Adapting to Vermont's Changing Climate

Route 7, 2011, Photo: K. Aurelius

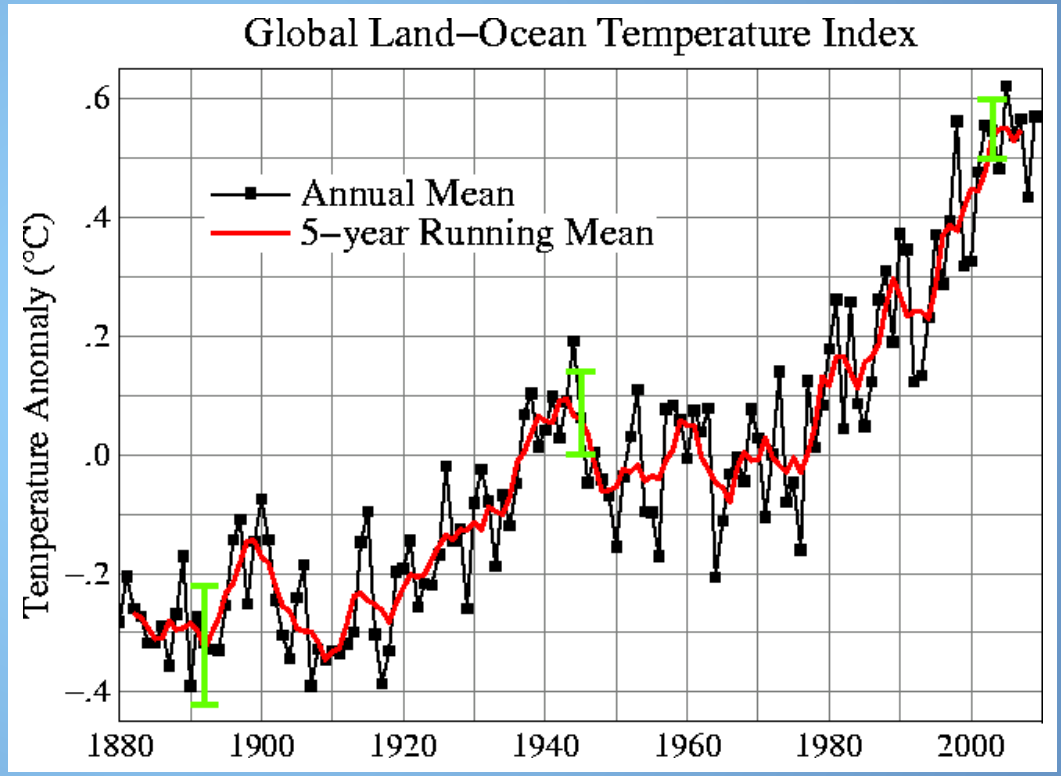
Brattleboro, 2011, Photo: N. Carreno

Kari Dolan, VT Ecosystem Restoration Program
December 3, 2011

VERMONT
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

Earth is Warming

The planet's average surface temperature rose by 1.4°F between the first decade of the 20th century (1900-1909) and the first decade of the 21st century (2000-2009), with the sharpest warming (~1.0°F) over the past three decades



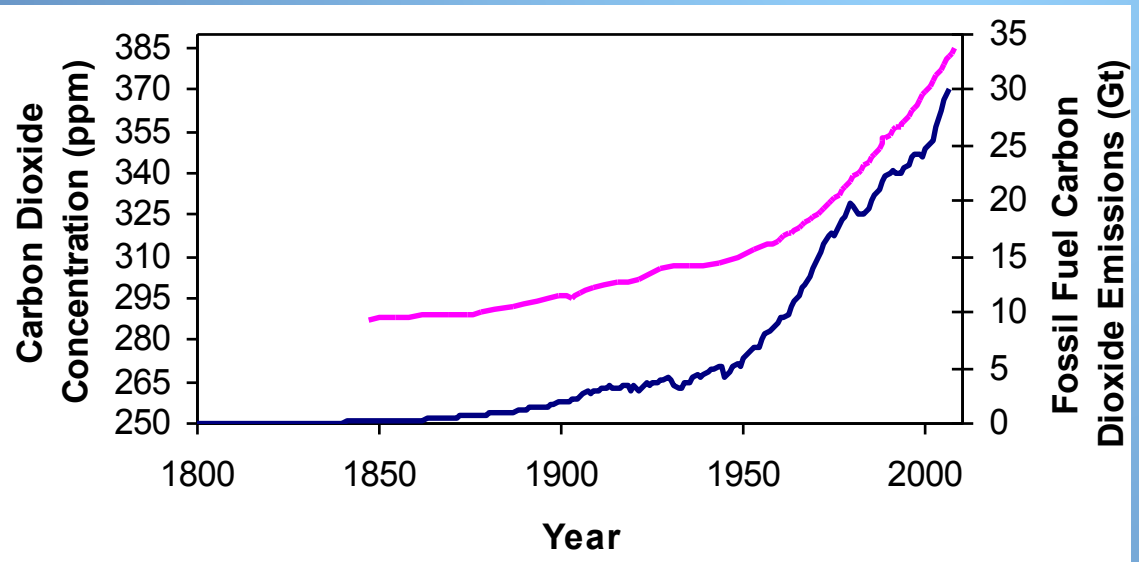
Source: NASA GISS 2010

Role of Human Activities

Most of the observed warming, especially over the last several decades, can be attributed to human activities.

This conclusion is also based on many lines of evidence, e.g.:

- Observed increases in carbon dioxide and other greenhouse gases can be unambiguously linked with human activities, especially burning fossil fuels for energy.



Based on data from Boden et al. (2009); Keeling et al. (2009); Neftel et al., (1994)

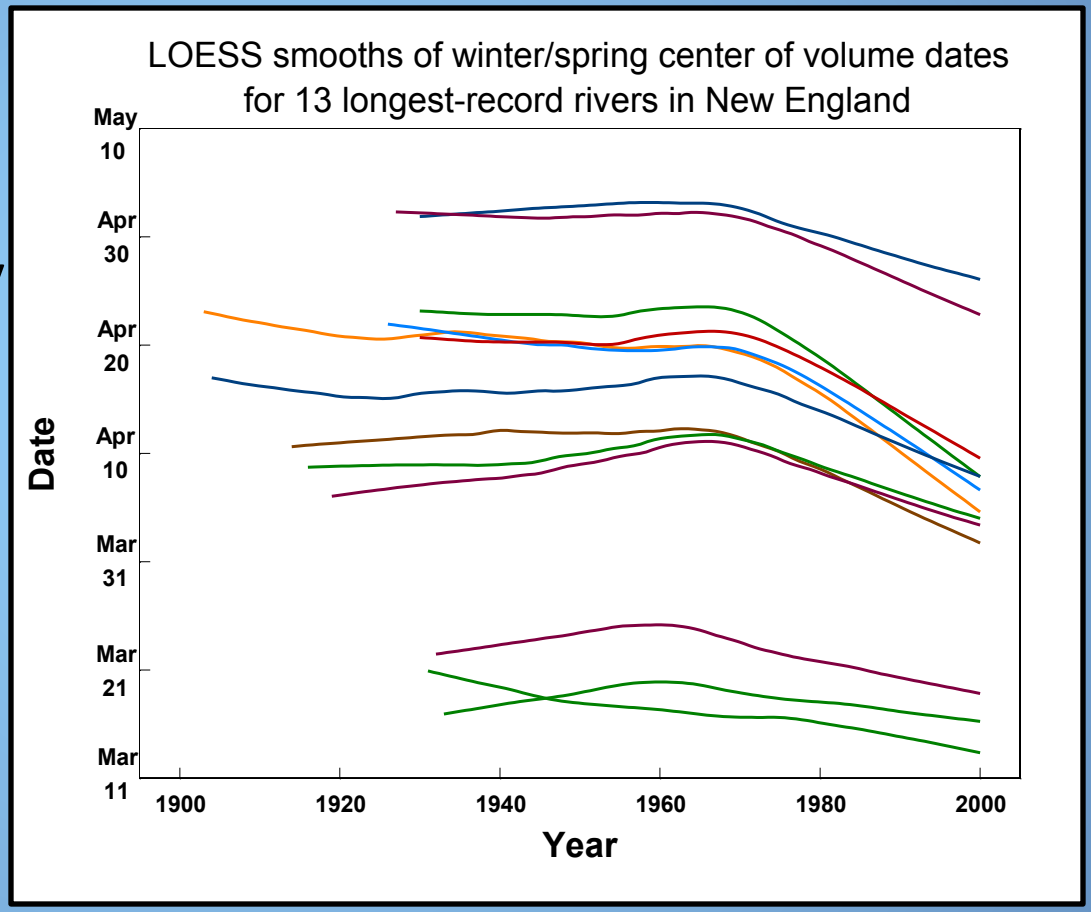
Atmospheric carbon dioxide concentrations (pink curve)

Carbon dioxide emissions from fossil fuel burning (blue curve)

Why Study Climate Change in New England?

