needs sustainable sources of long-term climate adaptation infrastructure funding to support climate adaptation measures that will reduce the physical, economic, and social tolls of future extreme weather events, support communities looking to move away from risky areas, and protect and restore the natural environment. State funding would also leverage additional federal funding by providing a local match for programs that will be made available under the Inflation Reduction Act, the Infrastructure Investment and Jobs Act, Justice40, and other federal sources.

This report could not have been created without the incredible partnership of APTIM and iParametrics, as well as the generous support of the Siegel Family Endowment, the Rockefeller Family Fund, the Rockefeller Brothers Foundation, and Tiger Global Philanthropic Ventures. Rebuild by Design worked with an unbelievable team of engineers, researchers, finance experts, data managers, and volunteers supporting, identifying, analyzing, and synthesizing different data sets and ideas into an accessible compendium of county-by-county climate impacts. Special thank you to Judy Huynh for research and design on this report, and to the local Vermont organizations who contributed the on-the-ground knowledge. We are so fortunate to work with these partners, and we want to work with you, too. If you are passionate about these issues and are interested in our work, please reach out to info@rebuildbydesign.org to explore how to build climate-forward communities together.

This work builds on the work of Atlas of Disaster (November 2022), which examined similar data from all 50 states, which can be viewed here.

* Early estimates were presented at the Joint House Committee on Commerce and Economic Development Hearing, July 27, 2023.

VERMONT

VERMONT STATISTICS SUMMARY (2011 - 2021)	
17	CLIMATE DISASTER DECLARATIONS
EVERY	COUNTY HAS HAD FOUR OR MORE DISASTERS
5TH HIGHEST	PER CAPITA SPENDING ON CLIMATE DISASTERS IN THE COUNTRY
$593	PER CAPITA SPENDING ON CLIMATE DISASTERS
7TH HIGHEST	NUMBER OF DISASTERS IN THE COUNTRY
WASHINGTON	COUNTY WITH THE HIGHEST DISASTER OCCURENCES
6	COUNTIES WITH TEN OR MORE DISASTERS
11	COUNTIES WITH FIVE OR MORE DISASTERS
C	ASCE INFRASTRUCTURE REPORT CARD GRADE
$370 MILLION	FEMA + HUD POST-DISASTER FUNDING
643 THOUSAND	POPULATION TOTAL
$600 MILLION	OF CLIMATE INFRASTRUCTURE COULD BE SUPPORTED THROUGH A SMALL INSURANCE SURCHARGE

14

counties were hit hard by a historic flood in July 2023, resulting in extensive property damage, closure of 100+ roads, and significant damage to rail lines.[2]

IN A SPAN OF 38 HOURS,

VERMONT WAS DRENCHED WITH 6.23 TO 9.05 INCHES OF RAIN, ACCORDING TO THE NATIONAL WEATHER SERVICE. THE WINOOSKI AND LAMOILLE RIVERS SURGED PAST THEIR PREVIOUS WATER LEVEL RECORDS SET DURING THE DEVASTATING HURRICANE IRENE IN 2011.[3]

JULY 2023 | MONTPELIER

MIMAGE SOURCE: SENIOR MASTER SGT MICHAEL DAVIS| US AIR NATIONAL GUARD

800 businesses and 4,000 homes were destroyed from extreme rainfall in July 2023.[4]

IMAGE SOURCE: KRISTIN WARNER

7.5

inches is the increase in average annual precipitation in Vermont between the early 1900s and 2020, averaging a rise of 1.4 inches per decade since 1960.[5]

$558 MILLION IN LOSSES

ACCORDING TO THE VERMONT DEPARTMENT OF FINANCIAL REGULATION, WEATHER-RELATED INSURED LOSSES COST AUTO, HOMEOWNERS, AND FARM POLICIES $558 MILLION FROM 2010 TO 2019.[6]

JULY 2023 | BARRE CITY

IMAGE SOURCE: JONATHAN WILLIAMS

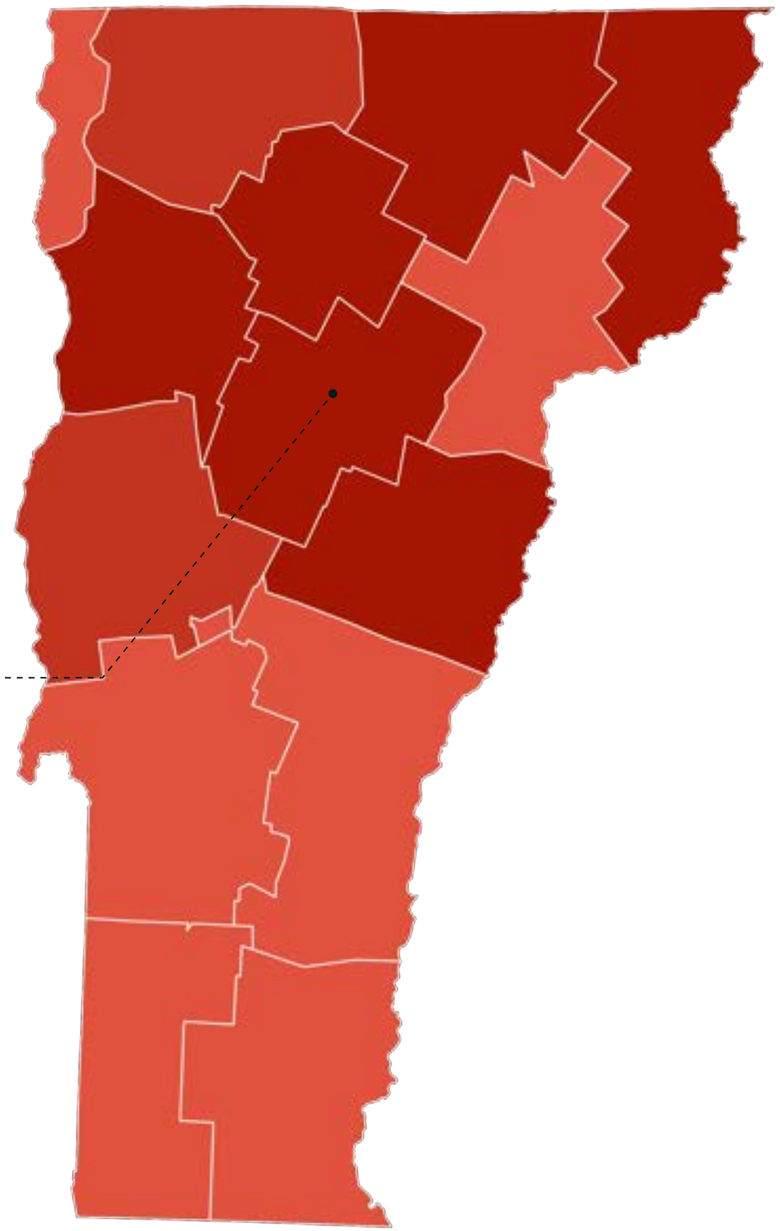
DISASTER OCCURRENCES 2011-2021

FEDERALLY DECLARED CLIMATE DISASTERS BY COUNTY

17
disaster declarations

Every county in Vermont has had four or more recent climate disasters. Six out of the 14 counties have had 10 or more.

Washington County has experienced 11 recent disaster declarations - the highest in the State.



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

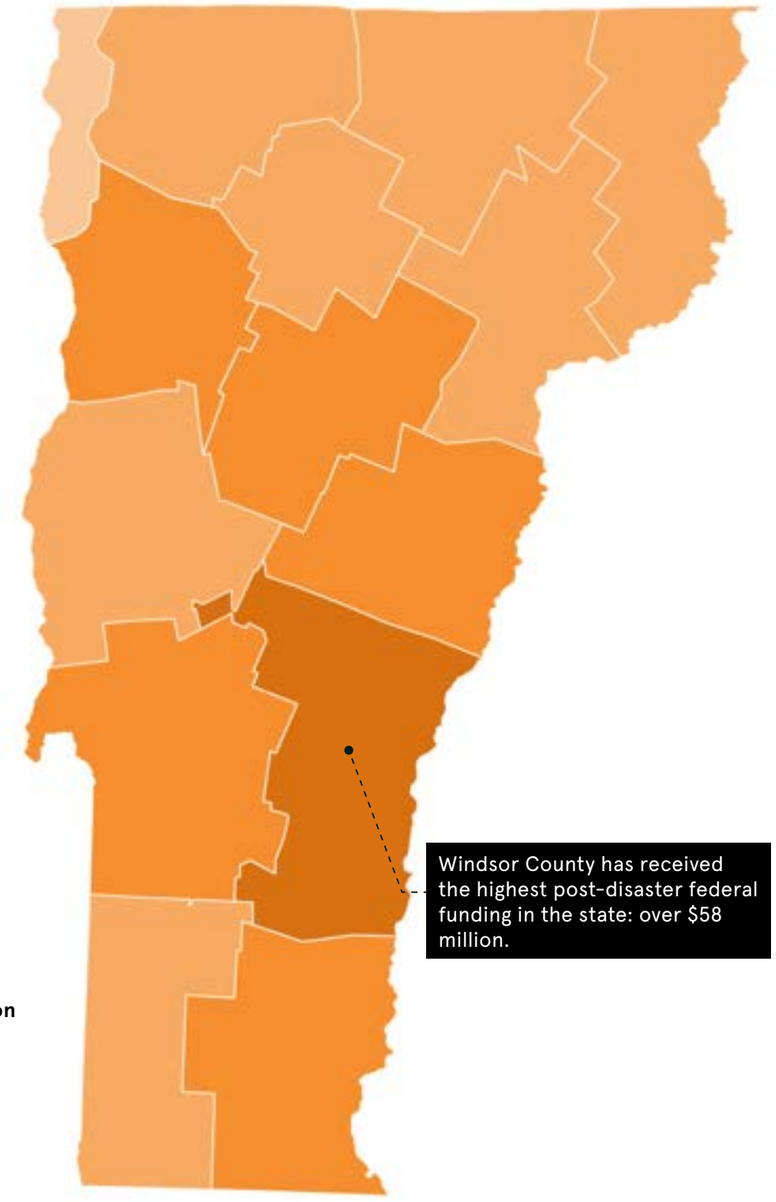
$370M
post-disaster assistance

$331M FEMA obligations

$39.5M HUD CDBG-DR Funds

$370M FEMA + HUD assistance

$593 per capita cost



Windsor County has received the highest post-disaster federal funding in the state: over $58 million.

