Health Impacts of Climate Change and Health Benefits of Climate Action

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Introduction

A desire to protect human health from the impacts of climate change was one of the motivations for the passage of Vermont's Global Warming Solutions Act in 2020: "[a] climate emergency threatens our communities, State, and region and poses a significant threat to human health and safety, infrastructure, biodiversity, our common environment, and our economy."[1] Deepening our understanding of how the climate emergency threatens human health can be instructive in directing which actions should be prioritized as part of the climate action plan.

This chapter attempts to help the reader to understand the scope and scale of climate change impacts the upstream conditions (like access to housing, food, recreation, and healthcare) that support health and wellbeing in Vermont as well as on the downstream illness and deaths that result both directly and indirectly from climate impacts. The objectives of this chapter are to:

1. provide a conceptual framework that helps the reader to understand the scope and scale of climate change impacts on health and well-being
2. provide Vermont-specific examples of those impacts, and

3. highlight the individual, regulatory, and policy actions that can reduce health risks associated with climate change.

This chapter does not quantify the health impacts of specific actions taken as part of the Global Warming Solutions Act. For example, it does not attempt to quantify the health benefits of changes in air quality emissions associated with transitioning from gas/oil to electric in the transportation or heating sector, or attempt to comprehensively quantify the health benefits of home weatherization. Nor does this chapter attempt to prioritize health risks associated with climate change. We defer to the hazard rankings provided by the 2023 State Hazard Mitigation Plan[2], which provides a prioritization of hazards and associated health risks for the state. Finally, this chapter does not examine the societal or health implications of positive feedback cycles, tipping points, or abrupt climate changes associated with triggering events such collapse of the Atlantic Meridional Overturning Circulation (AMOC), methane release from permafrost, or collapse of the Greenland Ice Sheet. The chapter assumes that climate changes experienced are essentially gradual and linear, which is unlikely in a "business-as-usual" emissions scenario.

Section 1. What are the impacts of climate change on health and wellbeing in Vermont?

Key Message 1: Climate change affects human health most directly through the immediate impacts of extreme weather events and changes in the risk of vector, food, and waterborne disease, and more indirectly through its upstream impacts on housing, economic, social, and environmental conditions that are necessary for human health and well-being.

Contemplating the health impacts of climate change can feel overwhelming. And when we feel overwhelmed, it can be more difficult to develop a plan of action[3]. To help provide a conceptual model for understanding the health impacts (and implications) of climate change, this chapter categorizes impacts into two groups:

- **Direct Impacts**: changing weather and infectious disease risks that directly impact our health
- **Indirect Impacts**: erosion of the social, economic, and physical infrastructure that our health depends upon, which makes it harder to be or stay healthy and can ultimately lead to illness.

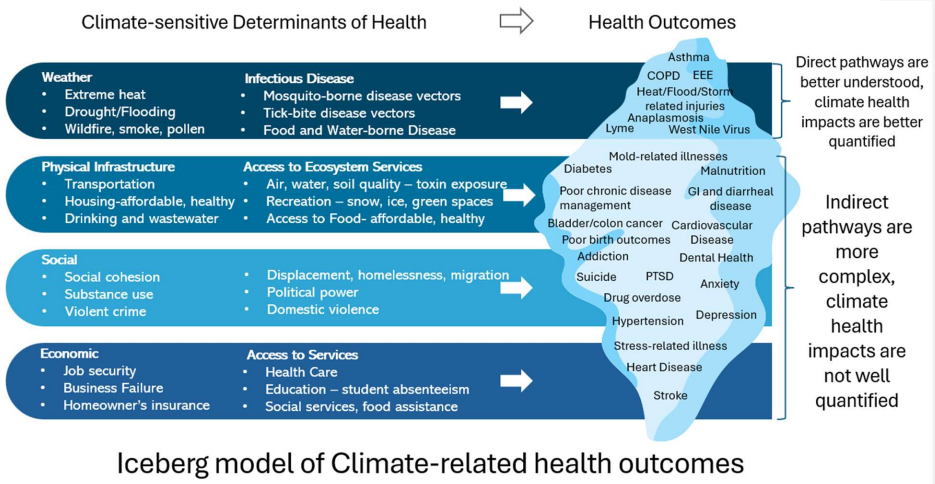


Figure X. The iceberg model of direct (visible) and indirect (hidden) health impacts of climate change.

