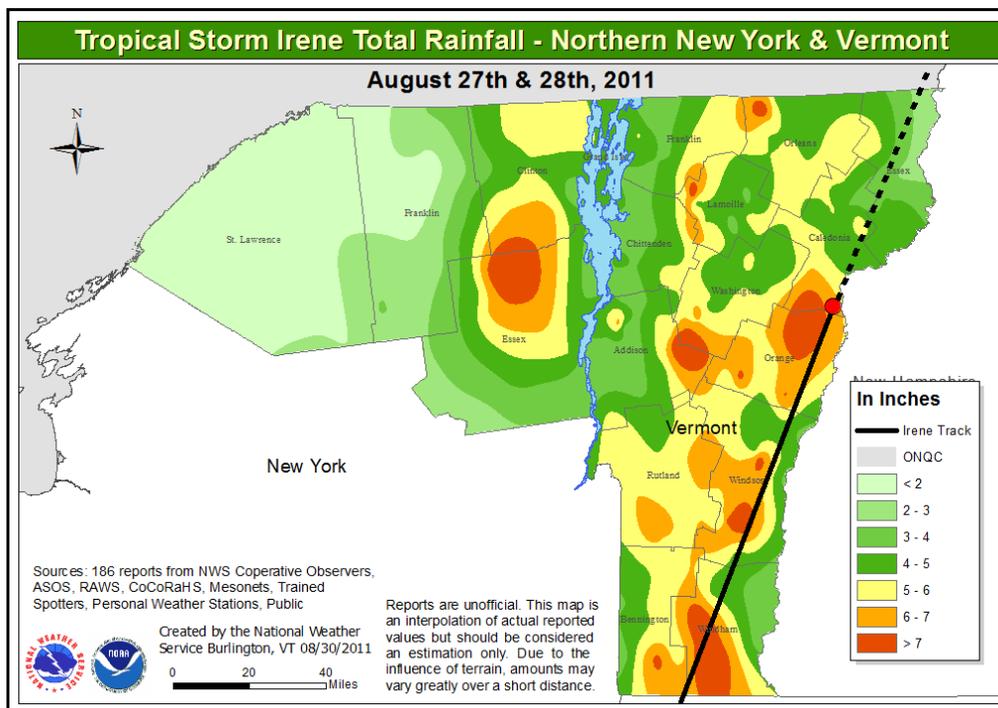


After Irene: Management, Policy, and Adaptation

Introduction

Tropical Storm Irene moved across coastal New Jersey, New York, western southern New England and eventually the Connecticut River Valley of Vermont during August 28th, 2011. In Vermont and Northern New York, Irene delivered copious amounts of rainfall which produced deadly record flooding resulting in several deaths and historic road, home, and infrastructure damage. 146 state roads were closed representing 519 miles, and an additional 2,260 local road segments were damaged. 34 state and 289 local bridges were damaged or destroyed.ⁱ The combination of flooding and damaging winds left at least 50,000 customers without electricity. The widespread flooding across Vermont is likely the second greatest natural disaster in the 20th and 21st century—the 1927 Flood being first—for Vermont.

Much of the area was affected by widespread tropical rainfalls of 4 to 8 inches with the heavier amounts over the steep mountain slopes resulting in widespread severe flash flooding especially in central and southern Vermont. Another reason for the extreme flooding in Central and Southern Vermont was that the soil moisture content was abnormally high in those areas—preceding Irene, Vermont and New England had moistures much higher than normal.ⁱⁱ



After touring some of the hardest hit areas, Gov. Peter Shumlin described the storm damage as "incomprehensible." He stated, "In the years to come, Irene will be the new benchmark, the weather event against which future high winds and rising waters will be measured."ⁱⁱⁱ