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

VERMONT

TOTAL: 17 DISASTERS
FEMA PA + HM: $331M
HUD CDBG-DR: $39.5 M
FEMA + HUD ASSISTANCE: $370 M

			2011								2012		2013		2014				2015				2017		2018				2019		2020		2021	
			1995: SEVERE STORMS AND FLOODING		4001: SEVERE STORMS AND FLOODING		4022: TROPICAL STORM IRENE		4043: SEVERE STORMS AND FLOODING		4066: SEVERE STORM, TORNADO, AND FLOODING		4120: SEVERE STORMS AND FLOODING		4140: SEVERE STORMS AND FLOODING		4163: SEVERE WINTER STORMS		4178: SEVERE STORMS AND FLOODING		4207: SEVERE WINTER STORM		4232: SEVERE STORM AND FLOODING		4330: SEVERE STORMS AND FLOODING		4356: SEVERE STORM AND FLOODING		4380: SEVERE STORM AND FLOODING		4445: SEVERE STORMS AND FLOODING		4474: SEVERE STORM AND FLOODING		4621: SEVERE STORM AND FLOODING	
County Name	**# of Climate Disasters 2011-2021**	**Total FEMA Obligations**	PA Obligations	HM Obligations	PA Obligations	HM Obligations	PA Obligations	HM Obligations	PA Obligations	HM Obligations	PA Obligations	HM Obligations	PA Obligations	HM Obligations	PA Obligations	HM Obligations	PA Obligations	HM Obligations	PA Obligations	HM Obligations	PA Obligations	HM Obligations	PA Obligations	HM Obligations	PA Obligations	HM Obligations	PA Obligations	HM Obligations	PA Obligations	HM Obligations	PA Obligations	HM Obligations	PA Obligations	HM Obligations	PA Obligations	HM Obligations
Statewide	17	$127,173,118	$6,777,749	$11,338	$674,418	$19,715	$93,255,030	$4,573,057	$20,995	$316	$22,133	$864	$44,018	$13,453	$1,289,572	$16,206	$5,127,881	$30,583	$605,660	$123	$249,787	$8,585	$126,093	$7,540	$2,606,802	$69,054	$2,653,844	$79,404	$1,591,800	$47,708	$3,003,296	$13,913	$4,145,482	$18,809	$67,893	$0
Addison County	8	$7,833,824	$288,312	$236,548			$3,628,573	$1,638,141			$129,636	$0									$146,185	$0	$795,594	$0	$651,505	$0	$69,643	$0					$249,686	$0		
Bennington County	4	$7,597,696					$6,339,296	$1,001,021																	$70,865	$0					$134,389	$52,125			$0	$0
Caledonia County	6	$6,326,165			$3,152,698	$0	$2,242,702	$113,495							$229,522	$0	$48,695	$7,313	$74,660	$0	$85,165	$0			$371,917	$0										
Chittenden County	10	$11,879,816	$2,460,958	$225,772			$439,637	$1,291,054					$1,436,953	$0	$1,254,214	$0	$68,377	$0			$236,296	$0	$484,504	$0			$141,546	$0	$1,498,243	$0			$2,342,263	$0		
Essex County	10	$2,269,186	$391,202	$0	$1,396,986	$0	$52,197	$0					$147,746	$0			$0	$12,864	$239,730	$0	$0	$0					$0	$0					$28,460	$0	$0	$0		
Franklin County	8	$4,400,614	$290,862	$0			$300,874	$592,394	$600,020	$0							$855,920	$0	$113,227	$0	$0	$0					$149,230	$0							$1,498,085	$0		
Grand Isle County	5	$642,564	$642,564	$0			$0	$0									$0	$0									$0	$0	$0	$0							
Lamoille County	10	$9,848,677	$909,281	$28,458			$1,536,312	$1,230,209			$263,102	$0	$285,965	$127,050			$81,703	$0	$386,450	$0	$2,202,073	$0					$451,110	$0	$40,781	$0			$2,106,183	$0		
Orange County	10	$11,123,688			$167,667	$0	$5,790,765	$549,046							$746,862	$0			$127,598	$0	$94,472	$0			$3,012,852	$0	$22,237	$0	$0	$0	$608,981	$0	$3,208	$0		
Orleans County	10	$6,319,426	$1,111,248	$0			$1,920,785	$657,688			$602,891	$0			$118,956	$0	$159,765	$12,864	$104,766	$0	$25,156	$0					$3,466	$0	$0	$0			$1,601,841	$0		
Rutland County	5	$20,115,836					$12,181,097	$3,619,559							$198,851	$0					$247,197	$76,787			$1,413,582	$310,684					$1,922,985	$145,095				
Washington County	11	$23,598,405	$836,627	$0	$5,154,030	$91,571	$9,115,274	$3,735,881	$220,072	$0					$996,628	$0			$172,431	$0	$480,187	$325,850			$773,641	$160,667	$560,601	$0	$115,963	$0	$234,543	$0	$624,439	$0		
Windham County	4	$33,446,662					$28,690,917	$3,501,209	$105,280	$0																	$1,075,220	$0							$74,037	$0
Windsor County	5	$58,177,312					$43,722,813	$7,781,951							$1,348,368	$38,013					$182,575	$0			$3,018,473	$0					$2,085,119	$0				
Total FEMA Allocation		$330,552,989	$13,708,804	$502,116	$10,545,799	$111,286	$209,216,271	$30,284,704	$946,367	$316	$1,017,761	$864	$1,914,683	$140,503	$6,182,973	$54,219	$6,342,341	$63,624	$1,824,523	$123	$3,949,093	$411,222	$1,406,191	$7,540	$11,919,638	$540,405	$5,126,898	$79,404	$3,246,787	$47,708	$8,017,772	$211,133	$12,571,185	$18,809	$141,930	$0

WINDHAM COUNTY

IN 2011, SEVERE FLOODING FROM TROPICAL STORM IRENE SWEPT A BRIDGE DOWNSTREAM, POSING THREATS TO DAM SITES INCLUDING BALL MOUNTAIN LAKE DAM IN JAMAICA, VERMONT.[7]

SEPTEMBER 2011

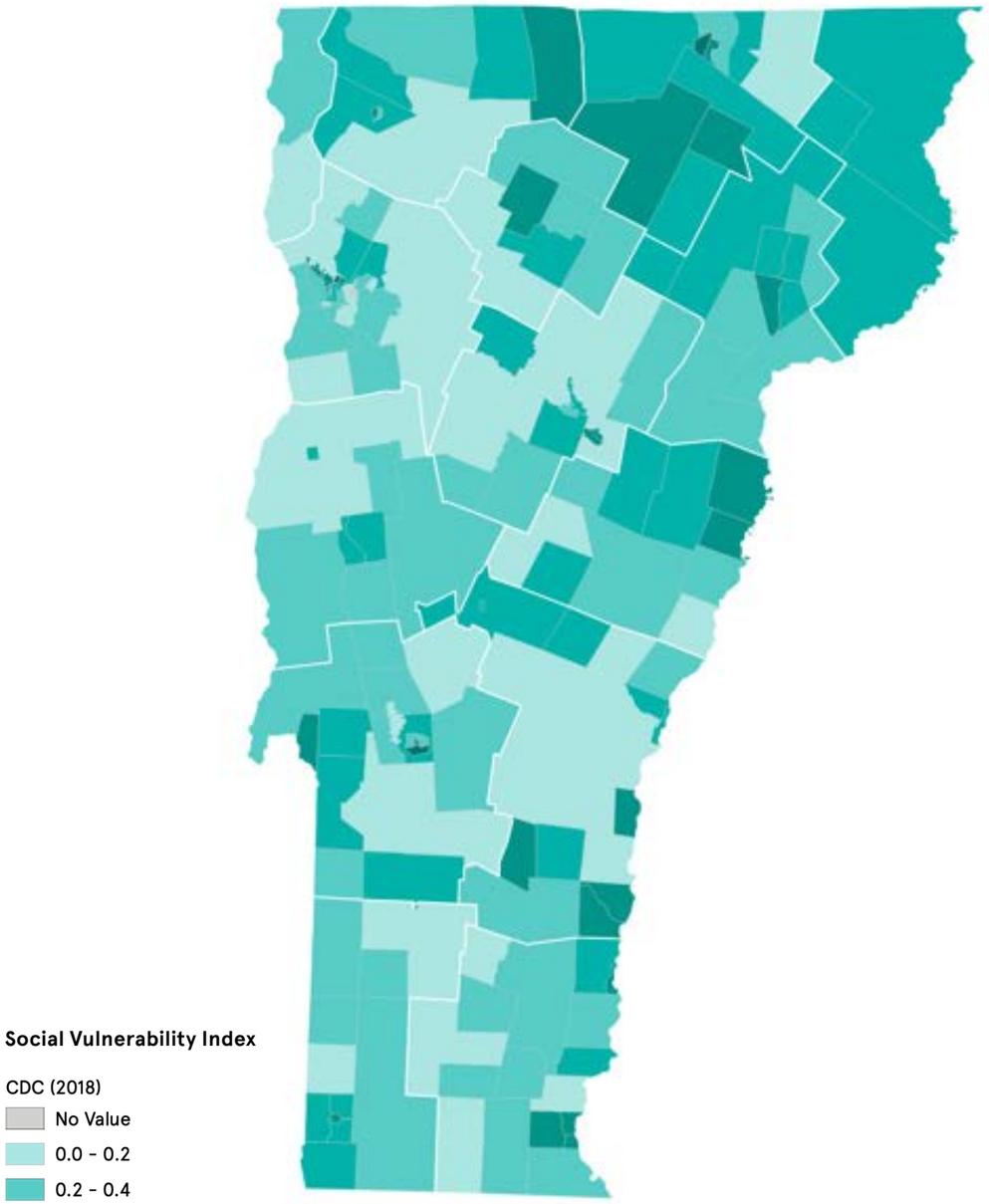
IMAGE SOURCE: FRANK FEDELE | US ARMY CORPS OF ENGINEERS

$5.29B

A 2021 study by University of Vermont predicts $5.29 billion in flood damages along the Winooski River in the next century, affecting over 140,000 Vermonters.[8]

SOCIAL VULNERABILITY INDEX 2011-2021

AREAS OF GREATEST SOCIAL VULNERABILITY



Social Vulnerability Index

CDC (2018)