Direct Impacts

The health impacts of climate change that directly result from extreme weather events or from climate's impacts on the weather and infectious disease have received the most attention to-date. These topics have been addressed previously in the U.S. Global Change Research Program's 2023 Fifth National Climate Assessment[4], Vermont Emergency Management's 2023 State Hazard Mitigation Plan[5], UVM's 2021 Vermont Climate Assessment[6] the Vermont Department of Health's 2017 Climate Change and Health in Vermont White Paper[7] the 2016 Climate and Health Profile Report[8]. Vermont-specific resources or data that were not cited in the resources above are listed by topic below.

Weather-related health risks

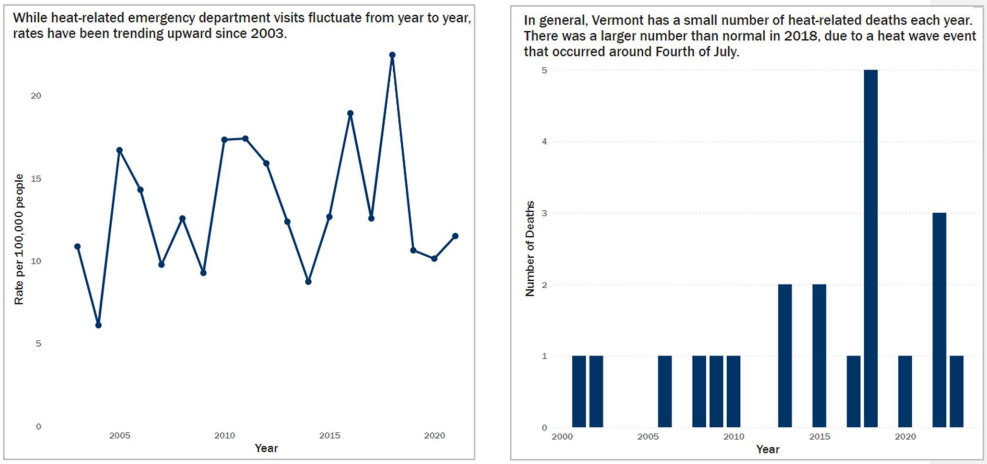


Figure X. Statewide trends in heat-related illnesses (2003 - 2022) and deaths (2000-2024).[9]

Heat-related illness and death[10]

- Heat-related health risks were most recently summarized in the in the 2023 State Hazard Mitigation Plan[11]. Since the publication of that plan, the following resources have also been published:
  1. Impacts of Excessive Heat on Health (August 2023)[12]
  2. Illness and Death due to Hot and Cold Weather (December 2024)[13]
  3. Statewide Weekly Heat-related illness Syndromic Surveillance Data (available from May through October)[14]
  4. County-level Heat and Health Data[15]
  5. County-level Historic Heat Data[16]

- Injuries and Deaths that occur during an extreme weather event and its immediate aftermath.

  Stay Safe When There is a Flood: Health Information in Many Languages[17], includes:

  a. Before & After the Flood
  b. Returning to Your Home After a Flood
  c. Flooding can contaminate your well or spring
  d. How to Prepare Infant Formula During an Emergency
  e. Mold After a Flood
  f. Recreational Water Safety After a Flood
  g. Protect Yourself When Cleaning Up Debris Outside After a Flood

- Cold-related injuries and death, e.g. cold-water immersion due to falling through the ice or boating accidents when the air temperature is warm and the water temperature is cold.

Commented [DG1]: Need to find a good summary of health toll of 2023 and 2024 floods.

Cold-Related Illness Season Summary, 2023-2024 [18]

- Poor air quality resulting from elevated temperatures (increased rates of tropospheric ozone production), drought (increased dust), or wildfire smoke[19].

