



## Climate Change Adaptation White Paper Series

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### **Vermont Climate Change Health Effects Adaptation**

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The broad consequences of climate change can be expected to affect nearly every aspect of human life, including physical and mental health. This section considers the human health implications of climate change for Vermonters.

#### **Evidence of Climate Change in Vermont**

Climate change is long-term change in the average weather of a particular location (Kovats et al., 2000). In Vermont, there is evidence of warming and changes in rainfall patterns. In the ~50 years from 1960 to 2008, mean winter temperatures have risen 4.5°F, and mean summer temperatures have risen 2°F (Betts, 2010). Unless there are drastic reductions in the burning of fossil fuels and carbon dioxide (CO<sub>2</sub>) emissions, warming trends are likely to continue and even accelerate (Betts, *Vermont Temperature Trends*, 2010). Warming leads to changes in the water cycle (Betts, 2010). In Vermont, this may mean that snow melts earlier and summer rains become heavier. As a result, more rainwater runs off, leaving less to moisten soil and keep it in place, more water evaporates, and the soil dries out faster between rainfalls (Betts, 2010). These water cycle trends can lead to both more droughts and more floods (Betts, 2010).

#### **The Health Consequences of Climate Change**



The range of possible climate change health effects is large. Main health effects in Vermont include: injuries, illnesses, and deaths related to extreme heat and weather events; infectious diseases related to changes in vector and zoonotic biology as well as changes in water and food contamination; allergy and respiratory symptoms related to increasing plant and mold allergens and irritants in air; and possibly less nutritious foods related to food production changes in response to climate change (Frumlin et al., 2008). Although populations may naturally develop physiologic and behavioral adaptations, deliberate strategies to prevent, mitigate, and adapt to climate change are also necessary (Kovats et al., 2000, Patz et al., 2000). This is true despite the fact that individual health effects may be treatable. CO<sub>2</sub> emissions-induced climate change is not reversible (Solomon et al., 2009). Therefore, efforts to

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reduce CO<sub>2</sub> emissions are vital to limit progression of human-induced climate changes and related negative health effects (Solomon et al., 2009). The human consequences of climate change include both direct and indirect health effects (Githeko & Woodward, 2003). **Table 1** lists predicted Vermont-specific climate change impacts and examples of likely health effects. This list is not comprehensive.

**Table 1. Predicted Vermont Climate Change Impacts and Examples of Likely Health Effects**

(Format adapted from Kovats et al., 2000)