Hydrology is Sensitive to Climate

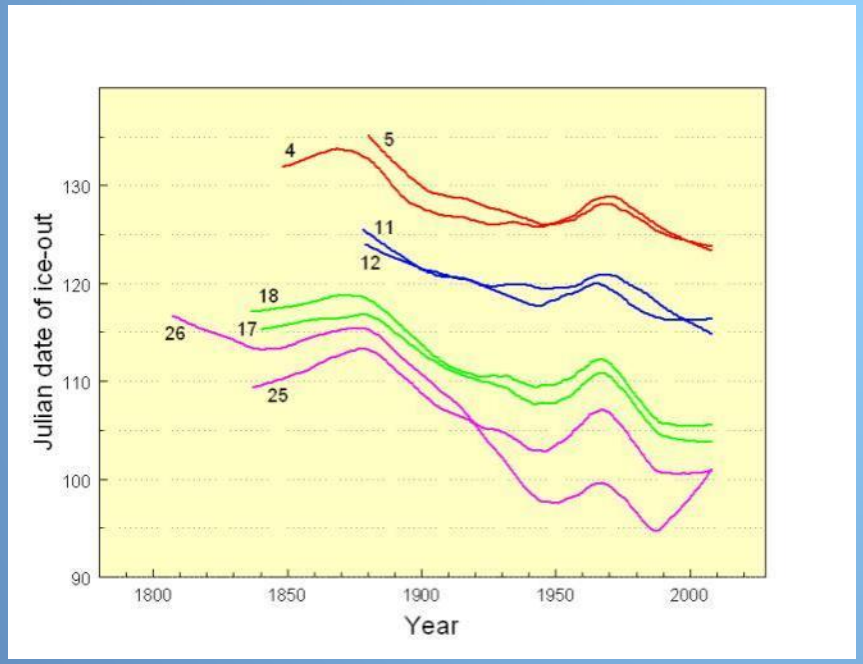
- Spring runoff dominates the annual hydrograph
- Occurring significantly earlier in northern New England in recent years
- Timing related to air temperatures