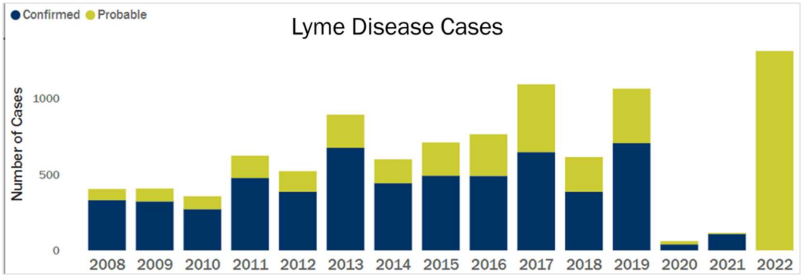
Infectious Disease-related health risks

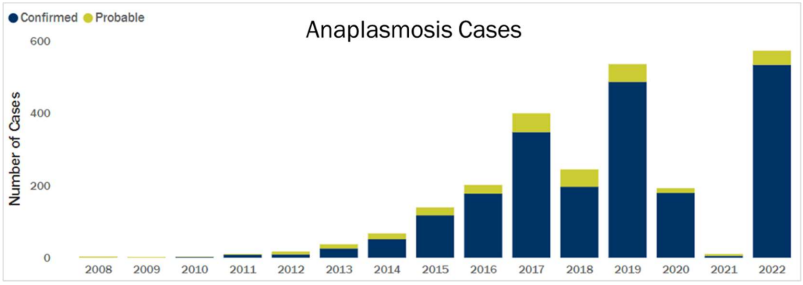
Climate-sensitive infectious disease risks were most recently summarized in the in the 2023 State Hazard Mitigation Plan[20]. Since the Mitigation Plan's publication, the following additional data for Mosquito and Tick-borne diseases have been published.

Mosquito-borne Diseases
In 2024, two human cases of Eastern Encephalitis were reported in Chittenden County, including one fatality. There was one human case of West Nile Virus.[21]

Tick Bite Illnesses

Currently, there are five tick bite illnesses in the state: Lyme disease, Anaplasmosis, Babesiosis, Hard tick relapsing fever (*previously named Borrelia miyamotoi*), and Powassan virus disease. While cases of hard tick relapsing fever and Powassan virus have occurred in Vermont, they are less common.





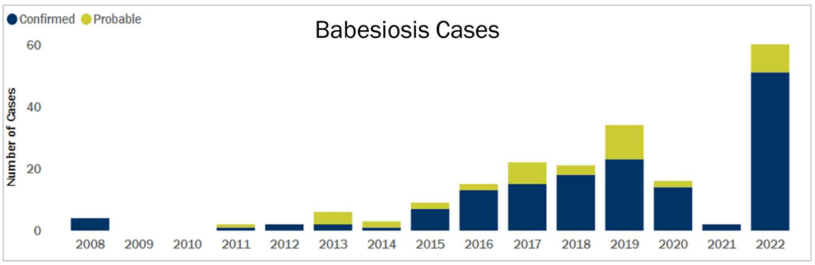


Figure X. Tick-bite illnesses: Cases of Lyme disease, Anaplasmosis, and Babesiosis have increased over the last ten years. In 2020-2021, the COVID-19 pandemic affected routine surveillance for most infectious conditions. In 2022, the national standardized surveillance case definition for Lyme disease changed for high-incidence states like Vermont. This change resulted in the increase in reported probable Lyme disease cases in 2022.