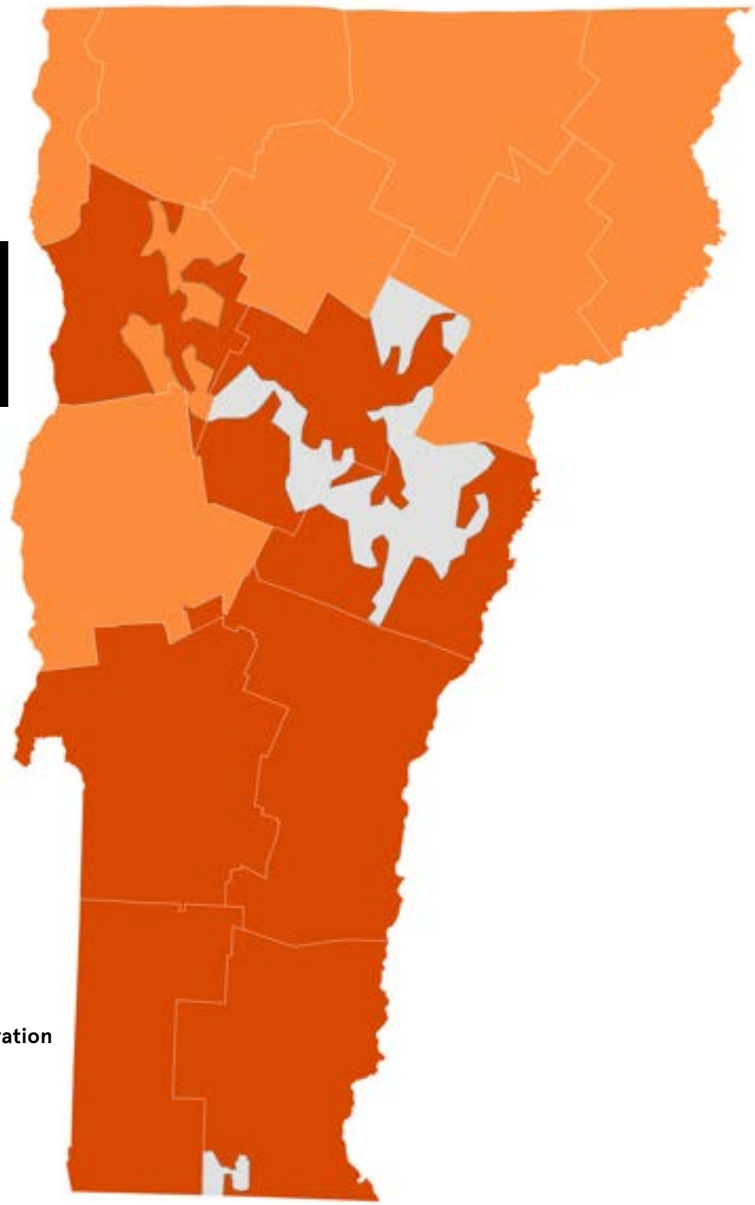
- No Value
- 0.0 - 0.2
- 0.2 - 0.4
- 0.4 - 0.6
- 0.6 - 0.8
- 0.8 - 1.0

SOURCE: CDC/ATSDR 2018 SOCIAL VULNERABILITY INDEX
MAPS COURTESY OF IPARAMETRICS

ENERGY RELIABILITY 2011-2021

COUNTIES AT GREATEST RISK OF POWER OUTAGES

115,000 customers lost power during the Halloween storm of 2019 that drenched Vermont with 3-5 inches of rain in a day, causing over $6 million in infrastructure damage.



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

$1M

Vermont's frequent freeze-thaw cycles are causing an increase in pothole formations, with the state spending up to $1 million on repairs during severe years like 2018 and 2019.[9]

CHITTENDEN COUNTY

VERMONT, RANKED 12TH NATIONWIDE FOR POTHOLES, IS TACKLING THE ISSUE WITH VTRANS USING 1,500 TONS OF ASPHALT FOR ROAD REPAIRS, PARTICULARLY IN BURLINGTON – ONE OF THE WORST REGIONS IN THE STATE. STILL, THESE REMEDIES ARE SHORT-TERM, REVEALING A CONTINUOUS INFRASTRUCTURE PREDICAMENT.[10]

MARCH 2022

IMAGE SOURCE: VERMONT AGENCY OF TRANSPORTATION

DISASTER OCCURRENCES 2011-2021

	TOTAL DISASTERS
California	25
Mississippi	22
Oklahoma	22
Iowa	21
Tennessee	20
Louisiana	18
Alabama	17
Texas	17
Vermont	17
West Virginia	17
Arkansas	16
Kentucky	16
New Hampshire	16
New York	16
Washington	16
Alaska	15
North Carolina	15
Nebraska	14
Missouri	13
Kansas	13
New Jersey	13
North Dakota	13
South Dakota	13
Montana	12
Oregon	12

	TOTAL DISASTERS
Virginia	11
Florida	11
Georgia	11
Minnesota	11
Connecticut	10
Hawaii	10
Maryland	10
New Mexico	10
Wisconsin	10
Idaho	9
Massachusetts	9
Pennsylvania	9
South Carolina	8
Colorado	7
Utah	7
Maine	6
Michigan	6
Ohio	6
Arizona	6
Delaware	5
Illinois	5
Indiana	4
Rhode Island	4
Wyoming	4
Nevada	3

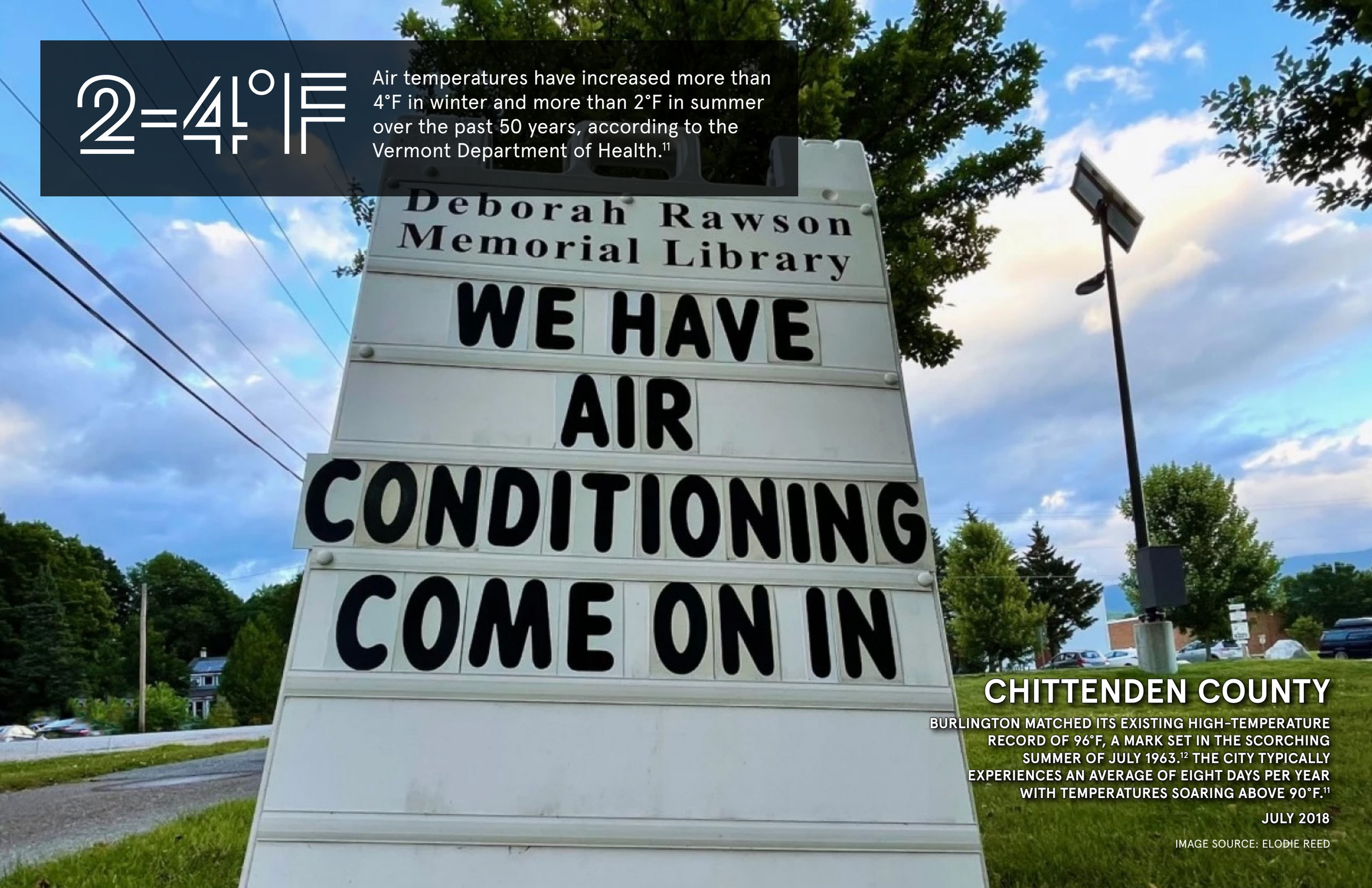
FEMA AND HUD COST PER CAPITA 2011-2021

	PER CAPITA
Louisiana	$1,736
New York	$1,348
New Jersey	$815
North Dakota	$738
Vermont	$593
Texas	$518
West Virginia	$481
Alaska	$401
Florida	$390
Nebraska	$390
South Carolina	$289
Alabama	$275
South Dakota	$269
North Carolina	$243
Hawaii	$229
Iowa	$228
Oklahoma	$215
Oregon	$210
Missouri	$162
Mississippi	$159
California	$157
Connecticut	$149
Colorado	$141
Kentucky	$105
Tennessee	$97

	PER CAPITA
New Mexico	$97
Arkansas	$81
Massachusetts	$73
Georgia	$64
Montana	$63
Kansas	$60
New Hampshire	$55
Rhode Island	$53
Minnesota	$49
Pennsylvania	$49
Virginia	$49
Maryland	$39
Washington	$36
Wyoming	$32
Idaho	$32
Wisconsin	$27
Illinois	$24
Michigan	$23
Ohio	$19
Maine	$18
Delaware	$14
Utah	$11
Nevada	$11
Indiana	$7
Arizona	$2

2–4°F

Air temperatures have increased more than 4°F in winter and more than 2°F in summer over the past 50 years, according to the Vermont Department of Health.[11]



CHITTENDEN COUNTY

BURLINGTON MATCHED ITS EXISTING HIGH-TEMPERATURE RECORD OF 96°F, A MARK SET IN THE SCORCHING SUMMER OF JULY 1963.[12] THE CITY TYPICALLY EXPERIENCES AN AVERAGE OF EIGHT DAYS PER YEAR WITH TEMPERATURES SOARING ABOVE 90°F.[11]