| <b>Predicted Climate Change Impacts</b>  | <b>Likely Health Effects (not comprehensive)</b>   |
|--|--|
| Increasing occurrence of <b>extreme heat events</b> from increasing temperature (Hayhoe et al., 2010)  | <ul style="list-style-type: none"> <li>• Heat stroke, heat cramps, heat fainting, heat exhaustion, death (Patz et al., 2000)</li> <li>• Heat-related respiratory and cardiovascular disease events (IWGCCH, 2010) (i.e. asthma attack, heart attack, stroke)</li> </ul>  |
| Increasing occurrence of <b>extreme weather events</b> from precipitation variability (Patz et al., 2000), including: heavy rainfall events (>2 inches in 48 hours) (UCS, 2006), floods (Betts, 2010), ice storms (Keim & Rock, 2002), winter storms (Keim & Rock, 2002), droughts (Betts, 2010), wildfires  | <ul style="list-style-type: none"> <li>• Injury, drowning, death (Frumlin et al., 2008, Patz et al., 2000)</li> <li>• Heavy rainfall-, flood-, and drought-related water- and food-borne infectious diseases (Frumlin et al., 2008)</li> <li>• Wildfire smoke-related respiratory diseases ( IWGCCH, 2010)</li> <li>• Carbon monoxide poisoning (CDC, 2009)</li> </ul>   |
| Increasing duration and intensity of <b>UV radiation</b> from ozone depletion (IWGCCH, 2010)   | <ul style="list-style-type: none"> <li>• Skin cancer (Squamous, Basal, Melanoma) ( IWGCCH, 2010)</li> <li>• Cataracts ( IWGCCH, 2010)</li> </ul>   |
| Increasing transmission of some <b>tick, mosquito, and rodent vector-borne and zoonotic infectious diseases</b> (Patz et al., 2000, 8) from increasing contact and biting frequency due to: expanding geographic ranges, shortening incubation periods and better winter survival from increasing temperature; potentially more mosquito breeding grounds from increasing precipitation or even from drought conditions turning rivers into breeding grounds (Patz et al., 2000); and potentially increasing rodent food supply growth from increasing precipitation (Patz et al., 2000) | <ul style="list-style-type: none"> <li>• Lyme disease (Frumhoff et al., 2007)</li> <li>• West Nile Virus disease (Soverow et al., 2009)</li> <li>• Rodent urine, fecal, and saliva-related asthma and viral diseases (Patz et al., 2000)</li> <li>• Hanta virus disease (Patz et al., 2000)</li> </ul>   |
| Increasing seasonal <b>water quality and quantity variation</b> from increasing water temperature, increasing precipitation and runoff, or drought (Patz et al., 2000; UCS, 2006)  | <ul style="list-style-type: none"> <li>• Water-borne microbiologic gastrointestinal diseases from viruses, bacteria, and protozoa including <i>Cryptosporidium parvum</i>, <i>Giardia lamblia</i>, <i>Escherichia coli</i>, and other fecal coliform bacteria from drinking contaminated water or eating produce irrigated or processed with contaminated water, and rare food poisoning from <i>Vibrio vulnificus</i> from eating seafood (especially shellfish) from contaminated water (Patz et al., 2000)</li> <li>• Blue-green algae bloom-related hepatotoxin and neurotoxin poisoning from contact with or ingestion of contaminated water (Patz et al., 2000)</li> </ul> |
| <b>Food production and quality disruptions</b> from changing environmental conditions and water availability ( IWGCCH, 2010)   | <ul style="list-style-type: none"> <li>• Seafood contamination from chemicals, biotoxins, and pathogenic microbes (IWGCCH, 2010)</li> <li>• Crop contamination from changing use of pesticides in response to changing pest type and distribution (IWGCCH, 2010)</li> <li>• Increasing food-borne disease from increasing temperature, including food poisoning, <i>campylobacteriosis</i> and <i>salmonellosis</i> (IWGCCH, 2010)</li> <li>• Sub-optimal nutrition and staple crop shortages from impaired crop growth or changing agricultural practices ( IWGCCH, 2010)</li> </ul>  |
| Increasing <b>aero-allergens, other allergens, and irritants</b> , including: pollen from longer growing season or changing geographic distribution of plant species (Patz et al., 2000; IWGCCH, 2010), dust from droughts (IWGCCH, 2010), mold and  | <ul style="list-style-type: none"> <li>• Aggravation of other respiratory diseases ( IWGCCH, 2010)</li> <li>• Increasing asthma occurrence and severity (Patz et al., 2000; IWGCCH, 2010)</li> <li>• Changing timing and duration of hay-fever (Patz et al., 2000;</li> </ul>  |

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|---|---|
| mold spores from increasing precipitation and temperature (IWGCCH, 2010)    | IWGCCH, 2010)<br><ul style="list-style-type: none"> <li>• Rhinitis (stuffy nose) (IWGCCH, 2010)</li> <li>• Atopic dermatitis (allergic skin rash) (IWGCCH, 2010)</li> </ul> |
| <b>Changes in material and pesticide use</b> in response to climate changes | <ul style="list-style-type: none"> <li>• Unknown development, neurologic, or cancer effects ( IWGCCH, 2010)</li> </ul>  |
| <b>Social disruptions</b>   | <ul style="list-style-type: none"> <li>• “Mental health and stress-related disorders” ( IWGCCH, 2010)</li> </ul>  |
| <b>Economic disruptions</b>   | <ul style="list-style-type: none"> <li>• Opportunity cost of adaptation</li> </ul>  |