While there have been several historic floods in Vermont history (1927, 1938, and 1973), one need not look far in the media for coverage of extreme weather events across the region, country, and globe. A 2011 IPCC summary for policy makers says there is at least a two-in-three probability that weather extremes have already worsened because of man-made greenhouse gases. Specific to flooding it states

that “it is *likely* that the frequency of heavy precipitation or the proportion of total rainfall from heavy falls will increase in the 21st century over many areas of the globe.”^{iv} Locally, a 2010 report, “Climate Change in the Champlain Basin” states that the basin could receive as much as 4–6 inches more precipitation in an average year, with heavy storm events becoming more frequent.^v

Numerous policy and management questions have come to light post-Irene—one of the most controversial being the fairly widespread dredging of river gravels for road repair and river channelization activities that took place in the rush to rebuild. In addition to being detrimental to these fluvial systems, these were shortsighted actions. Policy and management questions need to be viewed not only through the lens of how to prepare for, manage, and mitigate damage from the next natural disaster, but also through the lens of what we should be doing differently in the context of a changing climate. Adapting to our changing conditions and managing for resiliency of our social-ecological systems should be the driving themes informing river management, zoning, and disaster preparedness policies of the future.

There are no fewer than 8 bills that various house and senate committees of the Vermont legislature are currently considering during the 2012 session to address some of these issues. These bills cover topics ranging from emergency stream alteration permits, regulation of flood hazard areas, zoning bylaws in areas of high fluvial erosion risk, and improving collaborative scientific input during permitting processes.

The Vermont Agency of Natural Resources’s River Management Division and Climate Change Action Team, the Vermont Natural Resources Council, the Vermont Agency of Transportation, the Addison County Regional Planning Commission, and local fluvial geomorphology consultants have all contributed to the below-listed project needs. Your work on these projects will not only advance and support the work of these agencies, organizations, and individuals, but it will also inform the ongoing legislative discussions.

Adaptation and Risk Management in the Face of a Changing Climate

Tropical Storm Irene provided a stark example of Vermont's vulnerabilities and the types of risks we need to try to mitigate through sound management policies. The Vermont Agency of Natural Resources' Climate Change Team has begun work on a Climate Change Adaptation Project with the goal of developing a state climate change vulnerability assessment and adaptation strategy. In addition to mitigating climate change through greenhouse gas reduction strategies, they feel that adaptation is the second component of any comprehensive climate response program. They define adaptation as, "measures taken to prepare for, respond to, minimize, or eliminate impacts to people, communities, and ecosystems that are associated with a changing climate."^{vi}

The IPCC Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX) approaches this topic by assessing the scientific literature on issues that range from the relationship between climate change and extreme weather and climate events to the implications of these events for society and sustainable development. Their assessment concerns the interaction of climatic, environmental, and human factors that can lead to impacts and disasters and options for managing the risks posed by impacts and disasters.^{vii}

An additional layer to risk management that we will be discussing in class is the concept of managing for resilience, which Walker and Salt, in their book Resilience Thinking (2006), define as "the ability of a system to absorb disturbance and still retain its basic function and structure."^{viii} Similar to Vermont and the IPCC's approaches, Walker and Salt acknowledge that we are all part of complex social-ecological systems and stress the importance of understanding the interactions among all components of our systems.

Your work on this project will help advance the development of the state's climate change vulnerability assessment and adaptation strategy by researching the following:

- 1) While there are some regional climate change vulnerability assessments and adaptation plans already completed (including for the northeast) how are other states across the nation either translating these regional assessments to state-level policy and/or conducting their own state-level vulnerability assessments? How do they approach risk management?
- 2) Are there examples of states that are already implementing adaptation strategies?
- 3) Are there models of adaptation options aimed at reducing impacts and improving resiliency?
- 4) Based on your findings from the above questions, what scope and scale of approaches seem most appropriate for Vermont? What components would you recommend incorporating into Vermont's strategy?

Planning and Rebuilding in the Face of a Changing Climate

One key question facing land use planners and engineers in the context of a changing climate and changing precipitation patterns is how to manage and account for these variables and uncertainty in their decision-making processes. This project will look specifically at flood-related decisions and planning.