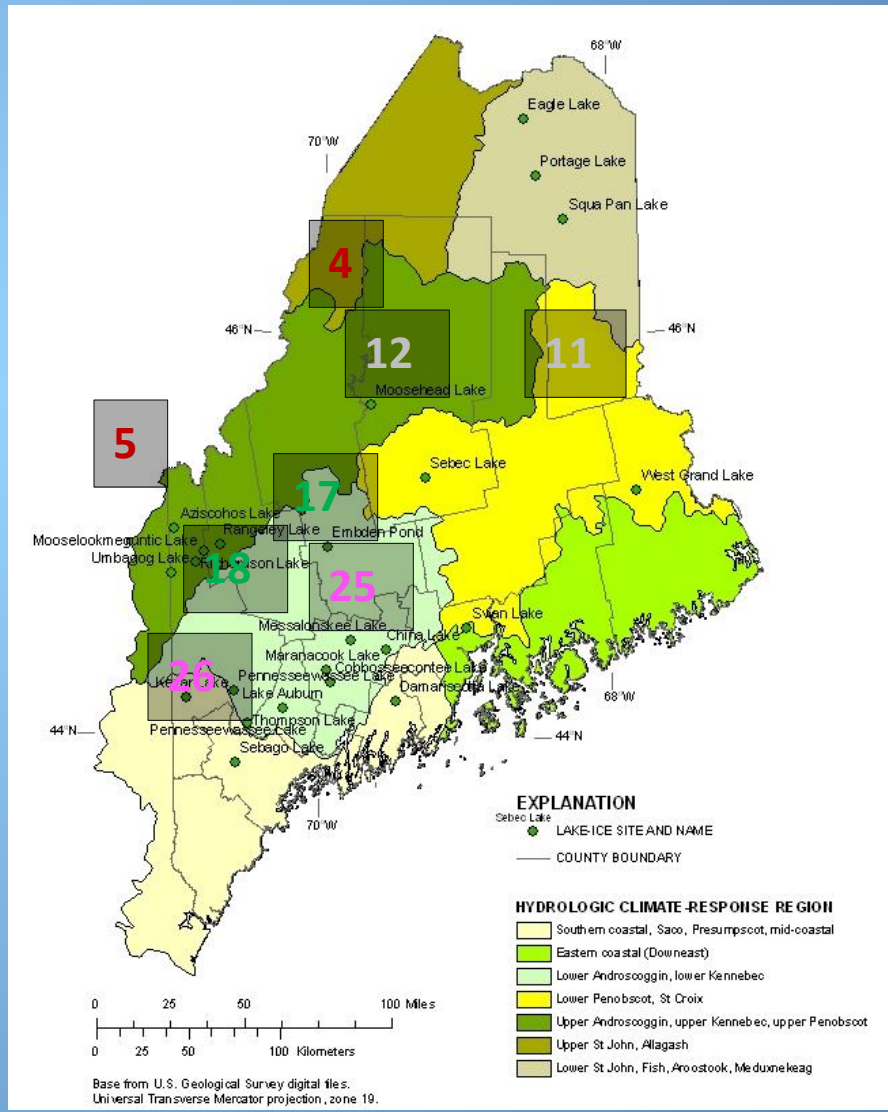


Hodgkins and others, 2003

Hydrologic Climate-Response Regions

- Historical changes in timing of lake ice-out dates, 1834-2008





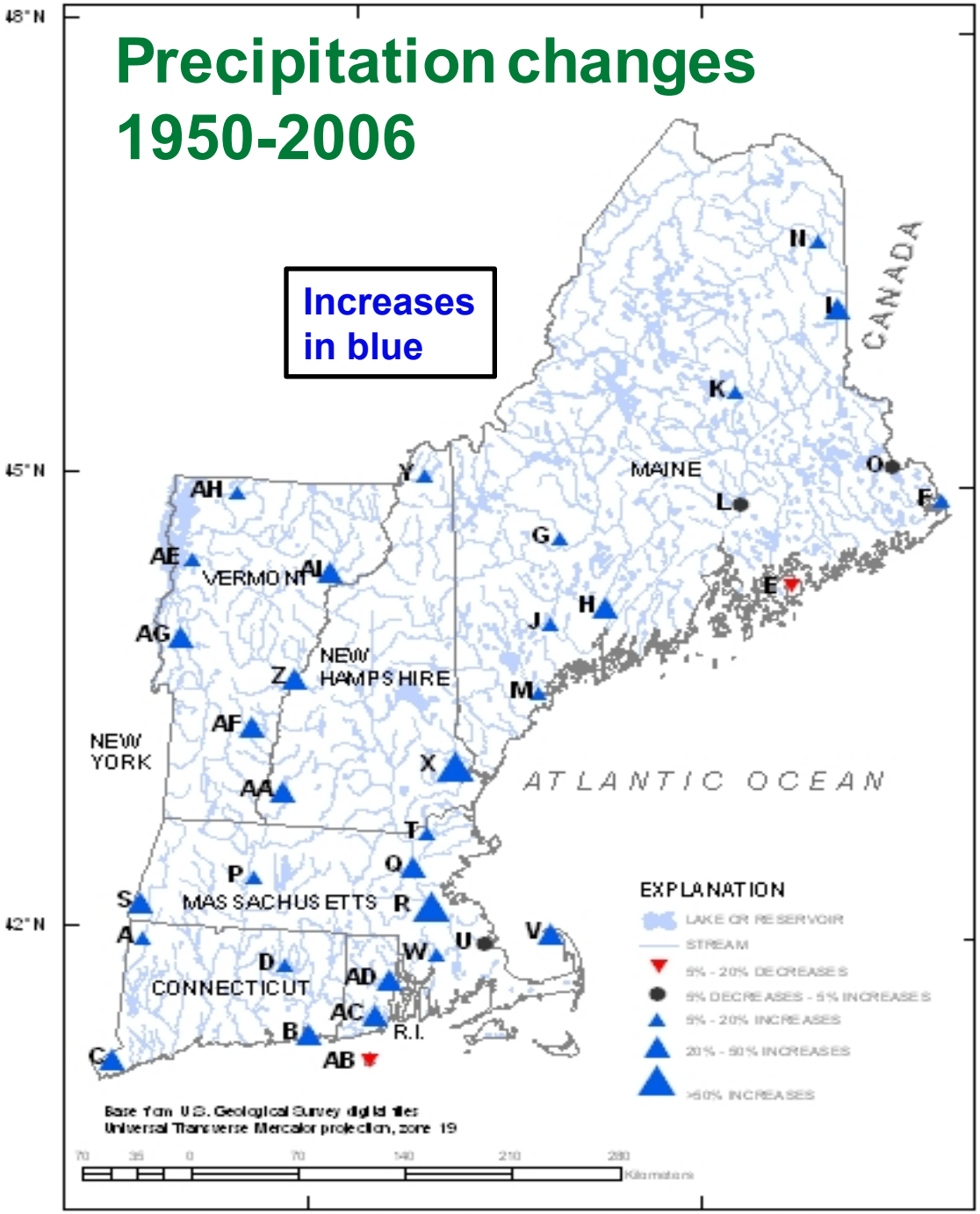


Figure 5. Geographic distribution of summer precipitation trends, 1950-2006.

Stormflow changes 1950-2006

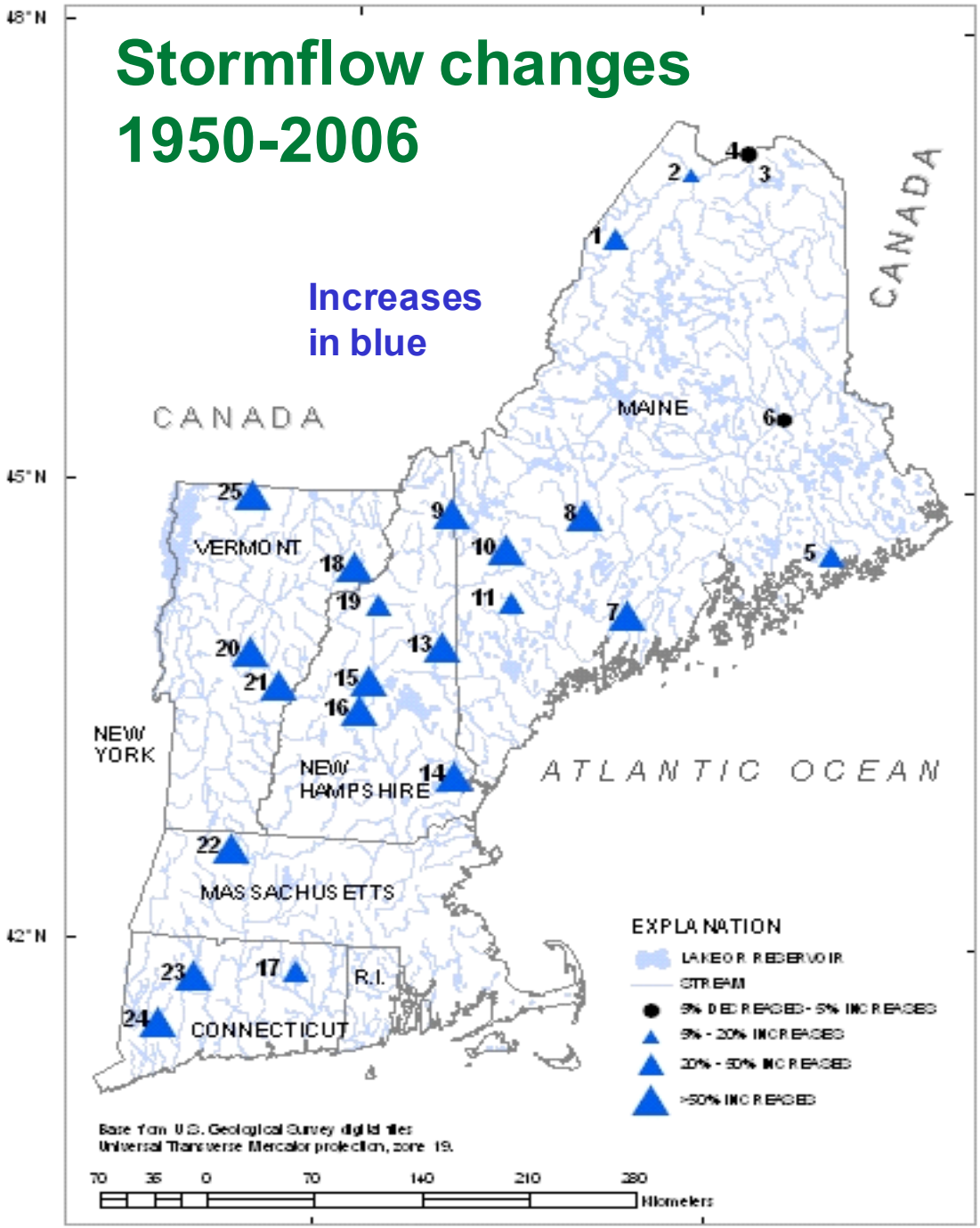
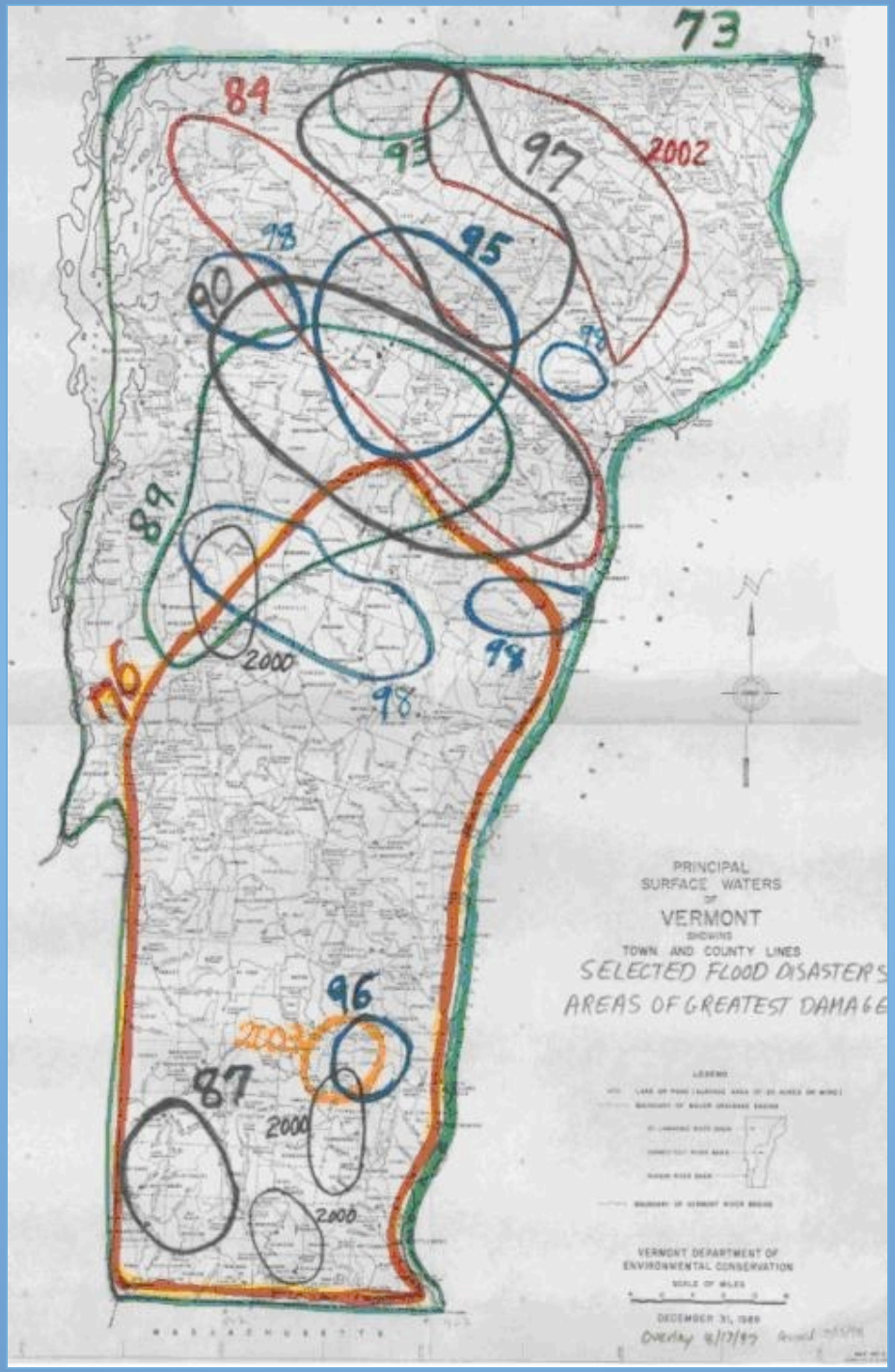