JULY 2018

IMAGE SOURCE: ELODIE REED

CASCADING IMPACTS OF CLIMATE EVENTS

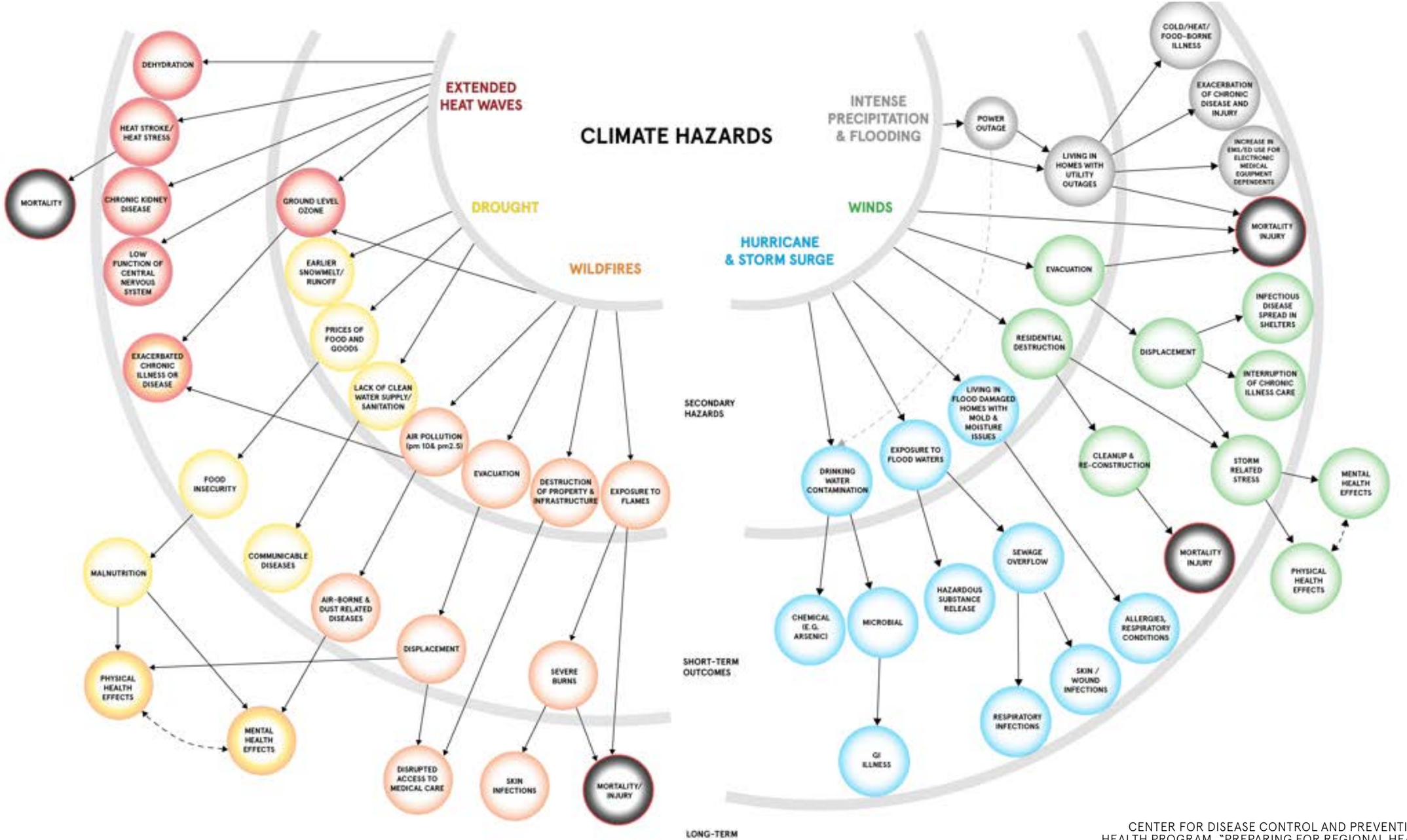


ILLUSTRATION: GEETHANJALI MR

CENTER FOR DISEASE CONTROL AND PREVENTION CLIMATE AND HEALTH PROGRAM, "PREPARING FOR REGIONAL HEALTH IMPACTS OF CLIMATE CHANGE IN THE UNITED STATES," JULY 2020.

GAIL CARLSON, "HUMAN HEALTH AND THE CLIMATE CRISIS," JONES AND BARTLETT LEARNING, JAN. 2022.

5TH

Vermont ranks 5th nationally in per capita disaster relief costs from 2011-2021, with $593 spent per resident. During the same period, the state received $370 million in federal assistance.[13]

WINDSOR COUNTY

TROPICAL STORM IRENE'S DEVASTATING IMPACT IN 2011 UNDERSCORED VERMONT'S VULNERABILITY TO FLOODING, INFLICTING A SHOCKING $733 MILLION IN DAMAGES. AS PER THE NATIONAL OCEANIC ADMINISTRATION AGENCY, THE STORM DAMAGED OR DESTROYED OVER 2,400 ROADS, 800 HOMES AND BUSINESSES, AND 300 BRIDGES.[14]

AUGUST 2011

IMAGE SOURCE: STEPHEN FLANDERS

RUTLAND COUNTY

PERSISTING DROUGHT CONDITIONS IN VERMONT CONTINUE TO STRAIN LOCAL FARMS, WITH REPORTS FROM ESTABLISHMENTS NOTING A SIGNIFICANT 50% DECREASE IN CATTLE FEED VOLUME AND QUALITY.[15]

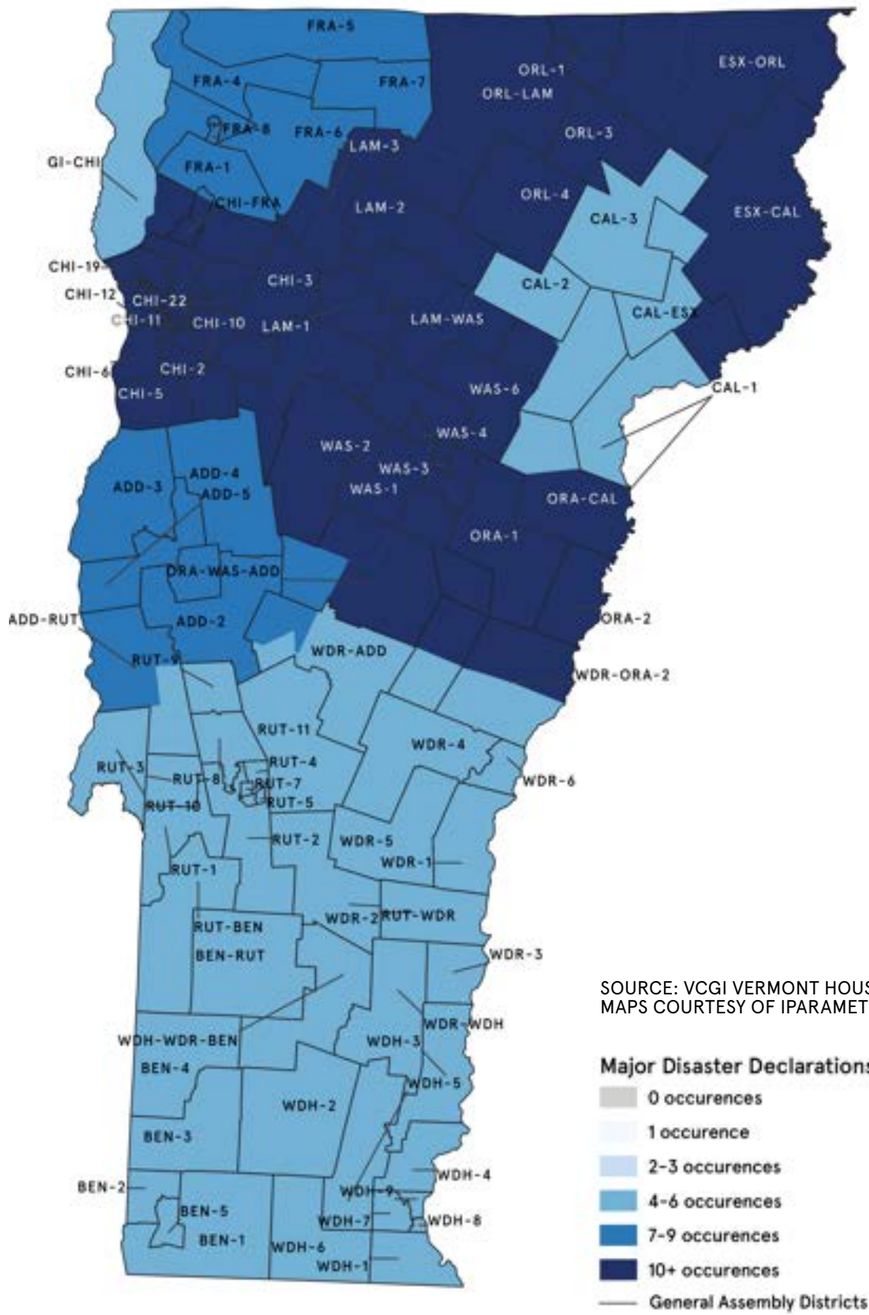
MAY 2015

IMAGE SOURCE: PUTNEYPICS | FLICKR

$27 million in estimated crop losses spurred a federal disaster declaration for 10 Vermont counties in 2020, due to severe drought conditions.[16]

VT GENERAL ASSEMBLY DISTRICTS

MAJOR DISASTER DECLARATIONS 2011-2021



SOURCE: VCGI VERMONT HOUSE DISTRICTS 2022
MAPS COURTESY OF IPARAMETRICS

Major Disaster Declarations (2011-2021)

- 0 occurences
- 1 occurence
- 2-3 occurences
- 4-6 occurences
- 7-9 occurences
- 10+ occurences
- General Assembly Districts

