STONE ENVIRONMENTAL

Community Resilience Using Web-based Tools

May 20, 2016

Presented by David Healy

Resilient Vermont: 2016 Conference

Contents

Background

Climate Resilience App Challenge – June 1-15, 2014

- Esri Sponsored app challenge in response to The President's Climate Action Plan
- Goal: "Develop game changing apps that promote climate resilience."
- Awarded a Runner Up
- Judges commented "…its nationwide scope in using data that provided for "large scale analysis in many areas"…in terms of "scientific vigor", this was the strongest app we received."

UNISDR
The United Nations Office for Disaster Risk Reduction

esri

THE WHITE HOUSE
WASHINGTON

Background

Global Disaster Resilience App Challenge - August 15-27, 2014

- Esri sponsored app challenge in collaboration with the UN's Office for Disaster Risk Reduction (UNISDR) Making Cities Resilient Campaign

- Goal: "Design an app around one or more areas on the United Nations 10 Essentials for Making Cities Resilient list. Explore all angles to reducing *urban risks."*

- App could be for everyday citizens or for policy and planning purposes

- Judges commented "…well worth noting as tools for assisting communities."

Background

HackVT 24-Hour Energy Innovation Competition – October 13-14, 2014

- HackVT sponsored app challenge in collaboration with Green Mountain Power, MyWebGrocer, Dealer.com, and FairPoint Communications
- Goal: “develop digital products, apps, and websites that support the state's vision of an affordable, efficient and renewable energy future for all Vermonters.”

Background

Stone App Development Team

- All 10 members of Stone's Applied Information Management (AIM) Group worked intensively together over a two-week period to develop each of the Esri sponsored applications.
- Four members of the AIM Group worked over 24 hours for the HackVT sponsored application.
- The Group is made up of GIS Scientists, Database Programmers, Web Developers, and Modelers.

Modeling Community Erosion from Climate Change

Response to the Esri Climate Resilience App Challenge – June 1-15, 2014

Help community members understand erosion risk as a result of climate change

Evaluates:

- changes in annual total erosion as a result of climate change
- seasonal variations in erosion
- soil losses due to extreme precipitation events
- erosion estimates based on land use change
- uncertainty in future climate predictions

CORE CAPABILITIES USED

GIS/Modeling Web Application

- MUSLE erosion modeling
- Climate change model analysis

Key Tools:

- ArcGIS Server (custom geoprocessing services,map services, image services)
- ArcGIS JavaScript API
- ArcSDE
- Python and ArcPy
- NetCDF python libraries
- ArcGIS REST API
- Google Charts
- PostGreSQL
- jQuery

URL:

- http://erosion.stone-env.net

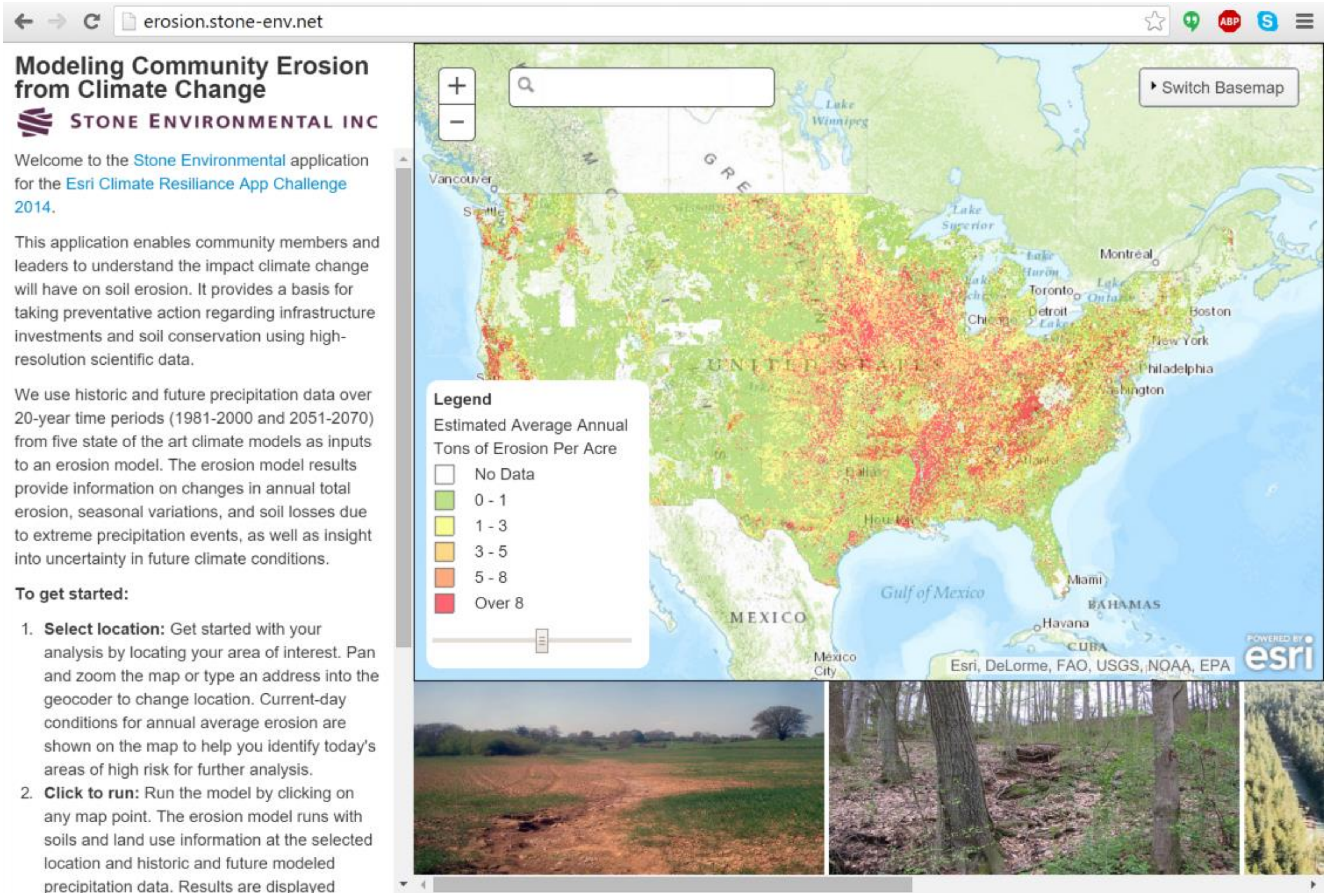
Modeling Community Erosion from Climate Change