Figure 4. Geographic distribution of summer stormflow trends, 1950-2006.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PRINCIPAL
SURFACE WATERS
OF
VERMONT
SHOWING
TOWN AND COUNTY LINES
SELECTED FLOOD DISASTERS
AREAS OF GREATEST DAMAGE
LEGEND
VERMONT DEPARTMENT OF
ENVIRONMENTAL CONSERVATION
SCALE OF MILES
DECEMBER 31, 1969
Overlay 8/17/97

21 Federally Declared Disasters in VT 1989-2008

- Over $147 Million in Flood Recovery Costs (2008 dollars)
- $94 Million in FEMA-Related Costs
- $27 Million in State, Municipal Costs

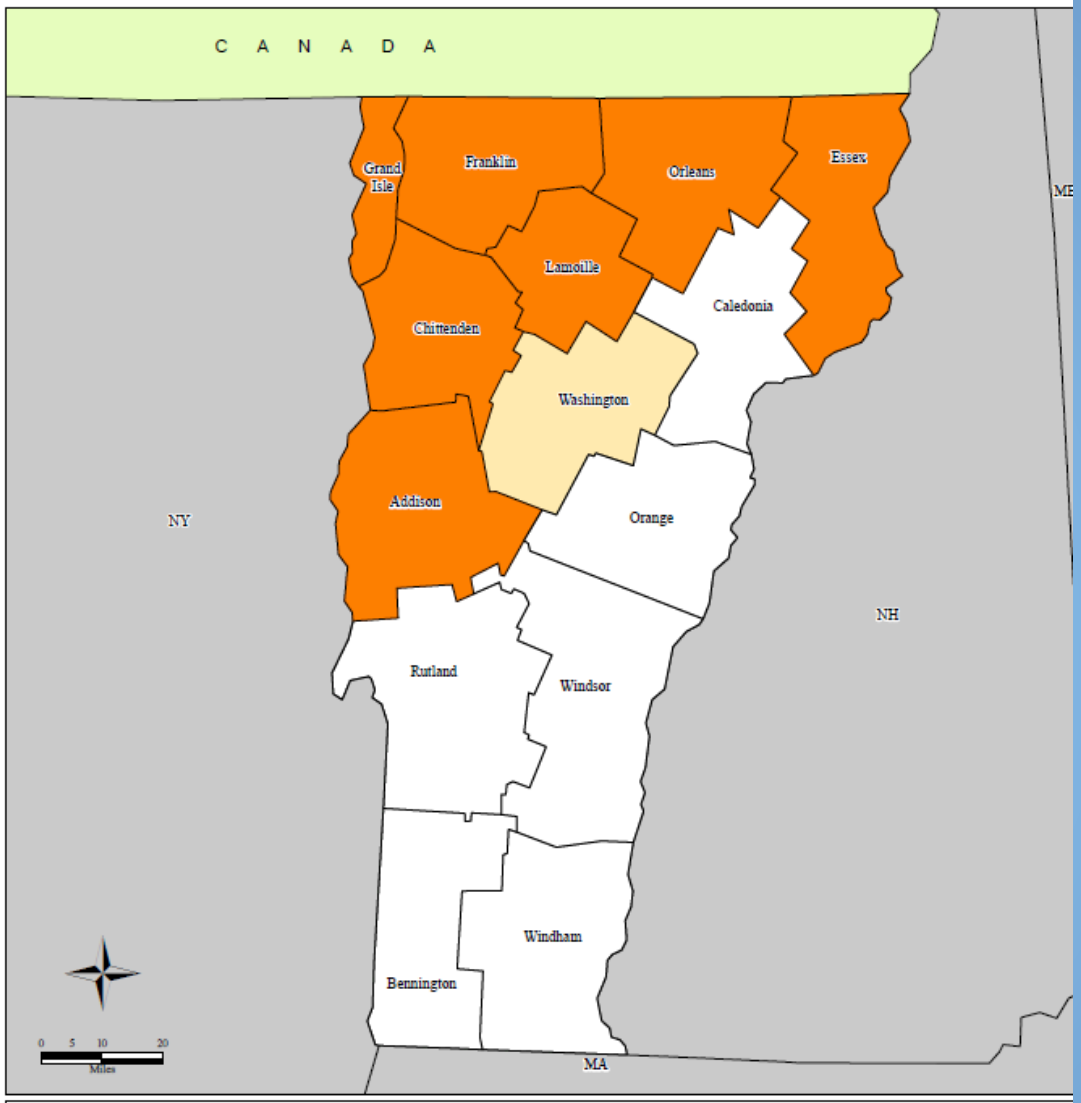

Settlement Brook, Cambridge, 1998


Tyler Branch, Enosburg, 1997


New Haven River, Bristol, 1998


West Hill Brook, Montgomery, 1997

FEMA-1995-DR, Vermont
Disaster Declaration as of 06/20/2011



Location Map

Legend

Designated Counties

- No Designation
- Public Assistance
- Individual Assistance and Public Assistance