At the state level, this question is very relevant to the Agency of Transportation. Chief Engineer for the AOT Richard Tetrault notes that “Understanding that our climate is changing and the frequency and intensity of storm activity likely will be greater in the next 100 years...it is prudent that as we rebuild we must also adapt.”^{ix} Considerations of “adaptive rebuilding” include location and types of bridges, types of roadways, and assessing community land-use patterns and zoning policies. The Vermont Natural Resources Council is also very interested in this question as they collaborate across their sustainable communities and water programs to bring sound information to land use planners. More locally, the Addison County Regional Planning Commission is urging towns to “drastically rethink their roads, public buildings and other infrastructure and get them out of the flood plain.”^x

Your research will support the efforts of these organizations by combining scientific assessments with policy research. Your findings will also inform the current legislative discussions of bills that address flood hazard areas. The work of this project group will include the following:

- 1) Repeat damage assessment: Using historical records and damage reports from Vermont’s major flood events (e.g. 1927, 1938, 1973, 2008 and 2011), document areas of repeated damage (properties, bridges, culverts, towns, etc.). You will work with our community partners to pick a geographic area of focus for this class and to develop an approach that could be replicated across the state.
- 2) As part of the policy discussion of how to deal with these repeatedly damaged areas, one key consideration is how to move critical infrastructure away from rivers. What are the necessary steps to put a plan in place that could be activated in response to the next big disaster (e.g. lining up landowner approvals, easements, purchases, Right-of-Ways, etc.)? This will include researching legal precedents & considerations, practical considerations (topography, alternate routes, pre-existing rights-of-way or Class 4 roads that could be improved to handle more traffic, etc). Look into the state or local laws (or federal laws & FEMA practices) that might need to be changed to permit or even incentivize this. Evaluate cost savings if these roads did not have to be rebuilt after every significant flood.

Documenting Physical Changes of River Channels

As we will read about in several articles, one of the more controversial activities that occurred during the rebuilding post-Irene was fairly widespread dredging of rivers for gravel to use as road material and straightening, channelizing, and armoring of rivers and streams. Brian Shupe, the Executive Director of the Vermont Natural Resources Council noted in a recent article that “we’ve learned from river science that gravel removal, and straightening and channelizing rivers, all pose greater risks to property. Those techniques starve the river of sediment and increase the velocity of floodwaters, which undermines streambanks and bridge abutments. Dredging puts property owners near the river at higher risk and results in significant ecological damage. It is a tough issue. It is counterintuitive to many people, but extracting gravel actually can increase, not reduce, flood risks. Dredging is a short-term fix that creates long-term problems.”^{xi} In addition to the issues of future flood risk, these activities also resulted in dramatic alterations of aquatic habitat and biotic communities.

Our partners believe that working towards flood resiliency is a key priority for Vermont and should be the focus of legislative action as well as local and regional planning. In order to build flood resiliency in Vermont, scientific research needs to be incorporated into our policies and mitigation strategies. Walker and Salt again provide some useful insight for us here with their statement, “The key to sustainability lies in enhancing the resilience of social-ecological systems, not in optimizing isolated components of the system.”^{xii}

This project will help provide additional scientific evidence to ongoing legislative discussions and will help the state work towards “resilience thinking” by:

- 1) Documenting the historical changes in a series of river channels, the locations of which you will choose in conjunction with your community partners. This will include documenting how river channels have naturally moved/migrated over time as well as documenting pre- and post-Irene channel locations.
- 2) Based on your channel research as well as the repeat damage assessment work of Project #2, develop a series of case studies looking at damage in certain locations. For each location these case studies should include historical river management practices (if any), the cost involved in implementing these practices, how the river responded to these practices, and how we should proceed with future practices. This will help provide a historical context for the impact of different management techniques on river channel migration.
- 3) How can these documented changes over time and your case studies inform our river management and land-use planning strategies moving forward?