Erosion estimates are based on:

- historic precipitation data over a 20-year time period (1981-00)
- predicted future precipitation over a 20-year period (2051-70) based on 5 climate models
- Modified Universal Soil Loss Equation (MUSLE)
  - Soil factors (SSURGO)
  - Landscape factors (SSURGO)
  - Land use (NLCD)
  - Dynamic storm-based runoff

Erosion from Winooski River into Lake Champlain, 2015, Airshark

Modeling Community Erosion from Climate Change



Modeling Resilience to Stormwater During Extreme Events

Response to the Global Disaster Resilience App Challenge - August 15-27, 2014

Help cities understand high risk areas due to runoff accumulation in relation to key infrastructure, public and residential buildings, and flood zones

Evaluates:

- storm-based runoff
- location of key infrastructure

CORE CAPABILITIES USED

GIS/Modeling Web Application

- Stormwater modeling
- Extreme precipitation analysis

Key Tools:

- ArcGIS Server (custom geoprocessing services,map services, image services)
- ArcGIS Desktop
- ArcGIS Server (custom geoprocessing services, dynamic and cached map services)
- ArcGIS JavaScript API
- ArcSDE
- ArcPy Python libraries
- ArcGIS REST API
- Google Charts
- jQuery
- json Python library
- numpy Python library

URL:

- http://runoff.stone-env.net

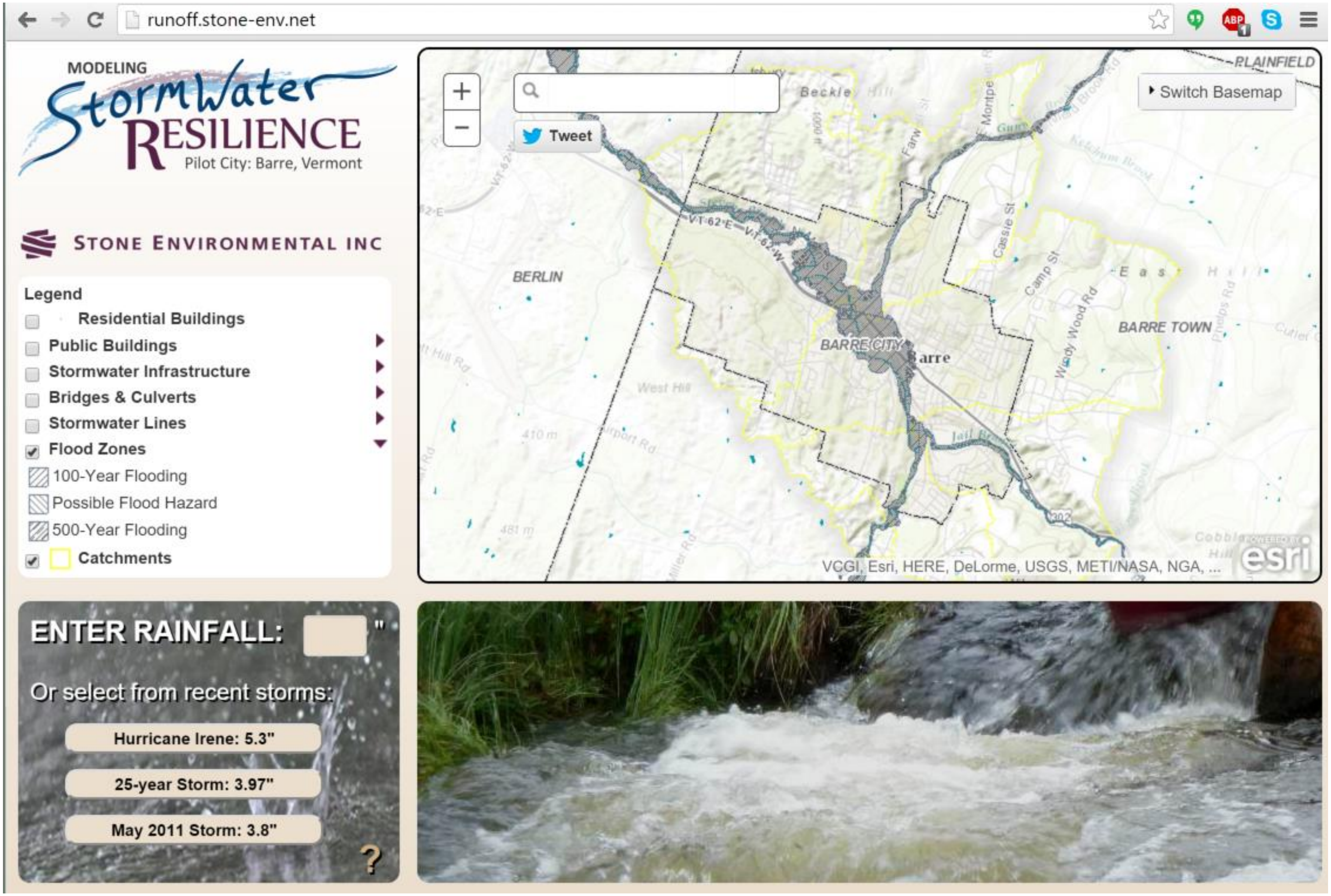
Modeling Resilience to Stormwater During Extreme Events

Runoff estimates are based on:

- user defined storm
- baseline storm (10-year, 24-hour)
- Soil Conservation Service (SCS) Curve Number Method:
  - Soil factors (SSURGO)
  - Landscape factors (NHD+)
  - Land use (NLCD)

Culvert Failure During Tropical Storm Irene in Townshend, Army Corps of Engineers

Modeling Resilience to Stormwater During Extreme Events



Vermont Solar Sandbox

Response to the HackVT 24-Hour Energy Innovation Competition – October 13-14, 2014

Help communities understand local solar potential and impact of solar installations

Evaluates:

- potential energy generation of solar installations
- compares to local energy needs

CORE CAPABILITIES USED

GIS/Modeling Web Application

- Solar modeling

Key Tools:

- ArcGIS Server (custom geoprocessing services,map services, image services)
- ArcGIS Desktop
- ArcGIS Server (custom geoprocessing services, dynamic and cached map services)
- ArcGIS JavaScript API
- ArcSDE
- ArcPy Python libraries
- ArcGIS REST API
- Google Charts
- jQuery
- json Python library
- numpy Python library

URL:

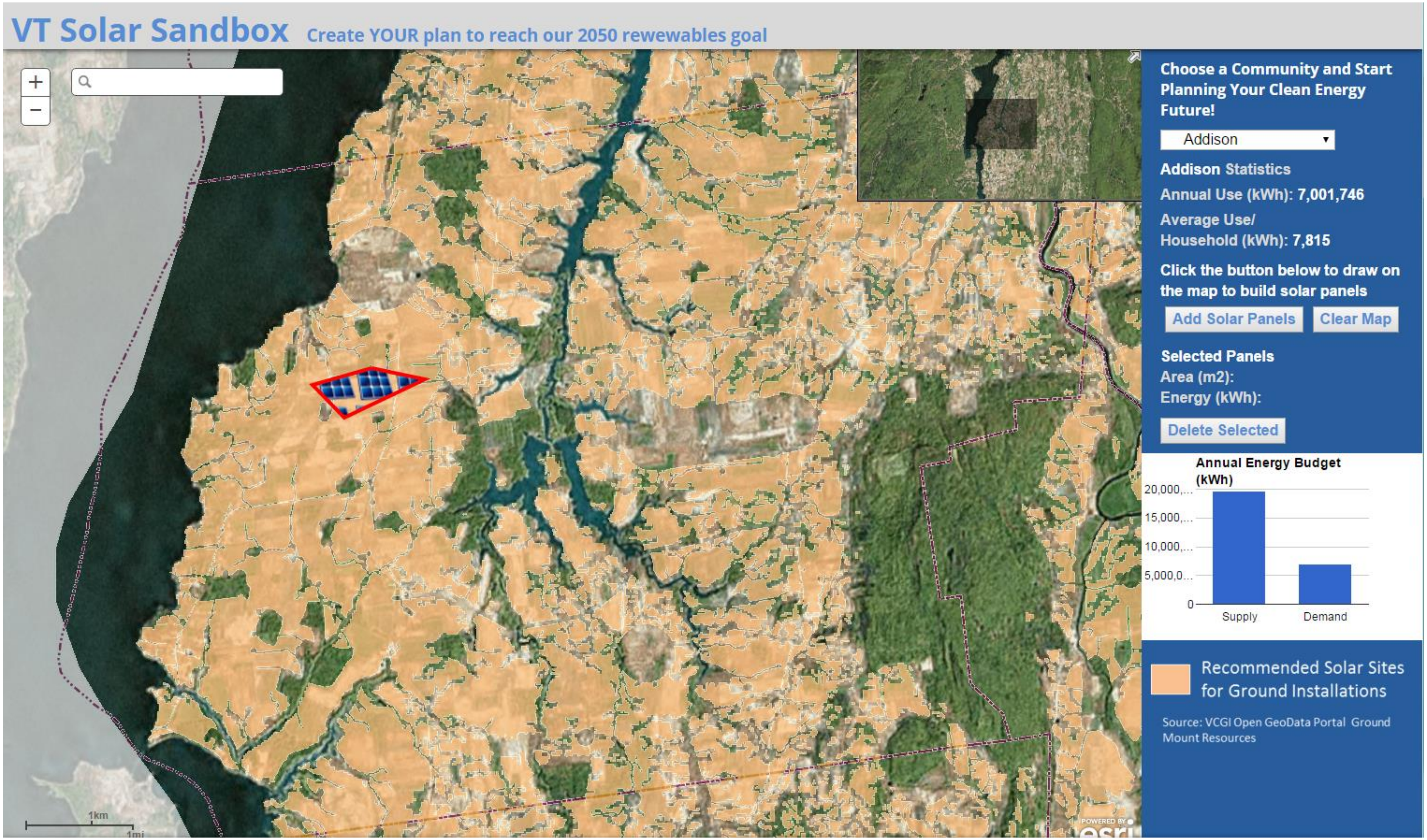
- http://energy.stone-env.net

Vermont Solar Sandbox

Solar production estimates are based on:

- user defined areas
- energy production estimates of solar panels for residential or commercial installations

Vermont Solar Sandbox



Outcomes

Push to use and test out available tools

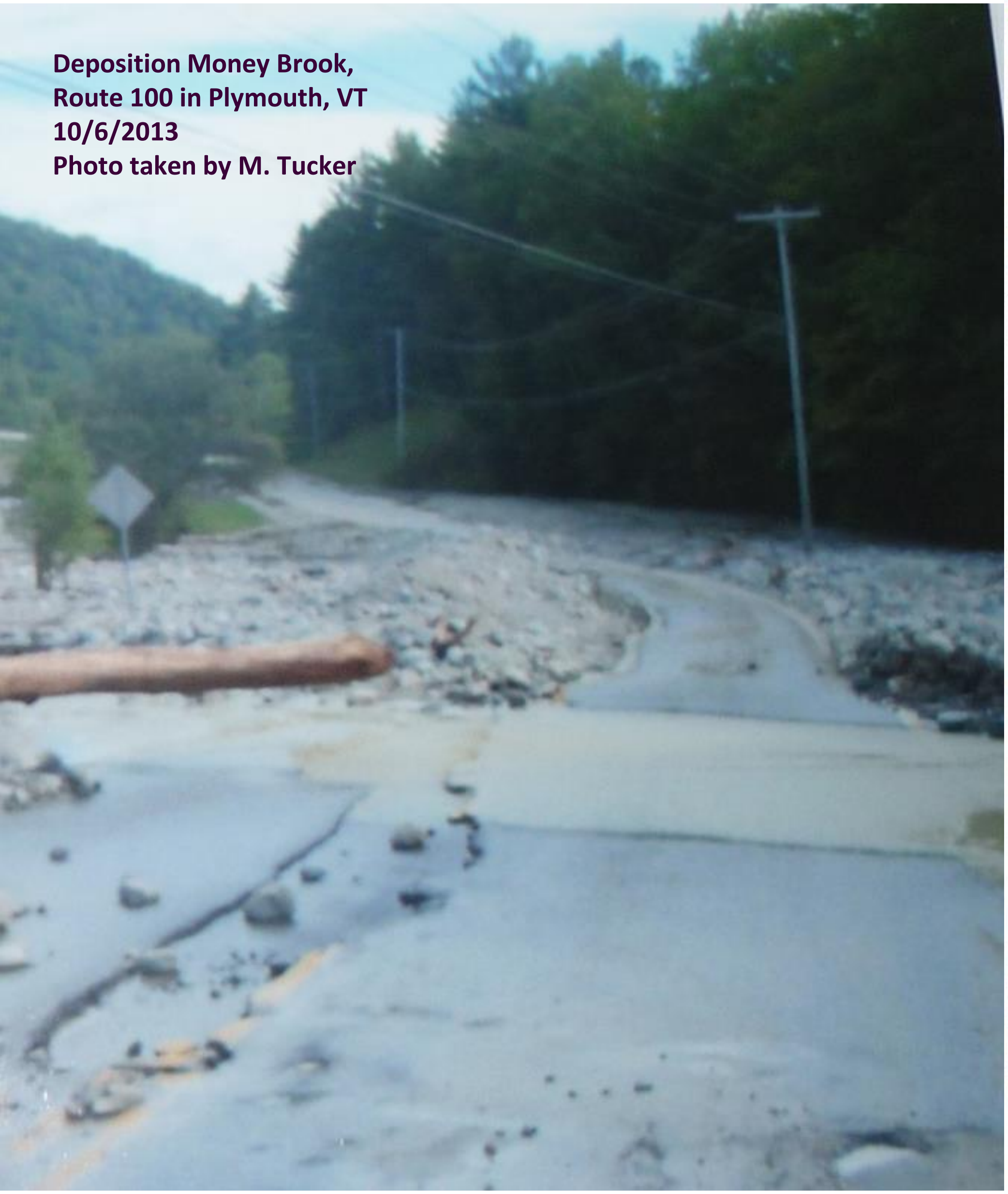
Brought team's creativity to new heights