VT DISASTER OCCURRENCES 2011-2021

2022 GENERAL ASSEMBLY DISTRICTS

DISTRICT	# OF DISASTERS
Addison-1	ADD (8)
Addison-2	ADD (8)
Addison-3	ADD (8)
Addison-4	ADD (8)
Addison-5	ADD (8)
Addison-Rutland	ADD (8), RUT (5)
Bennington-1	BEN (4)
Bennington-2	BEN (4)
Bennington-3	BEN (4)
Bennington-4	BEN (4)
Bennington-5	BEN (4)
Bennington-Rutland	BEN (4), RUT (5)
Caledonia-1	CAL (6)
Caledonia-2	CAL (6)
Caledonia-3	CAL (6)
Caledonia-Essex	**CAL (6), ESX (10)**
Caledonia-Washington	**CAL (6), WAS (11)**
Chittenden-1	**CHI (10)**
Chittenden-10	**CHI (10)**
Chittenden-11	**CHI (10)**
Chittenden-12	**CHI (10)**
Chittenden-13	**CHI (10)**
Chittenden-14	**CHI (10)**
Chittenden-15	**CHI (10)**
Chittenden-16	**CHI (10)**
Chittenden-17	**CHI (10)**
Chittenden-18	**CHI (10)**
Chittenden-19	**CHI (10)**
Chittenden-2	**CHI (10)**
Chittenden-20	**CHI (10)**
Chittenden-21	**CHI (10)**
Chittenden-22	**CHI (10)**
Chittenden-23	**CHI (10)**
Chittenden-24	**CHI (10)**
Chittenden-25	**CHI (10)**
Chittenden-3	**CHI (10)**
Chittenden-4	**CHI (10)**
Chittenden-5	**CHI (10)**
Chittenden-6	**CHI (10)**
Chittenden-7	**CHI (10)**
Chittenden-8	**CHI (10)**
Chittenden-9	**CHI (10)**
Chittenden-Franklin	**CHI (10), FRA (8)**
Essex-Caledonia	**ESX (10), CAL (6)**
Essex-Orleans	**ESX (10), ORL (10)**
Franklin-1	FRA (8)
Franklin-2	FRA (8)
Franklin-3	FRA (8)
Franklin-4	FRA (8)
Franklin-5	FRA (8)
Franklin-6	FRA (8)
Franklin-7	FRA (8)
Franklin-8	FRA (8)
Grand Isle-Chittenden	**GI (5), CHI (10)**
Lamoille-1	**LAM (10)**
Lamoille-2	**LAM (10)**
Lamoille-3	**LAM (10)**
Lamoille-Washington	**LAM (10), WAS (11)**
Orange-1	**ORA (10)**
Orange-2	**ORA (10)**
Orange-3	**ORA (10)**
Orange-Caledonia	**ORA (10), CAL (6)**
Orange-Washington-Addison	**ORA (10), WAS (11), ADD (8)**
Orleans-1	**ORL (10)**
Orleans-2	**ORL (10)**
Orleans-3	**ORL (10)**
Orleans-4	**ORL (10)**
Orleans-Lamoille	**ORL (10), LAM (10)**
Rutland-1	RUT (5)
Rutland-10	RUT (5)
Rutland-11	RUT (5)
Rutland-2	RUT (5)
Rutland-3	RUT (5)
Rutland-4	RUT (5)
Rutland-5	RUT (5)
Rutland-6	RUT (5)
Rutland-7	RUT (5)
Rutland-8	RUT (5)
Rutland-9	RUT (5)
Rutland-Bennington	RUT (5), BEN (4)
Rutland-Windsor	RUT (5), WDR (5)
Washington-1	**WAS (11)**
Washington-2	**WAS (11)**
Washington-3	**WAS (11)**
Washington-4	**WAS (11)**
Washington-5	**WAS (11)**
Washington-6	**WAS (11)**
Washington-Chittenden	**WAS (11), CHI (10)**
Washington-Orange	**WAS (11), ORA (10)**
Windham-1	WDH (4)
Windham-2	WDH (4)
Windham-3	WDH (4)
Windham-4	WDH (4)
Windham-5	WDH (4)
Windham-6	WDH (4)
Windham-7	WDH (4)
Windham-8	WDH (4)
Windham-9	WDH (4)
Windham-Windsor-Bennington	WDH (4), WDR (5), BEN (4)
Windsor-1	WDR (5)
Windsor-2	WDR (5)
Windsor-3	WDR (5)
Windsor-4	WDR (5)
Windsor-5	WDR (5)
Windsor-6	WDR (5)
Windsor-Addison	WDR (5), ADD (8)
Windsor-Orange-1	**WDR (5), ORA (10)**
Windsor-Orange-2	**WDR (5), ORA (10)**
Windsor-Windham	WDR (5), WDH (4)

Blue text indicates districts that have experienced ten or more disasters.

WASHINGTON COUNTY

CLIMATE CHANGE-INDUCED EXTREME WEATHER IS DISRUPTING VERMONT'S $1.6 BILLION SKI INDUSTRY.[17] THE UNUSUALLY WARM WINTER OF 2015-2016 LED TO EARLY CLOSURES AT MANY RESORTS, INCLUDING MAD RIVER GLEN, WHICH IS RESORTING TO STOCKPILE ARTIFICIAL SNOW TO COMPENSATE FOR SHORTER SEASONS.[18]

MARCH 2016

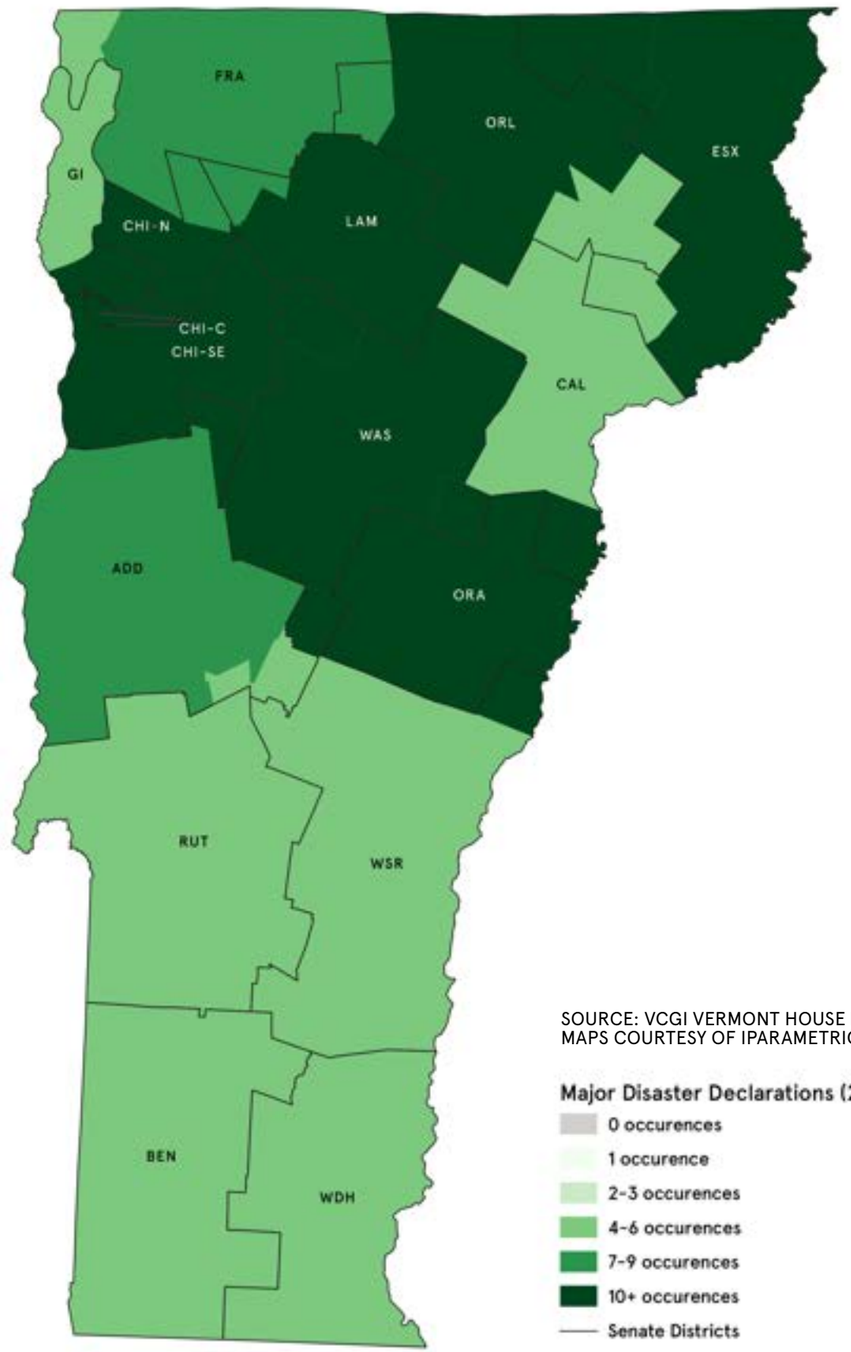
IMAGE SOURCE: ERIC FRIEDMAN | MAD RIVER GLEN

30 DAYS

The winter temperatures in Vermont are steadily rising, imperiling the ski industry with a forecasted loss of 30 days by 2080.[19]

VT SENATE DISTRICTS

MAJOR DISASTER DECLARATIONS 2011–2021



SOURCE: VCGI VERMONT HOUSE DISTRICTS 2022
MAPS COURTESY OF IPARAMETRICS

Major Disaster Declarations (2011-2021)

- 0 occurences
- 1 occurence
- 2-3 occurences
- 4-6 occurences
- 7-9 occurences
- 10+ occurences
- Senate Districts

VT DISASTER OCCURRENCES 2011–2021

2022 SENATE DISTRICTS

DISTRICT	COUNTIES	# OF DISASTER
ADDISON	ADDISON, CHITTENDEN, WINDSOR	ADD (8), CHI (10), WDR (5)
BENNINGTON	BENNINGTON, WINDHAM	BEN (4), WDH (4)
CALEDONIA	CALEDONIA, ORANGE	CAL (6), ORA (10)
CHITTENDEN CENTRAL	CHITTENDEN	CHI (10)
CHITTENDEN NORTH	CHITTENDEN, FRANKLIN	CHI (10), FRA (8)
CHITTENDEN SOUTHEAST	CHITTENDEN	CHI (10)
ESSEX	CALEDONIA, ESSEX, ORLEANS	CAL (6), ESX (10), ORL (10)
FRANKLIN	FRANKLIN, GRAND ISLE	FRA (8), GI (5)
GRAND ISLE	CHITTENDEN, GRAND ISLE	CHI (10), GI (5)
LAMOILLE	FRANKLIN, LAMOILLE	FRA (8), LAM (10)
ORANGE	ORANGE	ORA (10)
ORLEANS	CALEDONIA, FRANKLIN, ORLEANS	CAL (6), FRA (8), ORL (10)
RUTLAND	RUTLAND	RUT (5)
WASHINGTON	LAMOILLE, ORANGE, WASHINGTON	LAM (10), ORA (10), WAS (11)
WINDHAM	WINDHAM	WDH (4)
WINDSOR	ORANGE, RUTLAND, WINDSOR	ORA (10), RUT (5), WDR (5)

Green text indicates districts that have experienced ten or more disasters.