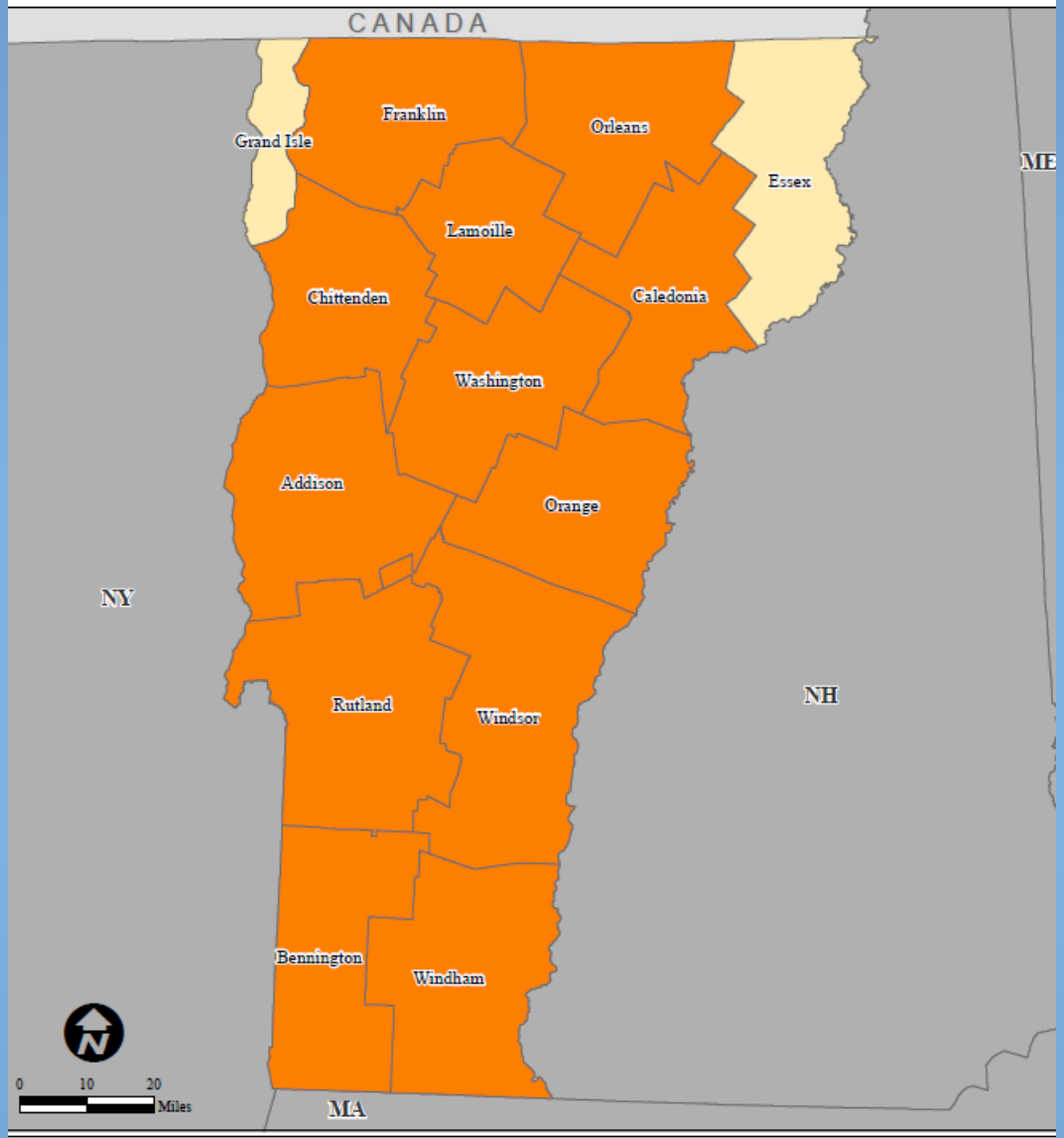
All counties in the State of Vermont are eligible to apply for assistance under the Hazard Mitigation Grant Program.

FEMA

ITS Mapping & Analysis Center
Washington, DC
06/20/11 -- 17:11 PM EST

Source: Disaster Federal Registry Notice 06/20/2011 - Amendment 1

FEMA-4022-DR, Vermont Disaster Declaration as of 09/16/2011



Location Map

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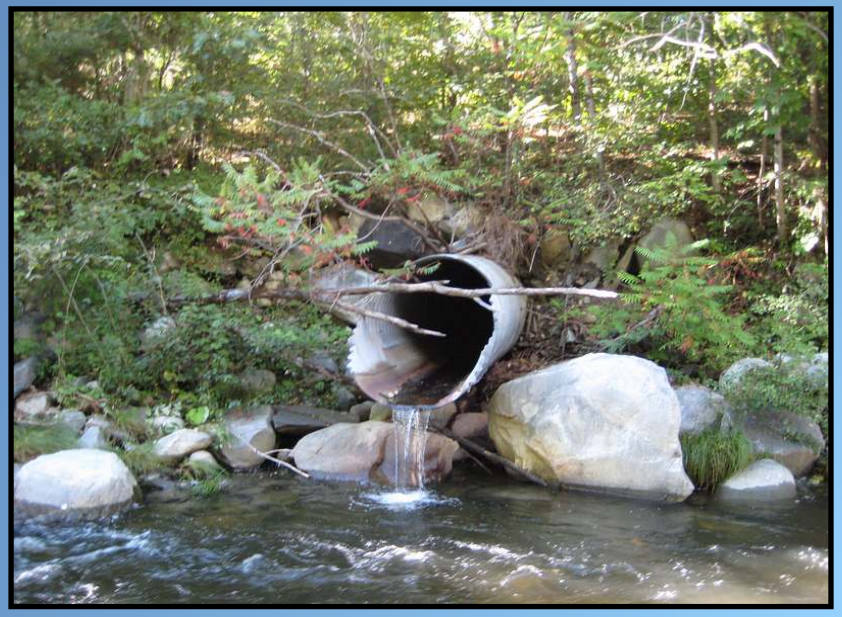
All counties in the State of Vermont are eligible to apply for assistance under the Hazard Mitigation Grant Program.

FEMA

ITS Mapping & Analysis Center
Washington, DC
09/16/11 -- 15:46 PM EST

Source: Disaster Federal Registry Notice Amendment No. 7: 09/16/2011

Exposure to flood events is increasing

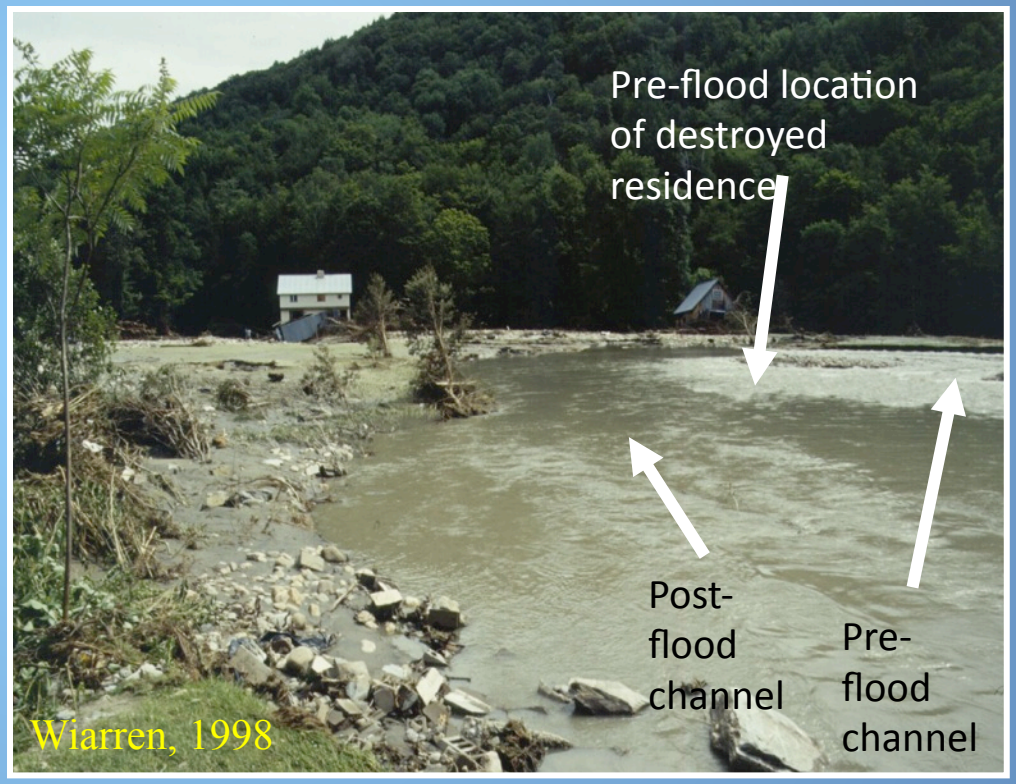


- Greater land development in susceptible areas
- Channels are enlarging due to stormwater conveyance
- Potential global climate shifts or cycles

Impacts of Climate Change

Example: Freshwater Resources

- The global water cycle is "speeding up", which tends to make wet places wetter and dry places drier.
- A higher fraction of rainfall is also coming in the form of heavy precipitation, which leads to flooding.
- Changes in snow and ice cover also affect water availability and quality.