Internal collaboration huge success

Socially beneficial

Has led to further consulting work

Need for Transportation Resiliency



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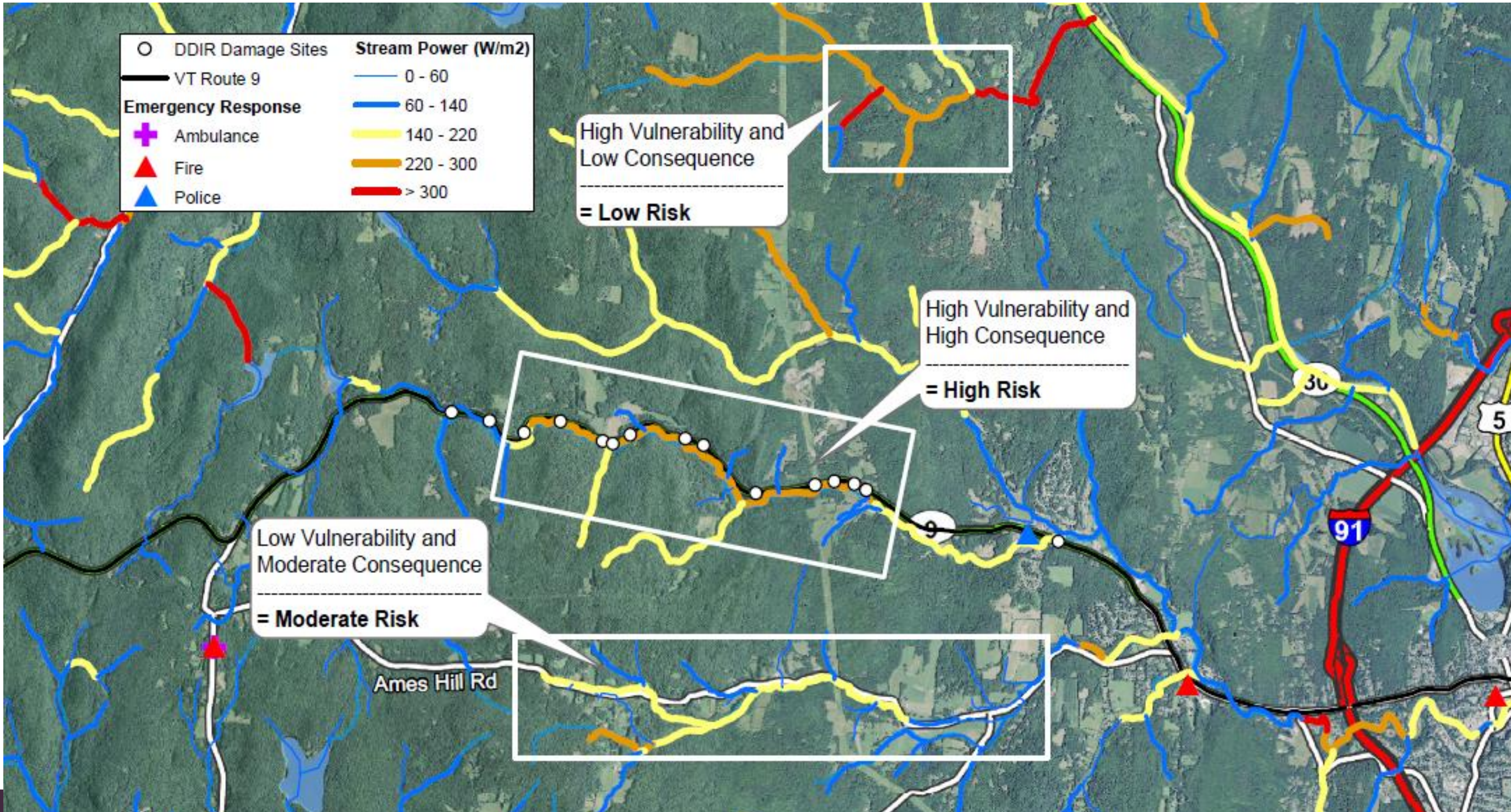
Goal: Develop Flood Risk Methods and Tools