10 DAYS

Climate change threatens Vermont's vital maple syrup industry, advancing the sugaring season's start and end by 10 days.[20]

BENNINGTON COUNTY

VERMONT, WHICH PRODUCES 50% OF THE NATION'S MAPLE SYRUP, HAS DOUBLED ITS GROSS SALES TO $54 MILLION FROM 2008 TO 2018.[21] CLIMATE CHANGE THREATENS THIS BOOMING INDUSTRY THAT EMPLOYS OVER 4,000 VERMONTERS.[22]

MARCH 2012

IMAGE SOURCE: SHANNON MCGEE

CLIMATE CHANGE INCREASES INEQUITIES

The impacts of storms and flooding disproportionately affect the most vulnerable people. Disasters are not created by natural events alone; rather, they are the product of natural events and a combination of social, political, and economic stressors. Therefore, as climate change increases the frequency of flooding, it will further reinforce underlying vulnerabilities and systemic inequality.

DURING A FLOOD

Low-income communities experience greater challenges evacuating due to the cost of transportation and relocation, placing them at a greater risk of injury, disease, or death.

Residents who do not leave during a storm have increased health risks, such as exposure to contaminated water, interrupted acces to medical care, and difficulty acquiring food.

Low-income and minority populations, as well as elderly nursing home residents are more likely to have chronic health problems, increasing their vulnerabiity to other storm hazards.[1]

AFTER A FLOOD

A medium-sized natural disaster leads to a 5% increase in the share of people with debt collections after one year, which doubles to 10% after four years.[2]

People in poverty are less likely to have flood insurance or to maintain flood insurance payments.

The Urban Institute has found that after 4 years, a medium-sized disaster has caused an average 31-point decline in credit scores for people living in communities of color, whereas people living in majority white communities experienced a 4-point decline.[3]

FEMA funding largely focuses on homeowners, meanwhile renters typically face rent hikes and mass evictions.

Lower income households may not have the financial and educational resources to advocate for fair buyouts, repair damages, and afford temporary housing.

After federal aid has been distributed to communities that have experienced a disaster, predominantly white, well-educated home-owners experience a significant increase in wealth. Conversely, communities of color, particularly those who are less educated renters, experience a decline in wealth.[4]

1. Lane et. al,"Health Effects of Coastal Storms and Flooding in Urban Areas: A Review and Vulnerability Assessment;'2013
2. Urban Institute, "Insult to Injury: NaturalDiasasters and Residents' Financial Health,"2019.
3. Urban Institute, 2019.
4. Howell &Elliott, "DamagesDone, the Longitudinal Impacts of Natural Hazards on Wealth Inequality in the United States;'; Muf'ioz &Tate," Unequal Recovery? Federal ResourceeDistribution after Midwest FloodDisaster;'2016.
5. Deloitte, "The cost of inaction: The economic impact of climate change in the United States", 2018.

THE COST OF DISASTERS

Benefit - Cost Ratio for Investing in Hazard Mitigation Infrastructure

6:1

The National Institute of Building Sciences (NIBS) found that every $1 invested in disaster mitigation by three federal agencies (FEMA, EDA, & HUD) saves society $6.

Economic Impacts for USA

-$1.4 trillion — The staggering cost borne by the US over the past 50 years due to weather, climate, and water hazards

+$3 trillion — The economic gain from decarbonizing and becoming a net zero US economy.

-$14.5 trillion — The cost of insufficient climate action to the US economy over the next 50 years.

HAZARD MITIGATION FUNDING IS A STRATEGIC INVESTMENT IN OUR FUTURE, REDUCING RISKS AND COSTS ASSOCIATED WITH CLIMATE CHANGE WHILE BUILDING MORE RESILIENT AND SUSTAINABLE COMMUNITIES.

Project types range from green infrastructure, such as wetlands restoration or bioswales for stormwater management, to grey infrastructure, such as right-sizing a dam or bridge.

IMAGE SOURCE: BURO HAPPOLD

IMAGE SOURCE: REBUILD BY DESIGN

BLUEPRIINT FOR ACTION: A GUIIDE FOR STATES TO LEAD EQUITABLE ADAPTATION

1 **BUILD A COLLABORATIVE PROGRAM**

2 **FINANCE THE CHALLENGE**

STEP ONE: BUILD A COLLABORATIVE PROGRAM

In order to address the worsening impacts of climate change and head off future damages, we need bold action. Governments must work alongside communities and cross-sector partners to identify infrastructure investments that will drive physical, social, and ecological co-benefits and create hundreds of thousands of middle-class jobs – before climate events strike, not after communities have suffered. Using a co-creation process with stakeholders, states can deliver new, upgraded, innovative, and climate-ready infrastructure that protects communities in the face of climate vulnerabilities; work to make existing investments more resilient; and create a new source for "local match" to leverage additional federal funding opportunities.

Investing in climate infrastructure will bring short- and long-term benefits to both the state and the community where projects are implemented by creating new jobs and seeding new local industries, improving community physical and mental health outcomes, protecting and enhancing ecosystems, and providing a framework for future investments.

Building on the successes of the Rebuild by Design Hurricane Sandy Design Competition, the National Disaster Resilience Competition, Bay Area Resilient by Design, and the great work that is already underway in many communities throughout the U.S., Rebuild by Design proposes that this fund be coupled with a two-stage Statewide Community Planning Process that leads communities through a process to identify their specific vulnerabilities to climate hazards such as flooding, heat, wind, and drought.

PROGRAM OBJECTIVES:

1. Use funding to catalyze regional strategies for planning, designing, and building to drive investments in multi-benefit infrastructure that addresses physical, environmental, and social vulnerabilities;

2. Fully engage local stakeholders to create a better understanding of the risks and impacts that increasingly frequent and intense climate events will bring to their communities;

3. Support the needs of the most physically and socially vulnerable first;

4. Create jobs and job training opportunities, revitalize local/regional economies, promote healthy communities, and increase social resilience;

5. Create a replicable process that provides insight into other challenges in the community and can be recreated to address other challenges.

IMAGE SOURCE: CAMERON BLAYLOCK | REBUILD BY DESIGN

Communities are the experts of their neighborhoods. They know exactly what happens when there is a heat wave or a flood; they understand their community's existing needs and vulnerabilities; they know who is most affected and who needs the most assistance. Adapting to climate change presents a significant opportunity to create new or rebuild existing infrastructure that is designed to support the needs of communities on sunny days and promote climate resilience on days of increased rainfall, heat waves, storm surges, or fires. This type of infrastructure is known as "multi-benefit" since it is designed to serve more than one purpose. For example, a park that is designed to store and filter water during heavy rainfall events can provide multiple other benefits to the surrounding community, such as space for recreation and exercise, shade during hot days, species habitat, improvements to mental health, carbon capture, and cooling of local temperatures.

By using a collaborative design methodology, the State can incentivize regional planning processes to design and build infrastructure with multiple benefits alongside the communities who are most affected to ensure each project addresses local physical and social vulnerabilities and embeds local knowledge and expertise with current and future needs. Additionally, the involvement of stakeholder support from the very start ensures that projects are built faster and that every dollar invested goes further by addressing the specific needs of the intended community.

States can lead a two-stage *Statewide Community Planning Process*:

(1) STAKEHOLDER INCLUSION, RESEARCH, RISK ASSESSMENT: align community and government aspirations in the face of climate change, and to create a shared understanding of the interdependencies between local and regional infrastructural, ecological, and social systems that will be further affected by the increased occurrences and severity of climate events.

(2) COLLABORATIVE DESIGN: create a comprehensive vision with specific fundable projects, policies, or initiatives that will directly address the vulnerabilities identified in Stage One

These stages are further detailed in the Atlas of Disaster on page 369.

WE ALL BENEFIT

Climate change is a collective risk that will pose challenges to all of our lives and livelihoods. Thus, everyone stands to benefit from adaptation interventions. Resilient green and gray infrastructure can have multiple benefits while fulfilling their primary purpose of reducing the risk of climate impacts. For example, the adaptation measures provided to vulnerable communities can help reduce risk to individuals and property from extreme harm or loss during climate events, which can in turn reduce the payout from insurance companies after an event. In addition, infrastructure that can better withstand shocks and stressors can also contribute to the stabilization of the supply chain by reducing the frequency and length of disruptions to production, costs, and delivery.