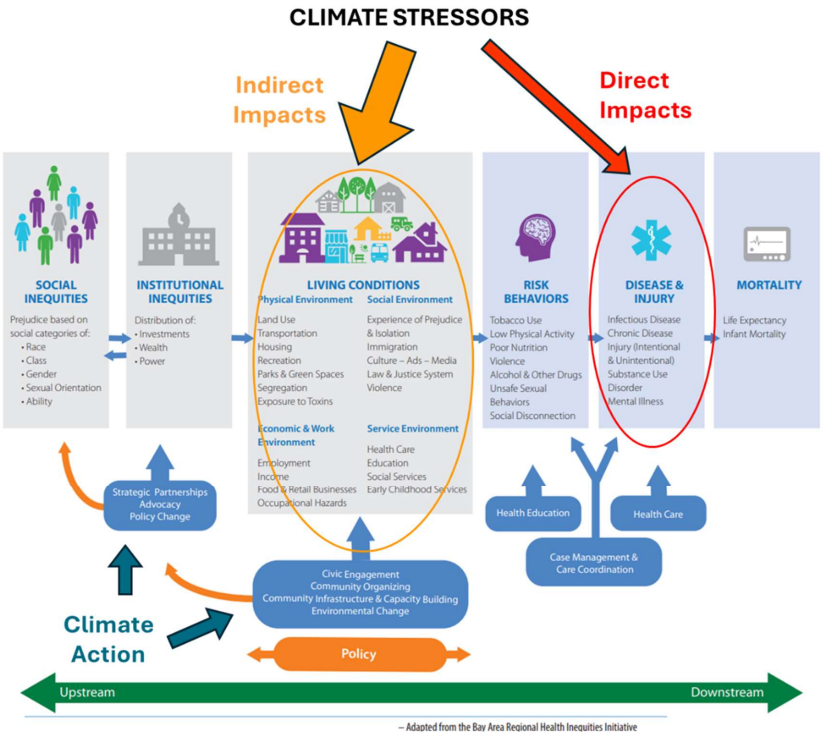


Figure X. Figure adapted from: Bay Area Regional Health Inequities Initiative: A Public Health Framework for Reducing Health Inequities.

Indirect Impacts

> *"Because of the floods, there are less investments happening in regular paving projects. Because of the floods, there are less investments happening in public safety. Because of the floods, there is less investment happening in water and wastewater infrastructure."*
>
> -**Ted Brady**, Executive Director, Vermont League of Cities and Towns[22]

As discussed in the previous section, climate change can impact health by directly increasing the risks of climate-sensitive illnesses such as heat-related illness[23] or Lyme disease[24]. Alternatively, climate change can 'load the dice' reducing the likelihood that an individual will be healthy by degrading the environment in which they live. It does this through its impacts on the economic, social, and environmental conditions that are necessary for human health and well-being. For example, a family

living in an area impacted by repeated weather events made more extreme by climate change will experience higher costs for homeowner's insurance, groceries, air conditioning, or storm repairs[25]. With less time or money available to spend on food, housing, recreation, or healthcare a family, is likely to be less healthy than they would have been absent the effects of climate change. The same is true for towns and for the state as a whole. Funds that are spent repairing roads and essential infrastructure after a flooding event can't be invested in walkable/bikeable roads, Police/Fire/EMS services, trash collection, libraries, parks and recreation, drinking or wastewater infrastructure maintenance or improvements, or other infrastructure investments that lay the foundation for sanitation and good health.

Definition of Indirect Health Impacts: Climate change affects human health indirectly through its upstream impacts on the physical, economic, and social conditions that provide the foundation for human health and well-being.

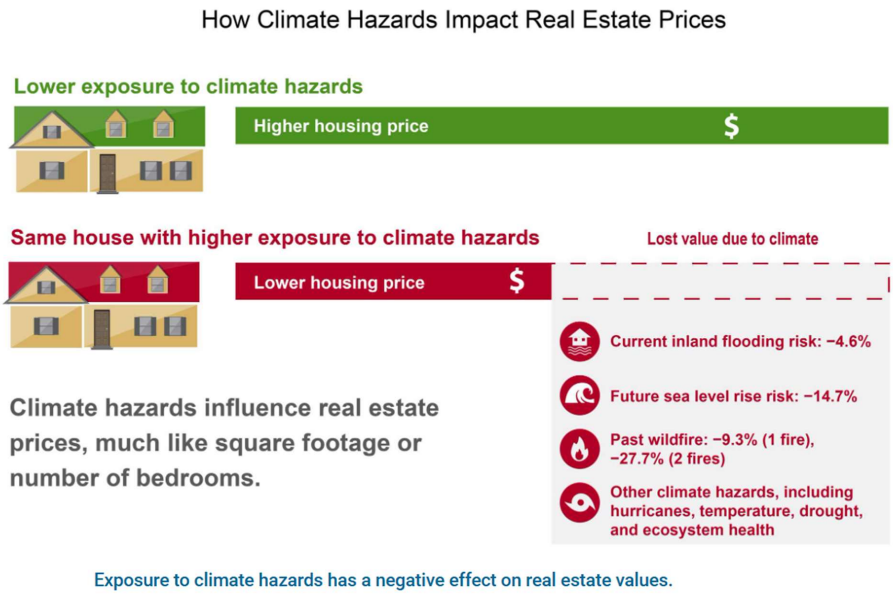
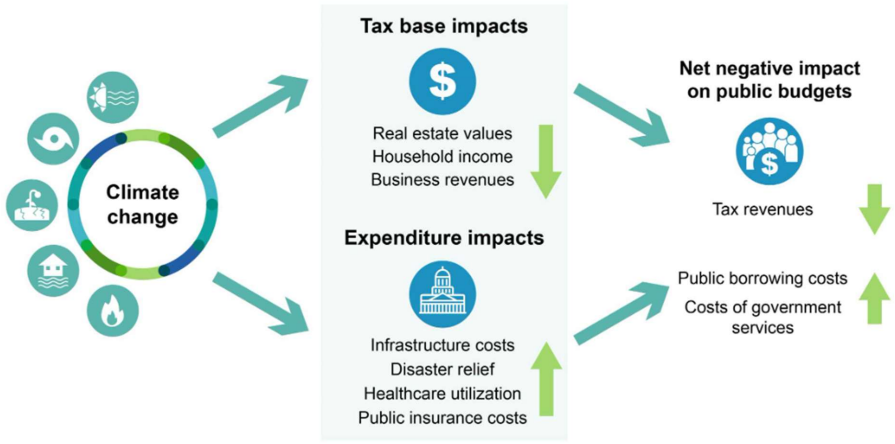