- Systematically identify high risk road segments and crossing structures
- Incorporate vulnerability and risk into planning process



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Definitions

- **Vulnerability** – The extent that a transportation asset is exposed to a threat from inundation, erosion, or deposition.
- **Probability** – The likelihood that a threat will damage a transportation asset.
- **Consequence** – The effect of the disruption to mobility due to damage to a transportation asset.
- **Risk** – The combination of the probability of vulnerability and consequence of damage.

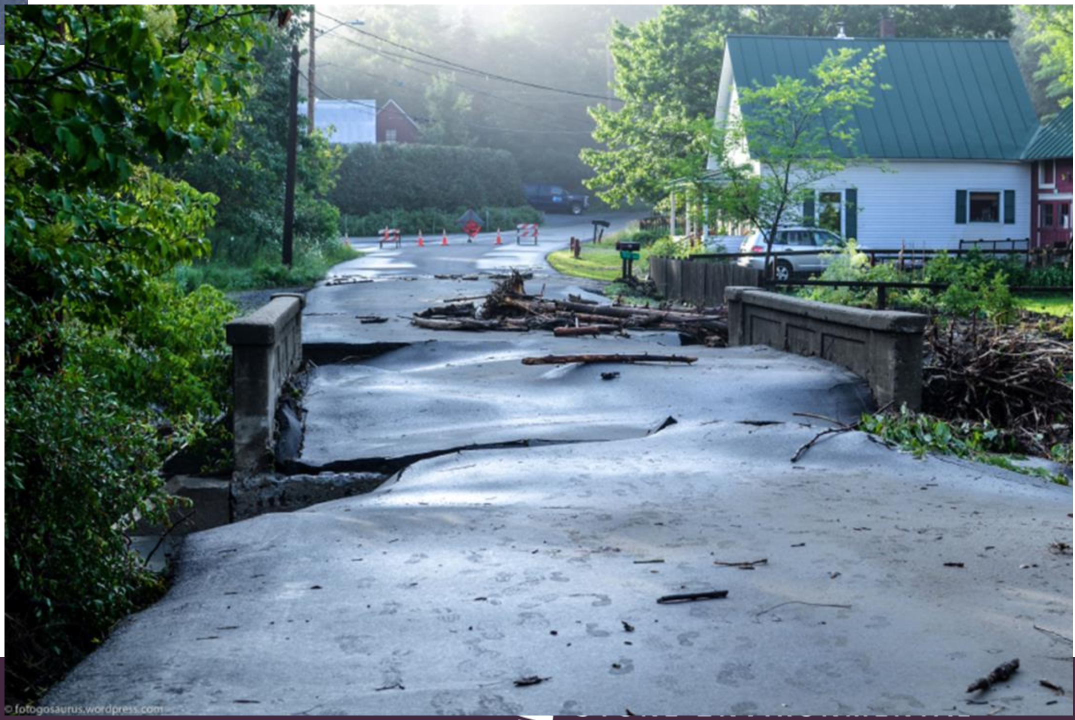
Vulnerability

Money Brook,
Route 100 in Plymouth, VT
1973
Photo taken by M. Tucker

Vulnerability

Great Brook
Brook Road in Plainfield, VT
7/19/2015
Photo taken by B. Towbin

Great Brook
Brook Road in Plainfield, VT
7/20/2015
Photo taken by B. Towbin



Vulnerability

Great Brook
Brook Road in Plainfield, VT
5/26/2011
Photo taken by G. Springston

Great Brook
Brook Road in Plainfield, VT
5/27/2011
Photo taken by G. Springston

Vulnerability

Inundation Vulnerability Screen – VTrans Methods and Tools for Transportation Resilience Planning

March 3, 2016

VULNERABILITY DUE TO INUNDATION	HIGH		MODERATE		LOW	

More detailed variables

Documented Past Damages due to Inundation	**Present**					**Absent**	*Data Replacement*
River-Roadway Relief or Structure-Roadway Relief (feet)	**< 5**		**5-10**			**> 10**	None
Incision Ratio and Entrenchment Ratio	**IR<1.2; ER>5**	**IR=1.2-1.4; ER>5**	**IR<1.4; ER=3-5**	**IR<1.4; ER<3**	**IR≥1.4; ER>3**	**IR≥1.4; ER<3**	
FEMA 100-Year Flood Depth Above Road (feet)	**>2**		**0-2**			**0**	
Length of Road in FEMA 100-Year Floodplain (detailed study) (feet)	**>200**		**50-200**			**0-50**	
Structure Hydraulic Capacity for Design Flow (Hw/D)	**>1.2**		**1.0-1.2**			**<1.0**	