### Health Effects Adaptation Vulnerabilities

All Vermonters are at risk for the negative health effects of climate change. However, it is useful to identify groups who are most at risk in order to plan for their unique needs. Vermont populations with higher intrinsic susceptibility to the negative health effects of climate change include children, the elderly, and people who are immune-compromised or who have pre-existing medical conditions or disabilities (IWGCCH, 2010). Vermonters of lower socioeconomic status may not have the means to adapt and may therefore be more vulnerable to negative health effects ( IWGCCH, 2010). For this reason, climate change is likely to intensify health disparities among Vermonters, widening the gap between those who are healthy and those who are not (Frosch et al., 2009). Vermonters who work outdoors or participate in vigorous physical work in a hot environment will be especially affected by climate change and may sustain disproportionately more direct or indirect health effects. This could include workers in agriculture, tourism, manufacturing, construction, and metallurgy, as well as athletes.

The complexities of forecasting climate change and researching health consequences become vulnerabilities if we allow incomplete evidence or uncertainty to keep us from taking action to prevent, mitigate, or adapt to the impact on public health. Most human disorders are caused by multiple factors, and background socioeconomic, demographic, and environmental contexts change over time (Githeko & Woodward, 2003). Thus “conclusively proving (or disproving) a link with climate change is highly problematic” (Githeko & Woodward, 2003). These problems should not impede prevention and adaptation planning.

### Efforts Relevant for Preventing Negative Climate Change Health Effects

The term *adaptation* as referred to here means protecting people from harm associated with changes in the climate that cannot be avoided. “The primary objective of adaptation in the public health context is to reduce disease burdens, injuries, disabilities, suffering, and deaths” (Kovats et al., 2000; Grambsch & Menne, 2003). Efforts to reduce the negative health effects of climate change impacts can be considered in terms of the conventional public health categories of primary, secondary, and tertiary prevention (Kovats et al., 2000; Grambsch & Menne, 2003).



**Primary prevention corresponds to anticipatory adaptation**, which involves intervention before evidence of disease or injury (Kovats et al., 2000; Grambsch & Menne, 2003). Primary prevention of climate change impacts involves efforts to reduce CO<sub>2</sub> emissions. Primary prevention of the negative

health effects of climate change impacts thus includes both efforts to reduce CO<sub>2</sub> emissions and more direct health effect-specific prevention plans, such as interventions to prevent extreme heat event-related heat strokes or heart attacks. Primary prevention of the negative health effects of climate change impacts also includes climate-related environmental hazard tracking and surveillance.

**Secondary prevention corresponds to reactive adaptation**, which involves intervention after disease has begun but before symptoms appear, for example disease tracking and surveillance and screening for early detection, including subsequent intervention or treatment that averts full progression to disease (Kovats et al., 2000; Grambsch & Menne, 2003).

**Tertiary prevention corresponds to inherently reactive adaptation** because the negative health effects are not prevented (Kovats et al., 2000; Grambsch & Menne, 2003). Tertiary prevention involves minimizing the effects of an existing disease or injury, for example better treatment of heat strokes or improved diagnosis of vector-borne diseases (Kovats et al., 2000; Grambsch & Menne, 2003).

**Table 2** lists current Vermont Department of Health (VDH) efforts relevant for preventing negative health effects of climate change impacts.

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**Table 2. Current Vermont Department of Health Efforts Relevant for Prevention of Negative Health Effects of Climate Change Impacts**