Figure X. From Fifth National Climate Assessment, Economics Chapter.

Housing



Climate change puts pressure on public budgets.

FIGURE 19.4. Climate change increases demand for government services while also reducing governments' ability to fund those services, creating new risks for the fiscal sustainability of government budgets at local, state, and federal levels. Tax revenues may fall due to decreased real estate values, household income, and business revenues.[53, 100, 163] Meanwhile, expenditures on infrastructure,[164] disaster relief,[132] healthcare,[54, 68] and public insurance[135] are expected to increase. Together, this fiscal risk increases the cost to government for borrowing funds (e.g., the sale of bonds) by reducing the rating of public debt, which in turn further harms the ability of governments to fund services. Figure credit: See figure metadata for contributors.

Figure X. From Fifth National Climate Assessment, Economics Chapter.

Government and Institutions

Potential examples:

1. Example 1: Impact on people's mental health when their have to leave their homes due to flooding.
2. Example 2: Impact on health care access or ability to get medication when road washes out.
3. Example 3: Impact on stress related illness as a result of uncertainty in climate dependent economic sectors such as agriculture, outdoor recreation, or maple sugaring.
4. Example 4: Impacts on school attendance, educational attainment, and social cohesion in communities impacted by flooding.
5. Examples from VTDigger and Seven Days about effects of flooding on housing, health, stability, security, and community.
6. When a home is damaged by flooding, the shock and stress of temporary displacement increase student absenteeism and bankruptcy rates (citation?). When a storm damages a road, that makes it harder to see a doctor, or pick up groceries or medicine.

Commented [UJ2]: And on community leaders, members, volunteers responding to flooding, dealing with impacts to their community.

Commented [UJ3]: also thinking about impacts on people relying on locally grown food. i know CVOEO clients have been affected by Intervale flooding wiping out some of their food sources.

Commented [UJ4]: You might already be thinking about this, but I'm also thinking about the QoL, recreation, and solastalgia impacts - people may hike less from fear of ticks, avoid being outside during mosquito/EEE season, cyanoabacteria impacts on use & enjoyment of water, cold season impacts to skiing, ice fishing, snowmobiling, have resources or activities disrupted by flooding, etc.

Commented [UJ5]: also economic impacts. private and public $ spent on flood mitigation & recovery is $ not spent on other priorities.

7. Seven Days article about increased organic matter in drinking water sources resulting in increased DBP's. Climate Change demands greater investment in public health infrastructure (like drinking water systems and wastewater treatment facilities) at the same time it diverts resources to needs such road repair, storm cleanup, and repair of damaged infrastructure. "Climate change is going to continue to impact how we operate our treatment plants. The resources and the technology and the level of operation necessary are just going to get more and more complex." -Joe Duncan, general manager of the Champlain Water District

   https://www.sevendaysvt.com/news/flooding-is-affecting-vermonts-drinking-water-quality-42765988

   i. **Climate Change undermines investments in community development that would otherwise help to lessen health disparities and improve public health.** Climate change has a net extractive effect on the resources available to communities, resulting in decreased social goods such as:
      1. human health
      2. economic prosperity
      3. educational and economic opportunity
      4. social cohesion
      5. community resilience

      and increasing social ailments such as

      1. mental illness
      2. substance use
      3. domestic violence
      4. student absenteeism
      5. unemployment
      6. housing insecurity
      7. food insecurity
      8. business failure
      9. financial stress
      10. violent crime
      11. stress related illness
      12. outward migration
      13. lack of access to affordable healthcare
      14. lack of access to affordable homeowner's insurance

   ii. **Relative scale of direct vs indirect impacts:** While the indirect impacts of climate change on health are more difficult to quantify than direct impacts, they likely exceed the direct impacts of climate change on health.
      Citation: https://www.nature.com/articles/s41586-024-07945-5.