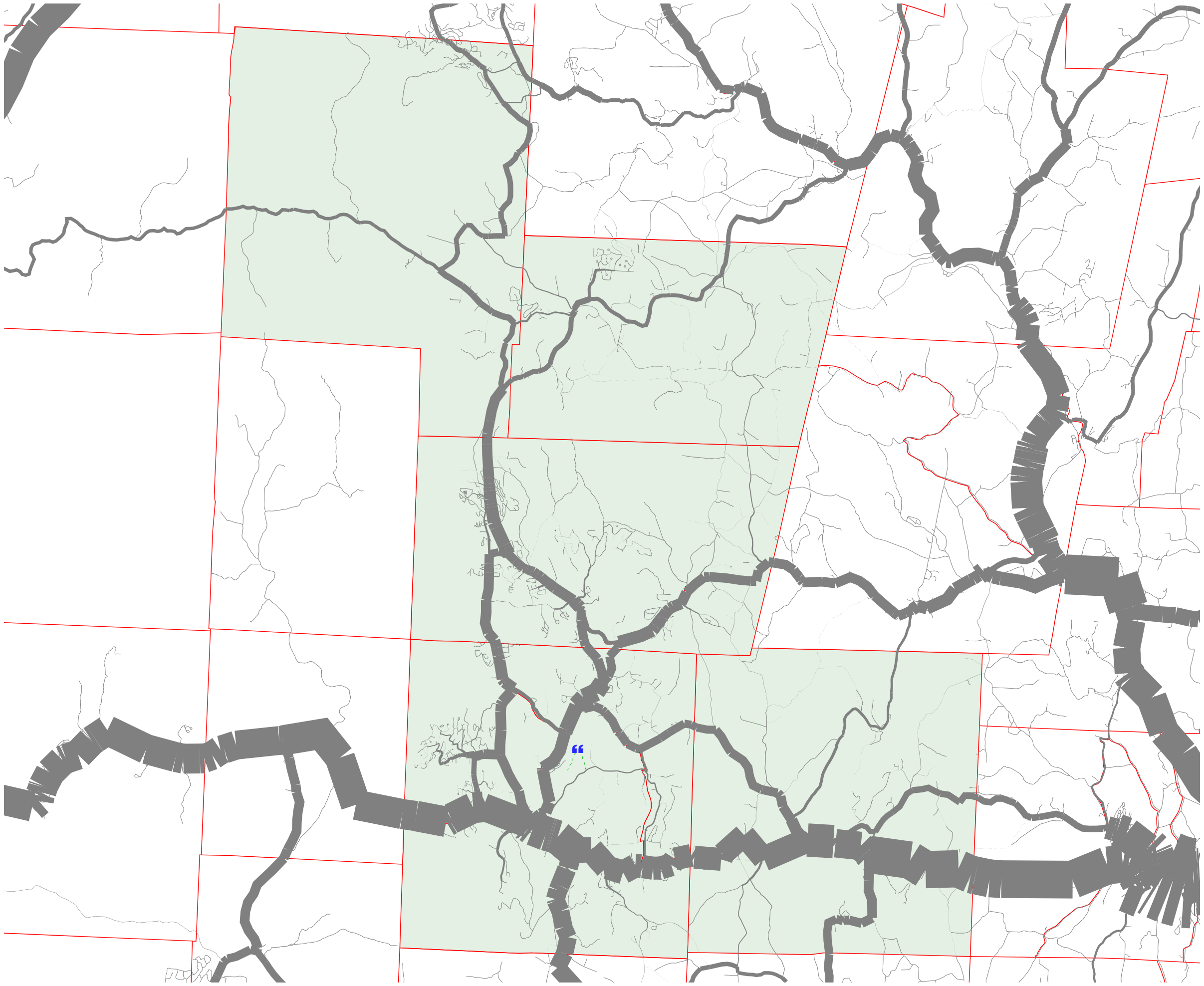
Less detailed variables (to replace more detailed variables when they do not exist)

Valley Slope	**<0.5**		**0.5-1.5**			**>1.5**	
Approximate FEMA (Zone A) or SSURGO-Derived Floodplains	**Present**					**Absent**	
Length of Road in Approximate FEMA or SSURGO Floodplains (feet)	**>200**		**50-200**			**0-50**	
Structure Width vs. Bankfull Channel Width	**<25%**	**25-50%**	**50-75%**		**>75%**	**≥100%**	

VULNERABILITY DUE TO INUNDATION	HIGH		MODERATE		LOW	

Transportation Modeling of Criticality

Consequences



North Branch Deerfield

Vermont Statewide Travel Model (TransCAD)

↓

Explore Network Criticality (TransCAD)