| Negative Health Effects  | Primary Prevention—anticipatory   | Secondary Prevention—reactive   | Tertiary Prevention—inherently reactive   |
|--|---|---|---|
| <b>Extreme heat event</b> -related health effects                            | <ul style="list-style-type: none"> <li>• Early warning protocols to communicate health alerts to the public</li> <li>• Health Alert Network—used to communicate health alerts to healthcare providers and responders</li> </ul>   | <ul style="list-style-type: none"> <li>• Environmental Public Health Tracking Program—tracking of heart attacks</li> </ul>  | <ul style="list-style-type: none"> <li>• All-Hazards Emergency Preparedness Plan</li> <li>• Emergency Operations Plan (Health Operations Center)</li> <li>• Emergency Medical Services (EMS) System</li> <li>• Vermont Emergency Response Volunteers (VERV)</li> <li>• Epidemiology All-Hazards Plan</li> </ul> |
| <b>Extreme weather event</b> -related health effects                         | <ul style="list-style-type: none"> <li>• Early warning protocols to communicate health alerts to the public</li> <li>• Health Alert Network</li> </ul>  |   | <ul style="list-style-type: none"> <li>• All-Hazards Emergency Preparedness Plan</li> <li>• Emergency Operations Plan (Health Operations Center)</li> <li>• Emergency Medical Services (EMS) System</li> <li>• Vermont Emergency Response Volunteers (VERV)</li> <li>• Epidemiology All-Hazards Plan</li> </ul> |
| <b>UV radiation</b> -related health effects                                  | <ul style="list-style-type: none"> <li>• State Cancer Plan (sun protection education)</li> <li>• Comprehensive Cancer Control</li> </ul>  | <ul style="list-style-type: none"> <li>• Vermont Cancer Registry</li> </ul>   | <ul style="list-style-type: none"> <li>• Comprehensive Cancer Control</li> </ul>  |
| <b>Vector-borne and zoonotic infectious disease</b> -related health effects  | <ul style="list-style-type: none"> <li>• Vector-borne disease public education</li> <li>• Central dead bird reporting line for West Nile Virus</li> <li>• Sentinel non-human host surveillance: Deer Sera Survey for mosquito-borne Eastern Equine Encephalitis Virus</li> <li>• Health Alert Network</li> </ul>  | <ul style="list-style-type: none"> <li>• Reportable Diseases surveillance</li> <li>• Monthly Infectious Disease bulletin—provides brief and timely updates about issues of concern in infectious disease epidemiology</li> <li>• National Electronic Disease Surveillance System</li> </ul> | <ul style="list-style-type: none"> <li>• Early Aberration Reporting System (EARS)—reports automated syndrome-sorted data useful for examining trends to VDH every 24 hours from seven hospitals</li> </ul>  |
| <b>Water quality and quantity variation</b> -related health effects          | <ul style="list-style-type: none"> <li>• Water testing and maintenance guidelines</li> <li>• Water test kits available for purchase for laboratory testing of private water</li> <li>• 800 line to Drinking Water Program offering technical advice on protective technologies for microbial or chemical treatments and on interpretation of water test results</li> <li>• Blue-green algae reporting line and email</li> <li>• Health Alert Network</li> </ul> | <ul style="list-style-type: none"> <li>• Reportable Diseases surveillance</li> </ul>  | <ul style="list-style-type: none"> <li>• Early Aberration Reporting System (EARS)</li> <li>• Town Health Officer complaint response and management</li> </ul>   |
| <b>Aero-allergen and other allergen and irritant</b> -related health effects | <ul style="list-style-type: none"> <li>• Health Alert Network</li> </ul>  | <ul style="list-style-type: none"> <li>• Vermont Asthma Program surveillance</li> </ul>   | <ul style="list-style-type: none"> <li>• Town Health Officer complaint response and management</li> </ul>   |
| <b>Food production and quality disruption</b> -related health effects        | <ul style="list-style-type: none"> <li>• Food and Lodging Program sanitarian inspections</li> <li>• Shellfish Sanitation Program</li> <li>• Health Alert Network</li> </ul>   | <ul style="list-style-type: none"> <li>• Food and Lodging Program regulatory enforcement</li> <li>• Reportable Diseases surveillance</li> </ul>   | <ul style="list-style-type: none"> <li>• Food and Lodging Program and Infectious Disease Epidemiology complaint, outbreak, and recall protocols</li> <li>• Food and Lodging Sanitarian Emergency Response</li> </ul>  |
| <b>Changing material and pesticide use</b> -related health effects           |   | <ul style="list-style-type: none"> <li>• Birth Defect Registry</li> </ul>   |   |

(Format adapted from Kovats et al., 2000)

The following are opportunities for the Vermont Department of Health to mitigate and to adapt to the health effects of climate change if increased funding and resources are designated.