- These changes create challenges resource managers in Vermont, the U.S. and worldwide

Irene: Lessons from an Extreme Event

- 500 miles of road and 200 bridges damages for cost of $175-350 million;
- Town road damages for 12 southern and central towns was over $1 million;
- Power outage for 72,000 customers
- 7,200 people registered for FEMA assistance;
- 4,900 structures were damaged;
- Hazardous waste spills increased by a factor of 14 in the first week of the flood;
- 9,200 acres of forest land were damaged;
- Approximately 20,000 acres of farmland were affected, resulting in an estimate crop loss of over $10 million
- 10 of VT's 17 major river basins experienced flooding;
- 14 trailer home parks sustained damage.

Flood's Devastating Consequences

Private Property

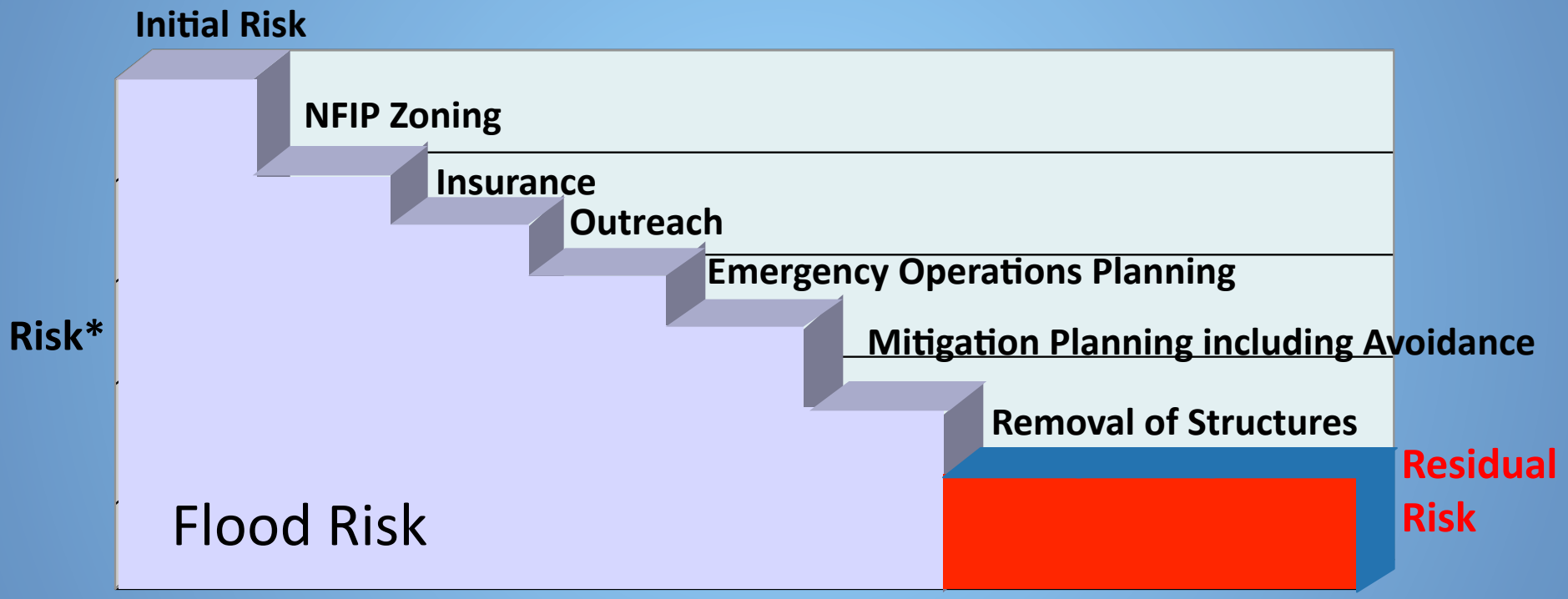
Consequences to Public Health and Safety


Vermont, 2011, Photo: N. Carreno

Quechee, 2011, Photo: M. Weinberg


Fayston, 2011, Photo: M. Trahan, Valley Reporter

Risk Management in an Uncertain World: Buying Down Risk, One Step at a Time



Risk Reduction Tools

* Risk = Probability x Consequences

Mitigation = Sustained Actions to Reduce Long-term Risks to People and Property

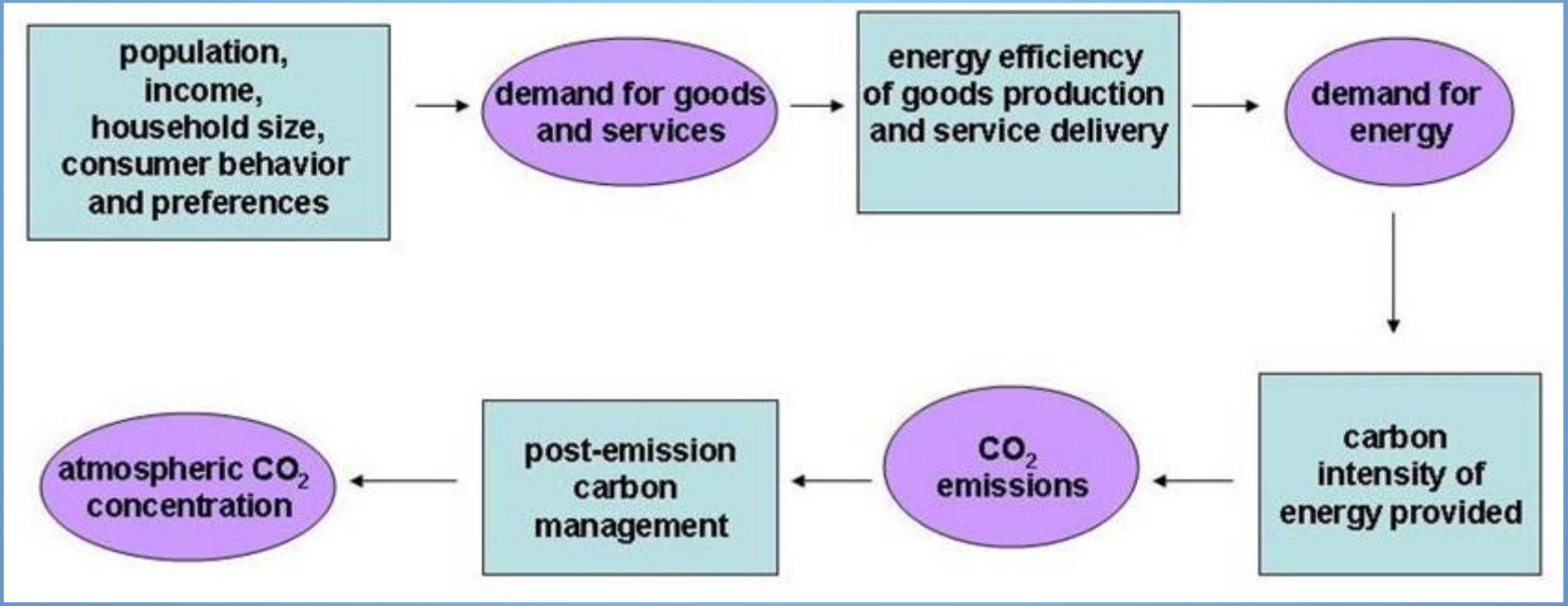
Responding to Climate Change

- **The details of future climate change may be uncertain, but there are clearly substantial risks to things people care about.**
- **There are some actions that can be taken—and in some cases are being taken—to reduce those risks.**
- **Two major categories of responses to climate change:**

  - Limiting the magnitude of climate change
  - Adapting to the impacts of climate change

Responding to Climate Change

Actions that can be taken to limit the magnitude of future climate change



Responding to Climate Change

- Developing and improving technologies, management strategies, and institutions to reduce net greenhouse gas emissions
- Supporting efforts to improve energy efficiency and energy choices in all sectors
- Improving understanding of behavioral and sociological factors related to the adoption of new technologies, policies, & practices (e.g., buying locally; supporting local agriculture)

People are Responding

For example, as of the end of 2009:

- 34 U.S. states have created climate change action plans, 20 have established emissions reduction targets, and 15 have developed adaptation plans
- Many U.S. cities and counties have also begun to respond to the challenges of climate change
- At least ten of the fifteen cabinet-level agencies and departments have made climate-related decisions
- 475 major companies had provided information on their carbon dioxide emissions to the Carbon Disclosure Project, over 60 major companies have set emissions reduction targets
- One in three Americans had rewarded companies that are taking steps to reduce greenhouse gas emissions by buying their products

Vermont is Responding

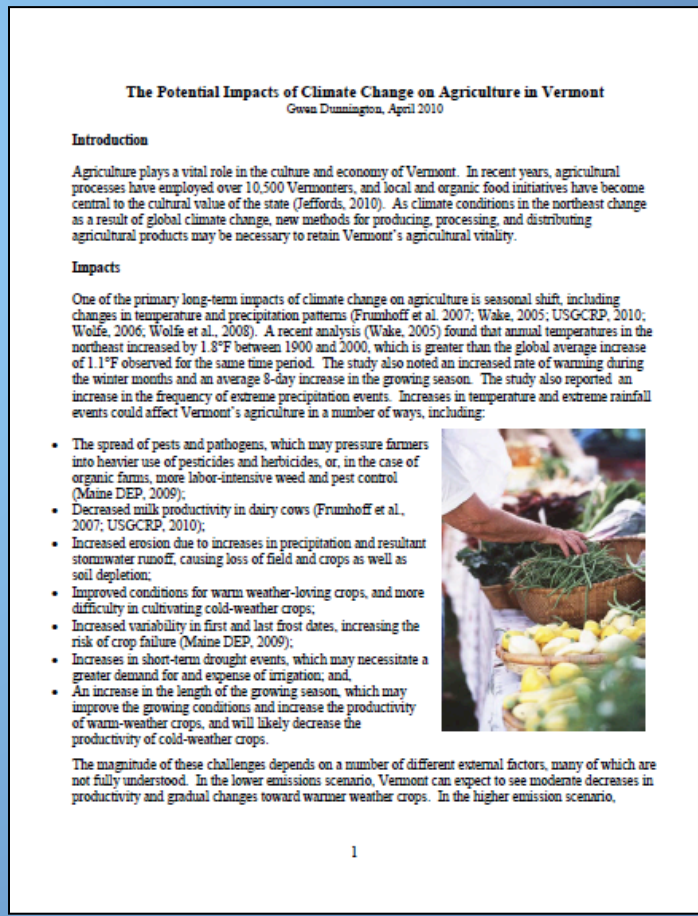
- Governor's Executive Order
- 2007 Governor's Commission on Climate Change Report
- New England Governors/Eastern Canadian Premiers Resolutions
- Climate Collaborative with UVM
- Governor Shumlin's Climate Cabinet
- Vermont Adaptation Strategy (under development)
- Vermont DRAFT Energy Plan
- Emissions Inventory
- Regional Initiatives

Climate Change Adaptation:

Strategies to reduce, minimize, or eliminate the adverse impacts of climate change on the natural and built environments.

Vermont's Climate Change Adaptation Planning Effort

- Adaptation Report /White Papers
  - Agriculture
  - Public Health
  - Public Safety
  - Water Resources
  - Fish & Wildlife
  - Forestry
  - Recreation
  - Transportation
- Adaptation Strategy Underway
  - Evaluate impacts
  - Identify vulnerabilities
  - Identify data needs
  - Review adaptation strategies



The Potential Impacts of Climate Change on Agriculture in Vermont

Gwen Dunnington, April 2010

Introduction

Agriculture plays a vital role in the culture and economy of Vermont. In recent years, agricultural processes have employed over 10,500 Vermonters, and local and organic food initiatives have become central to the cultural value of the state (Jeffords, 2010). As climate conditions in the northeast change as a result of global climate change, new methods for producing, processing, and distributing agricultural products may be necessary to retain Vermont's agricultural vitality.

Impacts

One of the primary long-term impacts of climate change on agriculture is seasonal shift, including changes in temperature and precipitation patterns (Frumhoff et al. 2007; Wake, 2005; USGCRP, 2010; Wolfe, 2006; Wolfe et al., 2008). A recent analysis (Wake, 2005) found that annual temperatures in the northeast increased by 1.8°F between 1900 and 2000, which is greater than the global average increase of 1.1°F observed for the same time period. The study also noted an increased rate of warming during the winter months and an average 8-day increase in the growing season. The study also reported an increase in the frequency of extreme precipitation events. Increases in temperature and extreme rainfall events could affect Vermont's agriculture in a number of ways, including:

- The spread of pests and pathogens, which may pressure farmers into heavier use of pesticides and herbicides, or, in the case of organic farms, more labor-intensive weed and pest control (Maine DEP, 2009);
- Decreased milk productivity in dairy cows (Frumhoff et al., 2007; USGCRP, 2010);
- Increased erosion due to increases in precipitation and resultant stormwater runoff, causing loss of field and crops as well as soil depletion;
- Improved conditions for warm weather-loving crops, and more difficulty in cultivating cold-weather crops;
- Increased variability in first and last frost dates, increasing the risk of crop failure (Maine DEP, 2009);
- Increases in short-term drought events, which may necessitate a greater demand for and expense of irrigation; and,
- An increase in the length of the growing season, which may improve the growing conditions and increase the productivity of warm-weather crops, and will likely decrease the productivity of cold-weather crops.

The magnitude of these challenges depends on a number of different external factors, many of which are not fully understood. In the lower emissions scenario, Vermont can expect to see moderate decreases in productivity and gradual changes toward warmer weather crops. In the higher emission scenario,

1

Vermont's Climate Change Adaptation Planning Effort

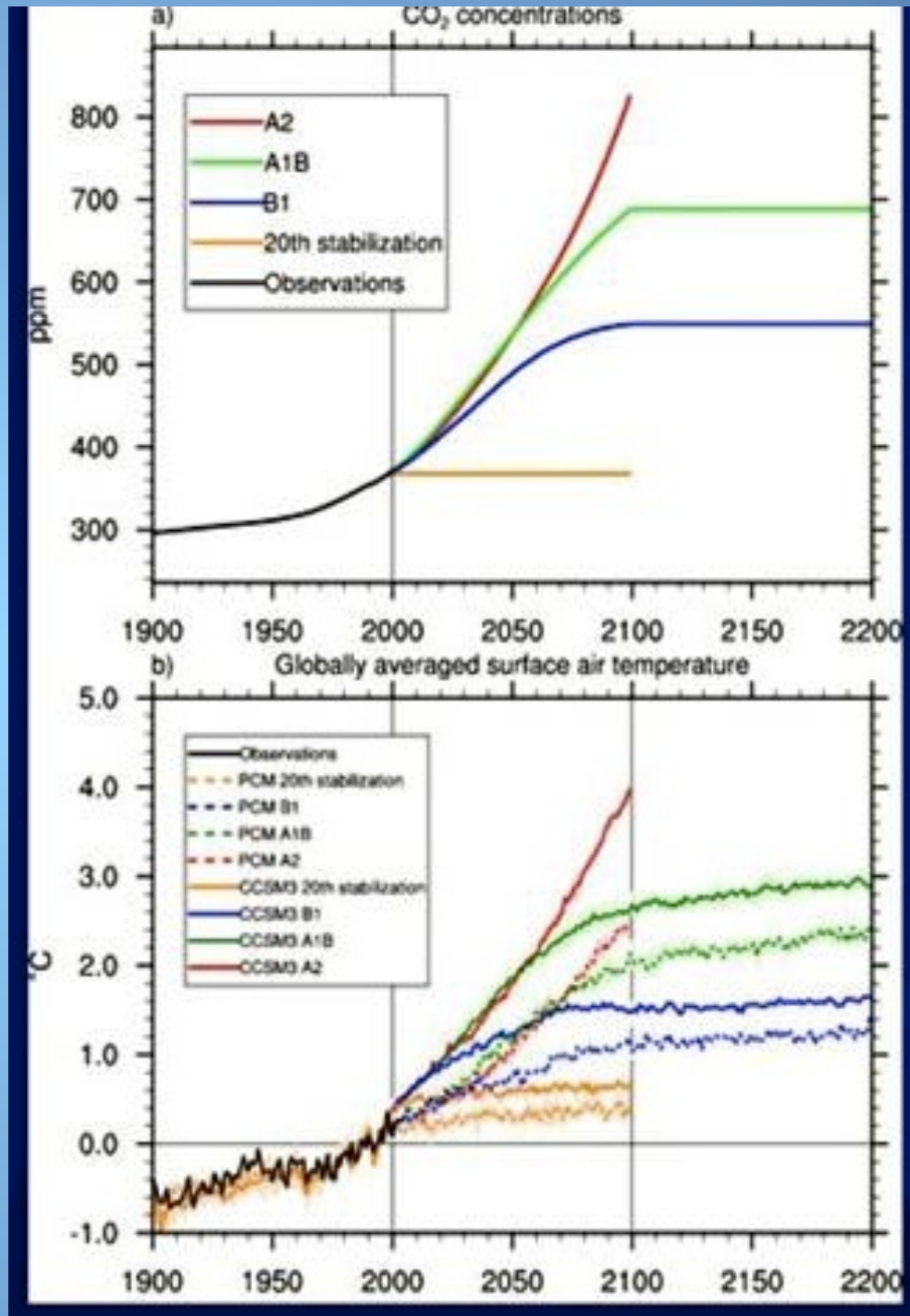
- Agriculture: Maple: $13.3 million/yr in NY and VT
- Public Safety
- Fish & Wildlife
- Recreation: $3.6 billion/yr in VT
- Public Health
- Water Resources
- Forestry: $14.4 billion/yr (NY, VT, NH, ME); $1 billion in VT
- Transportation