- Add local roads
- Add E-911 buildings
- Input probability of vulnerability
- Output failure consequences to identify risk

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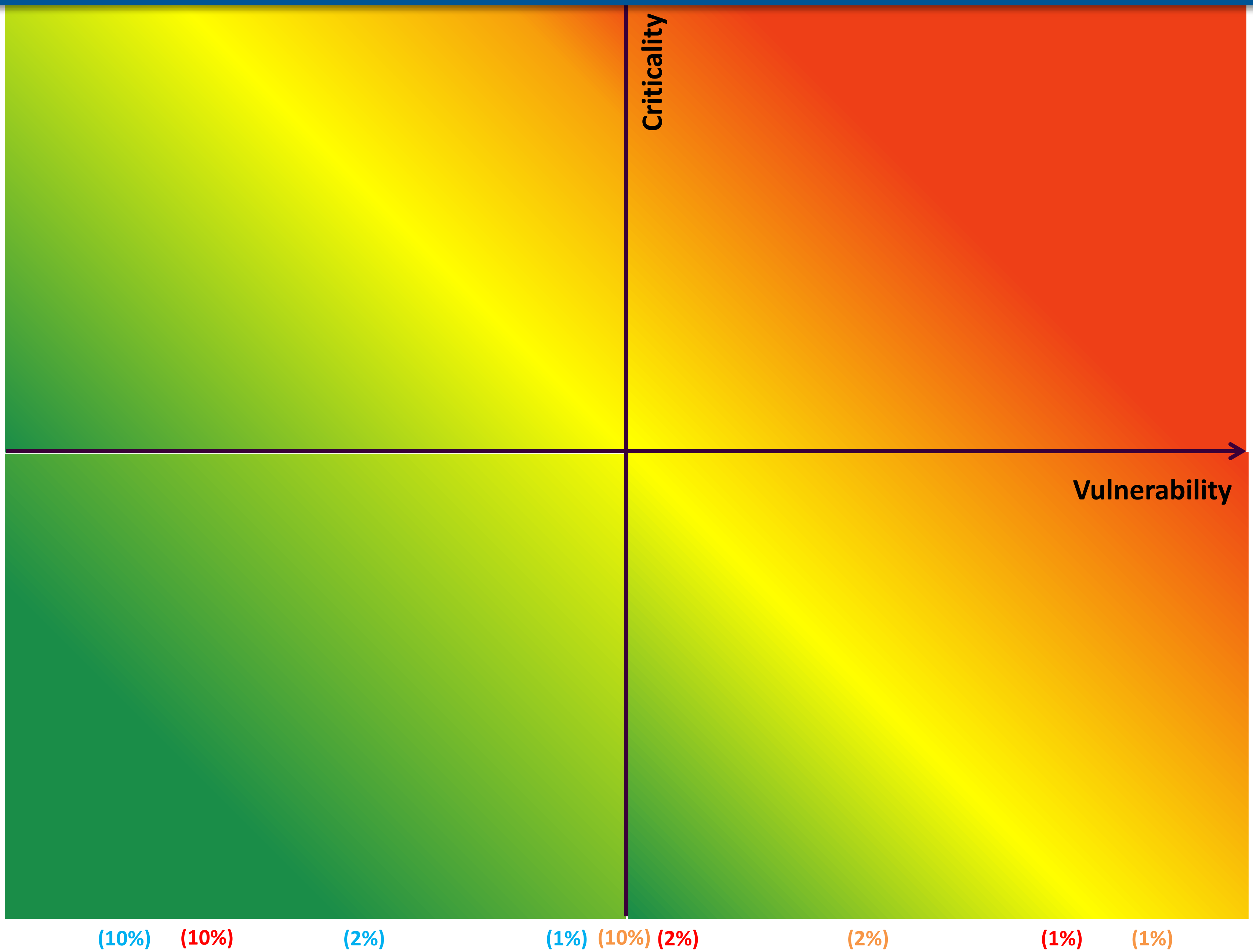
Resiliency App

Risk Assessment



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Mitigation Planning

Develop Mitigation Options

- **Infrastructure Improvements (Revised alternatives analysis and design standards)**
- **River Management**
- **Alternative Routes**
- **Roadway Relocation**
- **Conservation**
- **Land Use Regulation**

Transportation Flood Resilience App

Why have an App?

- Centralizes data for all users
  - Ensures everyone has latest version
- No commercial software requirements for users
  - Nothing to install or license
- Maximizes accessibility
- Simplifies complex data queries to answer technical questions for users/stakeholders
- Provides efficiencies over desktop GIS
  - Makes connections between datasets that would otherwise be cumbersome
- Structures/guides workflow to help users better understand the full risk picture

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Thank You!

Erosion App: http://erosion.stone-env.net/

Stormwater App: http://runoff.stone-env.net/

Solar App: http://energy.stone-env.net/

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Solar App: http://energy.stone-env.net/

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