b. Two examples of how climate change elsewhere can affect Vermont: Migration and Wildfire Smoke (Richard Hopkins)

In addition to direct impacts of climate change on Vermont and its inhabitants — through floods, heat waves, droughts, wind storms, wildfires and so on — Vermont may also experience harm from direct impacts of climate change occurring elsewhere. Two categories are especially prominent: climate migration and wildfire smoke.

In September, 2020, the news organization Politico published an analysis of climate risks at the county level, for every US county. They considered six factors: heat, wet bulb temperatures, crop yields, sea level rise, very large fires, and economic damages. Thirteen of Vermont's 14 counties were within the 40 counties at lowest risk nationally, and 6 were within the 7 lowest. (https://projects.propublica.org/climate-migration/)

Sea level rise is likely to affect tens of millions of people along the coast of the Northeast from Massachusetts to New Jersey. Some communities will become uninhabitable, while in others people will be subject to periodic flooding during storms and even during blue-sky high tides. In the latter communities, home insurance is likely to become unavailable, and thus flooding and storm damage repair is likely to become unaffordable, and houses unsalable. Many people will respond to the loss of their homes or jobs by relocating. While many will seek to relocate just far enough to be safe from sea level rise impacts, others will respond by seeking a safe harbor at a distance. Vermont is among the places people may seek to move to.from the coastal regions nearby. People may also seek to relocate from further south along the vulnerable coast from Maryland to Florida.

Coastal communities will, to varying degrees, attempt to adapt to or minimize the impacts of sea level rise. The extent and effectiveness of these adaptation measures are unknown, and are not under Vermont's control.

Increased average summer heat and intensity of heat waves will also increase across the northeast, though perhaps less prominently in Vermont than further south and at lower elevations. The increased heat may by itself influence some people to relocate, but people relocating because of sea level rise may go further north because of the heat. Similarly, an increased frequency and intensity of coastal storms may influence people to relocate farther from the coast, separately from the direct effect of flooding.

The magnitude and timing of large-scale climate migration into Vermont is unpredictable. We can expect that in the early stages, people will come (and a few have come already) with substantial resources, and perhaps with jobs and businesses they can relocate to their new home. But as coastal flooding worsens, more people may come as refugees, with few resources and little prospect of returning home. Vermont, and other states similarly situated all across the northern tier, will be faced with greatly increased needs: for schools, health and mental health care facilities, housing, water supplies, wastewater treatment, roads, fire and law enforcement services, support for indigent persons, and on and on.

Vermont may also be directly or indirectly impacted by climate migration from other parts of the world. Much of the world, especially those parts that are already struggling to reach a comfortable standard of living, will suffer at least as badly as the United States with respect to heat, drought, fires, flooding, crop failures, and other climate-related disasters. Climate change impacts are likely to lead to internal armed conflicts and wars as well, which will further drive desperate migration. Vermont's status as a border state, with Canada, may at some point come to have important implications.

The second out-of-state climate impact of note is wildfire smoke. Vermont already has experience in recent years with days of poor air quality related to wildfires in the American West

and in Alberta and northern Quebec. Poor air quality increases acute episodes and exacerbations of asthma and other chronic lung diseases, and days of wildfire smoke exposure have been shown to increase all-cause mortality risk. They also decrease quality of life, both because of direct discomfort and because of preventive measures (like staying indoors) that are recommended.

There is nothing direct that Vermont can do to reduce risk of smoke from wildfires elsewhere in North America, though there are steps Vermont could take to reduce wildfire danger in its own forests. Those forests are a valuable buffer against GHG accumulation in the atmosphere, as well as providing local cooling in summer. Warmer temperatures and higher atmospheric CO_2 levels, if combined with adequate rainfall, may promote forest growth, and this may in turn increase the risk of damaging wildfires. Wildfire prevention may, paradoxically, require some controlled burning in our forests, which presents its own logistical difficulties, and also other controversial management strategies.