– Why take action for a small state? What makes sense to do to mitigate impacts of climate change also makes sense to do from a sound resource management perspective

Adaptation

Even if mitigation efforts are successful, climate change will continue to cause impacts due to current concentrations of CO2.

New or increasing environmental risks will require new adaptation strategies.



Responding to Climate Change

Some of the impacts of climate change are unavoidable (and indeed some changes are already underway), so it is important to begin adapting to the impacts of climate change.

Climate Change Adaptation Planning:

- Work with uncertainty

- Characterize impacts and vulnerabilities to the adverse effects of climate change

- Realize multiple benefits

- Improve resiliency

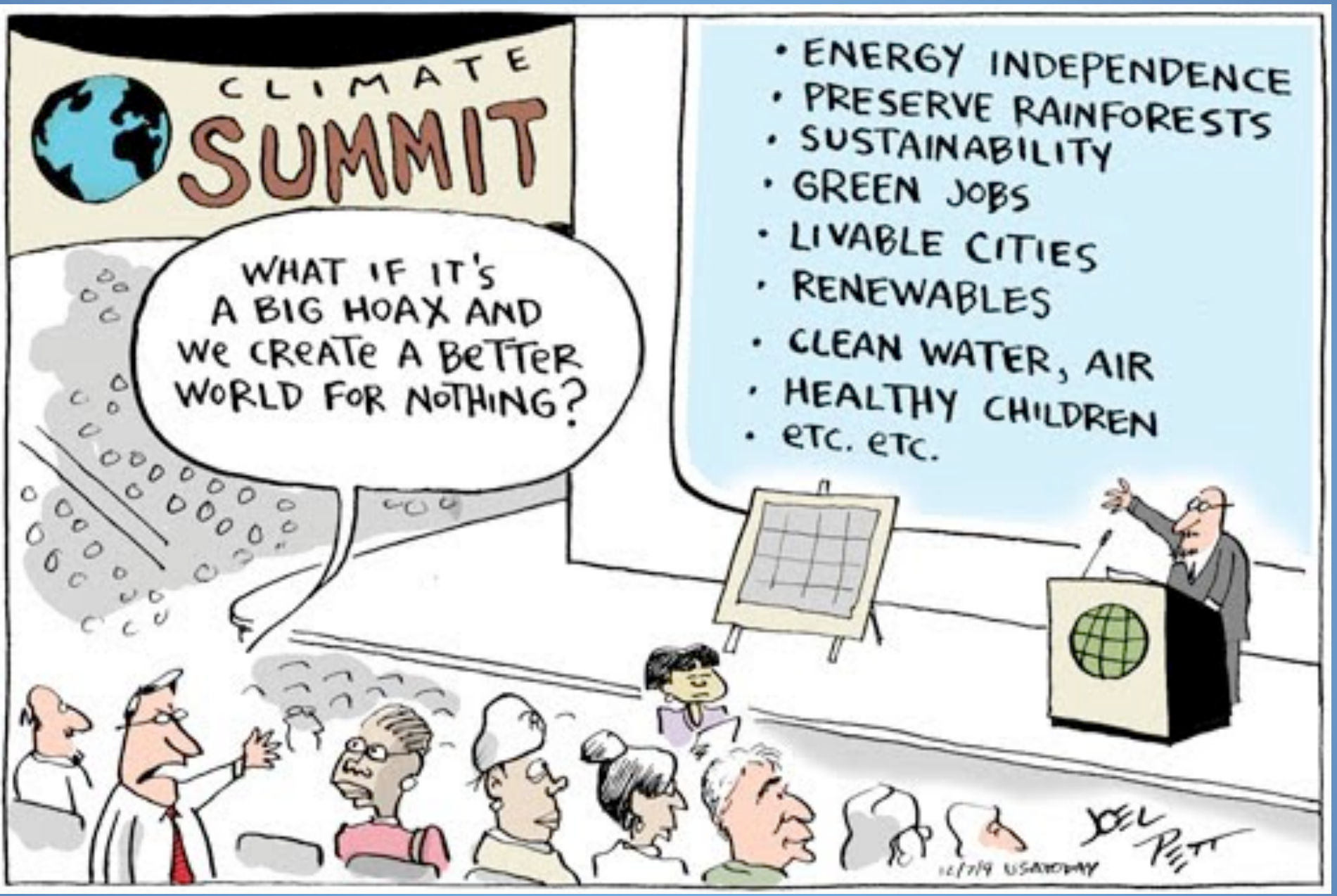
- Allow for recovery from the climate change impacts

For Example, Agricultural Sector Impacts Related to Climate Change

- Weather volatility
- Potential increase in the frequency of drought conditions
- Potential increase in the frequency of flood conditions
- Potential increased pest and disease pressures
- Economic consequences

Actions that Towns and Landowners Can Take for Adaptation

Desired Outcome	Recommendations
Adequate Baseflow	Promote infiltration of clean rainwater by "disconnecting runoff from stormwater collection systems using "Low Impact Development" techniques and "Green Infrastructure"
Stream shading	Buffers temp changes and aspect exposure (average, extreme, and timing)
Reduced impacts from unmanaged stormwater	Minimization of % impervious surface
Reduced flood risks by building local resilience	Adopt flood hazard and fluvial erosion hazard (FEH) bylaws that prohibit new development on floodplains and river corridors; protect and promote living lake shorelands; restore natural and beneficial functions of wetlands, river corridors, and floodplains
Reduced taxpayer costs associated with flood recovery	Promote use of larger stream crossings (open bottom, 1.2 X channel width during high spring runoff) and other flood hazard mitigation
Diverse refugia	Conserve with the focus on providing for refugia and multiple replicates of habitat types
Aware and Participatory Town Residents	Encourage the local school to participate in SWEEP's Environmental Literacy Program;
Reduction in Carbon Emissions	Promote energy efficiency across all sectors, buy locally


CLIMATE
SUMMIT
WHAT IF IT'S A BIG HOAX AND WE CREATE A BETTER WORLD FOR NOTHING?
• ENERGY INDEPENDENCE
• PRESERVE RAINFORESTS
• SUSTAINABILITY
• GREEN JOBS
• LIVABLE CITIES
• RENEWABLES
• CLEAN WATER, AIR
• HEALTHY CHILDREN
• ETC. ETC.
JOEL PETT
USATODAY

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- Dick Valentinetti, Director

  Air Pollution Control Division

  Dick.Valentinetti@state.vt.us, 802-241-3860

References and Publications available at our website:

http://www.anr.state.vt.us/anr/climatechange