### Opportunities for Primary Prevention

1. Organize a task force within the Vermont Department of Health to identify resources, develop plans and policies, and collaborate with other agencies or partners on efforts to reduce CO<sub>2</sub> emissions that will have immediate health benefits. Examples:



- Work with the Agency of Transportation on efforts to discourage motor vehicle idling;
- Work with the University of Vermont (Spire of Excellence) and Agency of Agriculture, Food & Markets on research and outreach concerning the agricultural, food production, and human nutrition impacts of climate change;
- Develop a model telecommuting and flexible sick leave policy that would allow employees to work at home in order to reduce CO<sub>2</sub> emissions from transportation, increase productivity, and keep illness from spreading in the workplace. A recent study revealed a 29.7% lower rate of working at the worksite while influenza-like illness symptoms were most severe among employees who had the ability to work from home (Rousculp et al., 2010); and,
- Consider methods to provide information to the public about the relative cost of different dietary choices in terms of CO<sub>2</sub> emissions. An estimated 25% of emissions in industrialized nations can be traced to food (Rosenthal, 2009), and foods lowest in associated CO<sub>2</sub> emissions are often more nutritious dietary choices.

2. Work to raise public awareness about the human health effects of climate change. Localize as much as possible to Vermont. Examples:

- Create a climate change and human health communication plan and web pages devoted to climate change on [healthvermont.gov](http://healthvermont.gov); and,
- Promote CO<sub>2</sub> emissions reduction strategies that have immediate health benefits, such as walking and biking to work or school, and healthy dietary choices that correspond with lower CO<sub>2</sub> emissions (more fruits, vegetables, and grains, and less meat and dairy). Promote locally-grown and sustainably-produced foods.

3. Work to provide public information about protective behaviors, such as use of sunscreen, and protective technologies, such as water testing, filtration, and treatment. Examples:

- Provide guidance to school administrators, nurses, and coaches about protective actions to take during extreme heat or other weather events; and,
- Coordinate public messages via the state’s Joint Information System managed by Vermont Emergency Management.

4. Develop event-specific Vermont Department of Health emergency plans, such as an extreme heat event plan, to append to the All-Hazards Emergency Preparedness Plan. Develop event-specific communication plans to append to the All-Hazards Crisis & Emergency Risk Communication Plan.

### **Opportunities for Secondary and Tertiary Prevention**

1. Evaluate and enhance current monitoring and surveillance systems needed to inform climate change adaptation strategies. Examples:

- Explain how climate change-related environment and health data will be used to identify data needs and guide selection of additional monitoring and surveillance variables;
- Consider updating reportable disease legislation to allow more key environment-related non-communicable diseases to be reportable;
- Revise the Early Aberration Reporting System (EARS) to include relevant environment-related health syndromes, such as heat stroke;
- Add selected environment variables that are indicators of climate change to the Vermont Environmental Public Health Tracking Program, such as temperature, extreme heat events, water supply quantity and quality, and flood plain maps;
- Add selected health variables related to climate change impacts to the Vermont Environmental Public Health Tracking Program, such as heat stroke and relevant vector-borne infectious diseases; and,
- Aggregate data with other states to analyze trends.



2. Identify and pursue funding opportunities to support this work.
3. Use data to quantitatively estimate health risks attributable to predicted climate change impacts.
4. Use the Health Alert Network to notify health care providers about rare and emerging health risks and illness that can result from climate change, including information about prevention, medication, and treatment.
5. Prepare for in-migration of people from areas affected worse by climate change impacts by reviewing and updating regulations for new buildings in compliance with healthy built environment research and regulations on well drilling with consideration of climate change impacts like increasing droughts and floods.

In summary, the Vermont Department of Health should develop a comprehensive approach for preventing the negative health effects of climate change, including plans for responding to events that

cannot be prevented and collection of surveillance data to monitor progress if increased funding and resources are designated.



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