Section 2. Who is impacted?

Key Message 2: Climate change affects everyone, but communities lacking economic, social, or political resources experience the greatest risks and impacts.

c. Because climate change extracts resources from individuals and communities, the impacts of climate change are most severe for segments of the population who have historically had the least social, political, and economic power and capital.
Provide examples or call-out boxes for:
   i. Low-income Vermonters
   ii. Black, Indigenous, and People of Color
   iii. Immigrants, Refugees, Asylees, and Asylum-Seekers
   iv. Farmworkers
   v. People with disabilities
   vi. Elderly people living on fixed incomes
   vii. People living in manufactured housing
   viii. Renters
   ix. People who live in rural settings
   x. People with chronic illnesses
   xi. People with substance use disorder
   xii. People experiencing homelessness
   xiii. Children
   xiv. People who are incarcerated
   xv. Members of the LGBTQ+ community

Section 3. What actions can reduce the health risks of climate change?

Key Message 3. Interventions that act on upstream institutional and social inequities can most effectively address both climate change and health inequities.

d. Reducing greenhouse gas emissions and/or removing existing GHGs from the atmosphere (mitigation) are the best means to prevent further harm to physical, social, and economic systems that support health and well-being.
e. Building political and economic power are essential components of building climate resilience.
    i. Provide supporting evidence
    ii. Giving those most affected a voice will help bring about conditions for positive change. [Seems like opinion presented as fact. Support it or remove it]
f. Interventions that help those at greatest risk also help everyone else
    i. Provide supporting evidence
g. Actions to reduce the potential impacts of climate change in the future can provide immediate health, environmental, economic, or other benefits today. These benefits must be equitably distributed (Act 154) Examples include:
    i. active transportation.
    ii. original health care cost benefits of weatherization in 2018, based on estimates from literature for how much disease prevention you get from weatherization.
    iii. new estimates of healthcare cost benefits of home weatherization for Medicaid recipients using Vermont data.
    iv. estimated benefits of electrification from Rewiring America in a Tableau dashboard
h. "Post-disaster programs face pressure to get a community "back to normal" as quickly as possible, even if pre-disaster "normal" included inequitable housing conditions, poor public health, and inequitable distribution of risk to natural disasters."
    i. Source: Smith, G. Disaster Recovery Funding: Achieving a Resilient Future?, in After Disasters: Strategies, Opportunities, and Planning for Recovery. Washington (DC): National Academies Press (US); 2015 Sep 10.

Commented [UJ6]: Perhaps consider if this needs nuance about global versus state action, i.e., state action alone will make little difference, but state contribution to global action is important.

Commented [UJ7]: also consider urban forestry. The VT UCF page specifically mentions health benefits: https://vtcommunityforestry.org/municipal-assistance/community-canopy-program

Call-out Box #1: Heat & Houselessness Storytelling Project



Summary: People who are unhoused may be at especially high risk of heat-related illnesses, but this is hard to validate with existing data. Many unhoused people can't access medical treatment because housing status is often not recorded in medical records, and heat illnesses are underreported. To help fill this data gap, the Health Department partnered with Middlebury College on a year-long project. Students interviewed 19 unhoused individuals and 7 service providers to learn more about the lived experiences of unhoused Vermonters during hot weather

It is clear that unhoused Vermonters are impacted by extreme heat. While systemic change is needed to aid

unhoused Vermonters, short-term action steps were identified during the project. For example, providing temporary shelter, storage, and survival gear can meet immediate needs, such as:

- Access to daytime relief – cooling centers, libraries, other spaces with air conditioning, mobile cooling vans, shade/misting tents, pools, parks and beaches
- Access to overnight shelters with air conditioning – keeping shelters open year-round or opening emergency shelters during periods of extreme heat
- Hydration resources – access to drinking water, water purification supplies, electrolyte packets
- Hygiene support – access to shower and laundry facilities, wet wipes, cleaning wipes, wash cloths, hand sanitizer, no-rinse body soap, deodorant, first aid items • Sun and insect protection

To Learn More: Please visit [link 2-pager] to hear direct quotes from study participants and learn more about the Heat & Houselessness Storytelling Project.