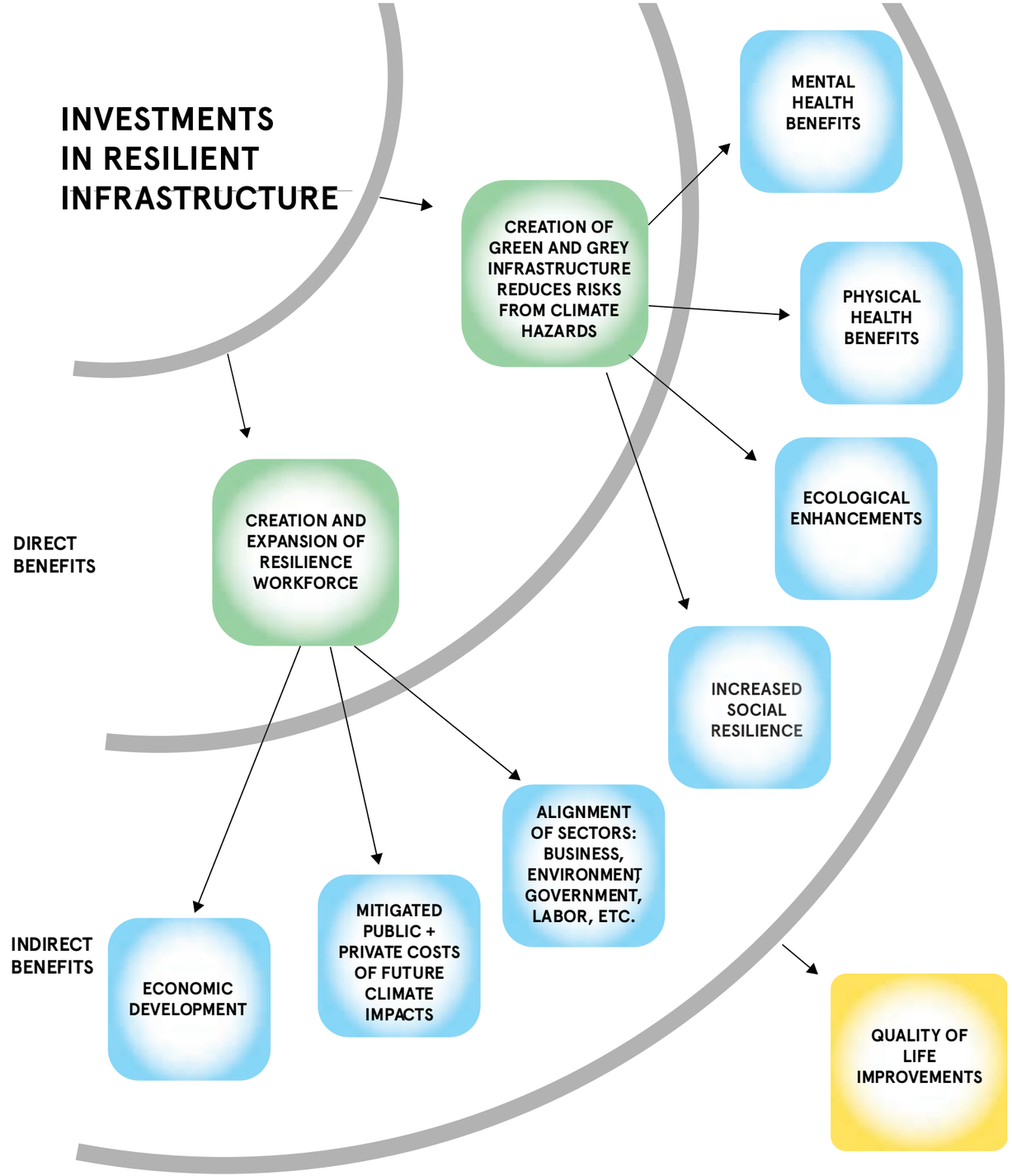
Even in the absence of extreme weather, communities will benefit from multi-purpose resilient infrastructure:

+ **Economic:** An investment in resilient infrastructure pays off economically with investments in manufacturing, construction, trade, labor, and development, which can spur the creation of new jobs and economic growth, along with investments in long-term maintenance. Simultaneously, the creation of high quality, high paid jobs must be coupled with intentional efforts to train workers who would otherwise be unqualified.
+ **Health:** Where green infrastructure projects are implemented, communities gain from the additional benefits of cleaner air, cooling from tree coverage, green space to exercise and socialize, improved neighborhood aesthetics, and more. This means healthier environments for children to grow up in, more walkable streets for seniors and people with disabilities, and less emergency room visits for people with underlying conditions.
+ **Social:** Investments in physical infrastructure, namely public spaces and green spaces, help build social resilience within communities. These spaces, such as libraries and parks, enable communities to build social connections. In the event of a disaster, these communities fare better, as neighbors are more likely to check on each other, understand each other's needs, and rebuild together.

PROJECT EXAMPLES:

IMPROVING SHORELINES AND STORMWATER MANAGEMENT SYSTEMS ● RESTORING WETLANDS AND PROTECTING MIGRATION PATHWAYS ● BUILDING BERMS, DIKES, AND LEVEES ● REMOVING DAMS ● RIGHT-SIZING CULVERTS AND ELEVATING STREETS AND RAILWAYS ● DAYLIGHTING RIVERS ● ADAPTING SEWAGE TREATMENT PLANTS, WATER SUPPLY SYSTEMS, AND OTHER UTILITIES ● BUYING OUT HOMES AND BUSINESSES FROM HARM'S WAY ● ACQUIRING LAND THAT CAN REMAIN PROTECTED ● STABILIZING SOIL FOR FARMLAND ● CREATING NEW PARKS OR ECOLOGICAL ENHANCEMENTS ● ABSORBING ENERGY FROM STORMS ● PROVIDING GRANTS OR TAX INCENTIVES FOR THE RELOCATION OF CRITICAL INFRASTRUCTURE ● INCENTIVIZING GREEN BUILDING ADAPTATION OR ELECTRICAL VEHICLE INFRASTRUCTURE ● FOREST MANAGEMENT

CASCADING BENEFITS



STEP TWO: FINANCING RESILIENT INFRASTRUCTURE

Innovative processes call for innovative finance solutions. Each state in the U.S. should create a Resilient Infrastructure Fund to serve as a catalyst to support innovative, data-driven, and community-led approaches to address climate risk throughout the United States. A Resilient Infrastructure Fund would enable investment in state-priority projects at both the regional and systems levels and in both individual and community actions by leveraging state and federal dollars to support capital projects that enhance communities' physical and social resilience and create a funding source to provide the "local-match" for federal investment.

A Resilient Infrastructure Fund can catalyze local planning and community understanding of what is needed to address the risks of future climate events and drive projects that support the well-being of communities every day, not just during extreme weather.

INVESTMENT SOURCES

The United States is always chasing the last storm. We need to get ahead of the physical and financial costs by utilizing creative and urgent financing solutions that invest in adaptation and mitigation efforts before communities suffer. Many states have capital programs and infrastructure banks to cover certain types of capital investments. However, in order to meet current and future needs, we need to invest a lot more in these programs than we currently are. Regardless of the source, funding should be held in a protected fund (such as an infrastructure bank) to ensure that the money is safe from other competing future needs. The following strategies could support the creation of State-led Resilient Infrastructure Funds:

1 Leverage a Two-Percent Surcharge on Property and Casualty (P&C) Insurance:

The increase in billion-dollar climate events is pushing the insurance system beyond its capacity, and all policyholders are paying the price without reaping the benefits of a safer community ahead of the next storm. To head off insurance premium spikes and insurance insolvency, states can utilize a pro-consumer model by applying a two-percent (for example) surcharge on P&C insurance (not including Medical Malpractice and Workers' Compensation). A small surcharge could leverage from $600 million to over $27 billion in states across the U.S, for a total of $287 billion across the U.S. This surcharge on certain types (lines) of property-casualty insurance could support a statewide Resilient Infrastructure Fund that gives communities the funding they need to build more resiliently and to leverage private, state, and federal budget sources. As climate adaptation and hazard mitigation interventions are implemented, the risk of loss or damage will decline, reducing the property and casualty payouts for some insurers (such as those who write policies for commercial flood and basement backup riders). This would also lower flood insurance premiums by five to 45 percent for those in the FEMA flood zones through FEMA's Community Rating System.

This will give the insurance industry a lifeline by creating new funding sources that can support physical and social infrastructure before an event, slowing down their exposure to large payouts.

A surcharge on certain types of property-casualty insurance can be equitable because community members with more resources are likely to insure more numerous, expensive, and energy-consumptive items (e.g., multiple homes, boats, cars), while community members with less resources are likely to insure less or have no insurance at all.

$600 MILLION

COULD BE RAISED THROUGH A 2% SURCHARGE ON CERTAIN LINES FO P&C INSURANCE, BONDED OVER TEN YEARS, IN VERMONT.

Additionally, states could exempt lower income policyholders from the surcharge or to exempt vital community services such as affordable housing or schools. States can also decide to hold some of this allocation aside before it is leveraged for the maintenance of new climate infrastructure.

2 Establish a Climate Superfund:

While taxpayers across the US have been experiencing rising costs from the impacts of climate change, the largest oil and gas companies have been experiencing record-breaking profits.

A "Climate Superfund," or "Polluter Pays" model, calls on the largest oil and gas companies to reinvest some of those profits into state climate mitigation and adaptation measures. This fund is modeled after the EPA's Superfund program, which was established in 1980 to hold companies responsible for toxic waste sites accountable for the cleanup.

$2.5 BILLION

COULD BE RAISED THROUGH CLIMATE SUPERFUND IN VERMONT.

A bill to charge the biggest climate polluters for a share of the cleanup costs has passed the New York State Senate. Similar legislation has been introduced in Massachusetts and Maryland. A campaign to establish a Climate Superfund in Vermont is calling for the biggest oil and gas companies to pay into a fund that would help modernize Vermont's infrastructure, weatherproof schools and public buildings, address public health costs of climate change, and clean up after storms and more.

IMAGE SOURCE: UNIVERSITY OF VERMONT
WATERBURY JULY 2023

IMAGE SOURCE: STERLING COLLEGE | CRAFTSBURY VERMONT 2011

3 States use their own funding sources, coupled with federal and other sources to support climate infrastructure:

According to Trimble, a construction technology firm, states spend from $100 million to $44 billion per year on building and upgrading infrastructure.[12] States can earmark existing dollars in the capital budget over the next ten years to support a Resilient Infrastructure Fund that can support the additional dollars needed to upgrade existing projects up to risk standards and can support new projects where existing ones will not be enough. Both capital and expense dollars will be needed to build and maintain the infrastructure. Better protection from extreme climate events means less damage to the physical environment and less suffering for communities. According to data collected by Trimble, approximately 0.5 percent of the Infrastructure Bill funds allocated to states will be spent on resilience or the environment and 9.6 percent will be spent on water infrastructure. The other 89.9 percent of funds will go towards highways, bridges, public transportation, airports, EV expansion, and broadband.[12] See page 665 of the Atlas of Disaster for examples of state-funded resilience programs.

Funding Allocated to States through the Infrastructure Investment and Jobs Act

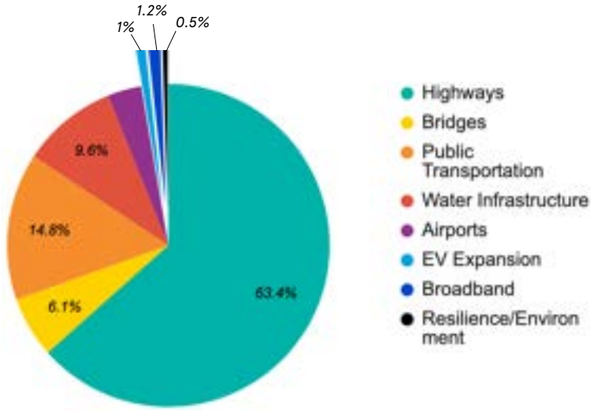


FIGURE SHOWS THE BREAKDOWN OF SPENDING BY CATEGORY
DATA SOURCE: TRIMBLE TRIMBLE

ARE THERE NEW FUNDING TOOLS WE SHOULD EXPLORE?