Psychology / Sociology of Disaster Recovery

In addition to floods of historic proportions like the ones caused by Irene, flooding is a common problem for the state. Since 2000, FEMA has declared nine major flooding-related disasters in Vermont. Floodplain maps are used by policymakers, insurers, and developers to determine probability and to make development decisions. However, the FEMA maps—based on a gradual inundation model—used to determine flood zones and assess risk are far from perfect. In Vermont, most floods occur as flash floods rather than as more gradual inundation events. The Fluvial Erosion Hazards Program, adopted in 2003 by the River Management Program of the Vermont Agency of Natural Resources, has been working with communities to produce maps that more accurately assess the risk of flood hazard given the specific geomorphology of Vermont's rivers. To date, fluvial erosion hazard (FEH) zones have been produced for the towns of Middlebury, Ripton, Lincoln, Bristol, New Haven, and Starksboro in the Addison County region.^{xiii} One purpose of designating these zones is that towns would then restrict activities—development or other—in these zones through local zoning bylaws with the goal of protecting lives and property.

A current bill in front of the state legislature, H.466, aims to take this a step further. It proposes mandatory fluvial erosion hazard zoning bylaws “limiting structural encroachment” in areas with “high probable risk of harm to life, property, or infrastructure.” While mandatory zoning bylaws are not likely to be politically palatable, the root question remains the same – how do we encourage people not to build / rebuild in floodplains?

There has been a wide range of responses from landowners affected by Irene that the state seeks to understand. Some have left their devastated properties and never wish to return; others insist on rebuilding regardless of the advisability of doing so based on science, flood probability, and risk assessment. Shedding light on the psychological and sociological factors behind these endpoint reactions and those in between will help our partners engage the public more successfully and inform their decisions and policies in a more holistic manner.

Your work on this project will include:

- 1) Identifying the demographics of floodplain residents. Then identify if certain demographic factors determine who wants to rebuild versus who looks to resettle elsewhere (e.g. long-time vs. seasonal residents, family ties to a piece of property, economic factors that prohibit buying land / property elsewhere).
- 2) What can you learn about the thoughts and motivations behind people's decisions to rebuild or move from stories? Many personal stories were documented in newspapers across the state as well as through the Vermont Folklife Center post-Irene, and archived stories from past-floods can also be drawn upon. Are there common threads or themes that emerge?
- 3) Potentially through a survey tool or interviews, can you identify what floodplain residents identify as an acceptable level of risk? Does this acceptable level of risk vary with demographic factors (e.g. low-risk tolerance, but cannot move due to other factors vs. high-risk tolerance and unwilling to move even if they could)?

Notes

ⁱ October 9, 2011. The Burlington Free Press. "A look at the damage Irene caused to Vermont's roads and bridges".

ⁱⁱ <http://www.erh.noaa.gov/btv/events/Irene2011/>

ⁱⁱⁱ September 1, 2011. The Burlington Free Press. "Tropical Storm Irene an 'historic' disaster".

^{iv} IPCC, 2011: Summary for Policymakers. In: Intergovernmental Panel on Climate Change Special Report on Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation. Field, C.B. et al., eds. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA

^v The Nature Conservancy, "Climate Change in the Champlain Basin: What Natural Resources Managers Can Expect and Do," 2010.

^{vi} <http://www.anr.state.vt.us/anr/climatechange/AdaptationRFP.html>

^{vii} IPCC, 2011. Ibid.

^{viii} Walker, B and Salt, D. (2006). Resilience Thinking: Sustaining Ecosystems and People in a Changing World. Island Press.

^{ix} November 13, 2011. The Burlington Free Press. "As we rebuild we must adapt."

^x December 1, 2011. The Addison County Independent. "Irene repairs offer chance to really fix infrastructure".

^{xi} January 8, 2012. The Burlington Free Press. "Brian Shupe: We need to focus on river science and what it tells us about how to manage land use."

^{xii} Walker and Salt (2006). Ibid.

^{xiii} Spring 2011 ENV5 0401 report, "Phosphorus Loading in Lake Champlain: A geographic, environmental, civic and economic investigation into its causes, effects, and prospects for the future." Available at:

http://www.middlebury.edu/media/view/276855/original/final_compiled_small.pdf