Call-out Box #2: Energy justice gaps in renewable energy transition policy initiatives in Vermont

Summary: This study examines Vermont's renewable energy policies and highlights the state's energy vulnerability and justice issues. Drawing on 569 surveys and 18 interviews statewide, the results demonstrate higher energy vulnerability—lack of access to sufficient and affordable energy—among respondents who are low-income, non-white, and renters, for example, the study shows:

- Low-income and renter respondents were over three times more likely, and non-white respondents were seven times more likely to report going without heat.
- Results show that non-white respondents were seven times less likely than white respondents to report having solar panels, and renters were three times less likely than homeowners to report having solar panels.
- Interviews also reveal household transition benefits (i.e., money to invest in solar panels) are primarily available to high-income households.

The authors argue that these disparities may result from structural discrimination and policies that distribute household transition benefits to households with disposable income and property rights. The unequal distribution of this 'investment capital' prevents widespread access for non-white, low-income, and renting households.

Energy justice

	Income		Race		Homeownership	
Energy Vulnerability	**Above $25,750**	**Below $25,750**	**White**	**Non-White**	**Home owner**	**Renter**
	n (%) Odds Ratio (CI)		n (%) Odds Ratio (CI)		n (%) Odds Ratio (CI)	
Participation in Household Transition Benefits						
Have Solar panels	11(6%)	7 (6%)	32 (11%)	1 (2%)	22 (15%)	11 (5%)
	1.031 (0.388-2.736)		**0.144 (0.019-1.075)**		**0.315 (0.148-0.670)**	
Home has been weatherized	116 (71%)	55 (61%)	167 (67%)	28 (60%)	95 (69%)	102 (63%)
	0.650 (0.379-1.117)		0.724 (0.382-1.372)		0.757 (0.468-1.223)	
Knowledge of energy transition policies						
Know how household fits into local, regional, or statewide energy plans	21 (11%)	8 (8%)	37 (13%)	3 (6%)	22 (15%)	17 (9%)
	0.658 (0.280-1.543)		0.401 (0.119-1.350)		0.529 (0.270-1.038)	

Our results show that non-white respondents were seven times less likely than white respondents to report having solar panels and renters were three times less likely than homeowners to report having solar panels.

To Learn More: Read Energy justice gaps in renewable energy transition policy initiatives in Vermont.

The R.E.J.O.I.C.E. Project

[1] Global Warming Solutions Act, 2020, Vermont State Legislature, Act 153, Sec 2.1, Page 1. https://legislature.vermont.gov/Documents/2020/Docs/ACTS/ACT153/ACT153%20As%20Enacted.pdf

[2] Vermont State Hazard Mitigation Plan, 2023, Vermont Emergency Management, Page X. https://vem.vermont.gov/sites/demhs/files/documents/2023%20SHMP_Adopted%20Draft%20Jan2024.pdf

[3] Matthew R. Sisco *et al.*, Examining evidence for the Finite Pool of Worry and Finite Pool of Attention hypotheses, Global Environmental Change, Volume 78, 2023, 102622, ISSN 0959-3780, https://doi.org/10.1016/j.gloenvcha.2022.102622

[4] Hayden, M.H. *et al.*, 2023: Ch. 15. Human health. In: *Fifth National Climate Assessment*. Crimmins, A.R., C.W. Avery, D.R. Easterling, K.E. Kunkel, B.C. Stewart, and T.K. Maycock, Eds. U.S. Global Change Research Program, Washington, DC, USA. https://doi.org/10.7930/NCA5.2023.CH15

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[10] VT Dept. Health. (Accessed February 11 2024). *Hot weather and health impacts*. Climate & Health Program. https://www.healthvermont.gov/health-environment/climate-health/hot-weather

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[12] VT Dept. Health. (August 2023). *Impacts of Excessive Heat on Health*. Lauren Prinzing, Climate & Health Program. https://www.healthvermont.gov/sites/default/files/document/env-epht-impacts-of-excessive-heat-on-health.pdf

[13] VT Dept. Health. (December 2024). *Illness and Death due to Hot and Cold Weather*. Lauren Prinzing, Climate & Health Program. https://www.healthvermont.gov/sites/default/files/documents/pdf/ENV_CH_illness-death-due-to-hot-cold-weather.pdf

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