States can use traditional approaches to support the building or rebuilding of infrastructure that will address an increasingly uncertain environment. However, there is a market under development for a new suite of tools that could be investigated as part of this investment:

Environmental Impact Bond (EIB) - Otherwise known as "Pay For Performance." The borrower will pay back their bond investors contingent on the performance of the adaptation measures, such as green infrastructure.

Green Bonds - Bonds that are specifically earmarked to be used for climate and environmental projects. These bonds are typically asset-linked and backed by the issuer's balance sheet, and are also referred to as climate bonds. Green bonds come with tax incentives such as tax exemption and tax credits.

Resilience Bonds - Generate risk reduction rebates from a city's catastrophe insurance premiums to pay for resilience projects. Resilience Bonds create incentives for cities to invest in resilience so as to reduce the human and financial cost of catastrophes when they strike.

Catastrophe Bonds - Or "cat bonds." Financial instruments designed to help manage the financial risks associated with extreme natural disasters. These bonds kick in after a disaster and do not raise money for resilience planning.

Resilience Districts - There has been a lot of discussion regarding leveraging the power of a location to pool resources to finance shared, community-wide infrastructure, known in shorthand as "resilience districts," which functions on the principle of "everyone pays, everyone benefits." One example is the City of Boston's Climate Resilience Fund, a form of Land Value Capture that recognizes that upgraded and new infrastructure benefits the private sector by offering a lower risk. The City asks developers to pay into a fund that will support community-wide infrastructure.

80%

greenhouse gas emissions reduction below 1990 levels by 2050. In 2020, the Vermont Legislature passed the Global Warming Solutions Act, setting legally binding GHG reduction targets.[23]

CLIMATE ACTION PLAN

FROM 1990 TO 2019, VERMONT'S GREENHOUSE GAS EMISSIONS ROSE 2%.[24] UNDER THE MANDATE OF THE GLOBAL WARMING SOLUTIONS ACT, VERMONT'S CLIMATE COUNCIL CREATED A CLIMATE ACTION PLAN TO IDENTIFY PATHWAYS TO REDUCE GHG EMISSIONS ACROSS ALL SECTORS AND PREPARE COMMUNITIES FOR WORSENING IMPACTS FROM CLIMATE CHANGE.[23]

DECEMBER 2021

IMAGE SOURCE: VPIRG

CHAMPIONS OF CHANGE

1. GLOBAL WARMING SOLUTIONS ACT

In September 2020, the Vermont State Legislature passed the Vermont Global Warming Solutions Act (H.688), creating legally binding emissions reduction targets. The Act calls on the state to reduce greenhouse gas pollution to 26% below 2005 levels by 2025, 40% below 1990 levels by 2030, and 80% below by 2050. The Act also created the Vermont Climate Council and charged them with developing an initial state Climate Action Plan. Notably, the Act creates a pathway for private citizens to take legal action against the State, should it not create, implement, or enforce rules necessary to achieve the targets.[23]

2. MIDDLEBURY RIVER RESTORATION

In a groundbreaking effort, the town of Middlebury spearheaded the restoration of the Middlebury River in 2019. By investing $3 million, they reconnected the river with its floodplain, enhancing stability and reducing erosion by 20%. Local collaborations further improved fish habitats and bolstered the region's resilience to climate change. This innovative project turns a once-degraded river into a symbol of Vermont's commitment to environmental integrity, reflecting a forward-thinking approach to climate adaptation that promises lasting impacts on the state's ecological landscape.[25]

3. BARRE CITY HOME BUYOUTS

Facing repeated flooding, Barre City implemented a strategic home buyout program in 2013. Investing over $1.2 million in funds from federal, state, and local sources, the city acquired and demolished 15 properties in flood-prone areas. These spaces were transformed into public parks and natural flood barriers, mitigating flood damage by an estimated 30%. The program stands as a compelling example of turning climate vulnerability into community strength, providing both safety and aesthetic value to the city's landscape.[25]

4. THE AFFORDABLE HEAT ACT

Enacted into law in 2023, The Affordable Heat Act (S.5) aims to provide financial support to low-income households struggling with heating costs. The Act offers subsidies and support to eligible individuals, while ushering a transition to cleaner energy. The legislature will vote on its implementation in 2025.[26]

5. REGIONAL GREENHOUSE GAS INITIATIVE

Vermont's participation in the Regional Greenhouse Gas Initiative has been instrumental in reducing the state's carbon footprint, with a 20% decrease in greenhouse gas emissions from power plants since 2008. The program also generated over $100 million in revenue for the state, further supporting its environmental efforts.[27]

6. GREEN INFRASTRUCTURE IN HINESBURG

Hinesburg, Vermont, sets a commendable example with its adoption of a green infrastructure plan. The town is pioneering strategies to manage stormwater and reduce flooding, contributing to the entire state's resilience and adaptation in the face of climate change.[28]

IMAGE SOURCE: STATE OF VERMONT | AGENCY OF NATURAL RESOURCES

IMAGE SOURCE: VPIRG | STUDENT CLIMATE RALLY 2019

APPENDIX

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 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

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, 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."

DISASTER DECLARATIONS. SOURCE: FEMA 2021 | MAPS COURTESY OF IPARAMETRICS.

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.

FEDERAL ASSITANCE. SOURCE: FEMA 2021

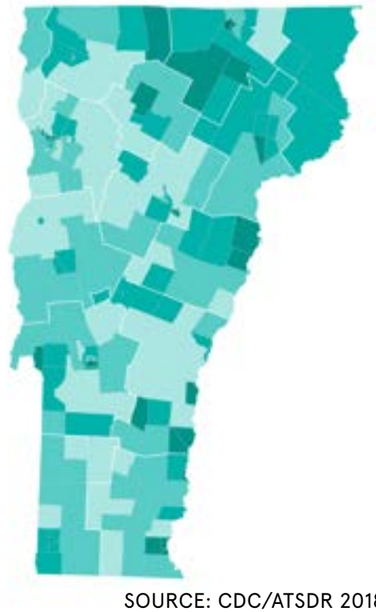
The Disaster Declaration tables provided at the end of each chapter show all federal Disaster Declarations declared between 2011-2021 and the corresponding FEMA obligations associated with those events. **However, in some instances, FEMA continues to obligate funds for years following a declaration. 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.

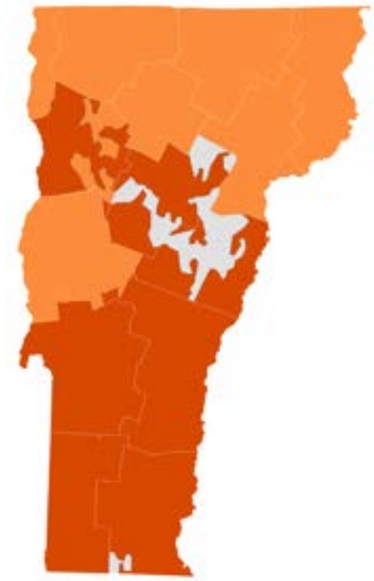
Since disaster aid is allocated to repair physical damage to property, events such as extreme heat, which largely creates physical damage to persons and not property, rarely qualify for federal disaster recovery aid. Additionally, there is only a shallow understanding of the economic impact of social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



SOURCE: CDC/ATSDR 2018 SOCIAL



SOURCE: US ENERGY INFORMATION

(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.

METHODS

ENERGY RELIABILITY

System Average Interruption Duration Index (SAIDI) is one of the performance metrics used to measure the reliability of an electric utility's service. This metric measures the total time (in minutes) an average customer experiences a non-momentary power interruption over a one-year (calendar) period. A Major Event Day (MED) is another metric which occurs when the SAIDI exceeds a specific threshold within a given day and tends to reflect outages on the longer end of the spectrum. The data presented in this report shows a metric of SAIDI combined with MED to highlight and report electric reliability in areas (utility territories) irrespective of the root cause of the interruption. The Energy Reliability Map displays the SAIDI_W_MED metric for utility territories and highlights areas that are susceptible to electric system vulnerabilities based on reliability performances. These vulnerabilities serve as an indicator as to where investments and improvements in the distribution grid should be focused.

Electric utilities experience power interruptions due to a variety of issues. Those issues include inclement weather, vegetation management practices, utility practices, maintenance patterns, and capital investment strategy, among others, which all play a part in a utility's overall reliability performance. The U.S. Energy Information Administration produces an Annual Electric Power Industry Report which utilizes data collected from U.S. electric utilities reflecting their reliability performance against certain industry standards and performance metrics. Utilities have the flexibility to report interruptions according to duration

and frequency either with major events, without major events, or both.

The annual SAIDI is the summation of the individual SAIDIs for each non-momentary interruption event over the entire year:

$$\text{SAIDI} = \frac{\sum(\text{Duration of Interruption} \times \text{No. of Sustained Customer Interruptions})}{\text{Total No. of Customers Served}}$$

For utilities that report SAIDI metrics using the Institute of Electrical and Electronics Engineers (IEEE) standards, "non-momentary" interruptions are those lasting longer than five minutes. A Major Event Day (MED) is another metric which occurs when the SAIDI exceeds a specific threshold within a given day and tends to reflect outages on the longer end of the spectrum.

Utilities have certain flexibilities when reporting with these metrics. Including MED in the SAIDI metric (SAIDI_W_MED) provides an overall picture of the electric reliability experienced by customers. Excluding MED from the SAIDI metrics (SAIDI_WO_MED) tends to separate power interruption events by their durations, which provides an indicator of the source of the power interruption (i.e., distinguishes a Major Event vs. Systematic Operation interruption).

Our methodology utilizes SAIDI_W_MED as the primary measurement indicator for the electric reliability experience of the end user (customer). Our SAIDI_W_MED metric highlights the reported electric reliability in areas (utility territories, counties, and states) irrespective of the root cause of the interruption. Our metric does not exclude interruptions categorized as MEDs.

This report endeavors to highlight areas across the national electric distribution network (utility territories) that are susceptible to electric system vulnerabilities based on historical reliability of performance. We view vulnerabilities caused by major events (longer duration outages) on par with vulnerabilities caused by systematic failures (shorter duration outages) and believe they should equally drive electric grid investment and improvement decisions.

These investments should also incorporate solutions aimed at mitigating systemic vulnerabilities that stem from issues like vegetation management practices, distribution automation improvements to major event vulnerabilities with root causes embedded in grid hardening, distribution generation schemes, and Automated Metering Infrastructure (AMI) upgrades aimed at minimizing customer interruption numbers and durations.

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