# STONE ENVIRONMENTAL INC

**INSIDE:**
*Stone's climate change app entries to the Esri App Challenges*

## Environmental Modeling and Analysis Applications: Driven by Science and Innovative Web Technology.

Stone Environmental provides scientific tools, information, and analyses to help clients solve complex environmental challenges. Our team of scientists and engineers works around the globe, and our clients rely on us because of our integrity, expertise, and innovation. Our capabilities include applied information management (environmental modeling, GIS, and database services), water resources management, contaminated site investigation and remediation, and support for agrochemical product stewardship and registration. Stone employs over 50 scientists, engineers, modelers, programmers, and project managers, and our daily work is informed by our three guiding principles: scientific integrity and innovation, respect and professionalism, and a focus on client needs.

### Areas of Expertise

- Stormwater Management
- Wastewater Management
- Agricultural Stewardship
- TMDLs and Clean Water Act Compliance
- GIS and Database Application Development
- Spatial Analysis
- Data Discovery, Documentation, and Access
- Remote Sensing and Analysis
- GIS Mapping
- Mobile GIS Solutions

### The Science of Data

A core competence at Stone is the ability to extract knowledge from data. Our clients rely on us to find and interpret rich data sources, manage large datasets, ensure consistency, and apply data to build mathematical and spatial models. We create informative data visualizations, engaging maps, and effective web applications, communicating insights to specialists, scientists, and non-expert audiences alike. Whether we conduct spatial analyses using ArcGIS, run hydrologic, hydraulic, and watershed models (HEC-RAS, SWMM, SWAT), or create 3D visualizations of contaminant plumes in EVS, our team develops scientifically based applications to help solve the problems and answer the questions associated with climate change and environmental stewardship.

### Esri Partner

Stone has been a leader in the scientific use of ArcGIS since 1995, and has been an Esri Business Partner since 2009. Esri's mission is to give customers around the world the power to think and plan geographically. The market leader in GIS technology, Esri software is used in more than 300,000 organizations worldwide including each of the 200 largest cities in the United States, most national governments, more than two-thirds of Fortune 500 companies, and more than 7,000 colleges and universities. Esri applications, running on more than one million desktops and thousands of web and enterprise servers, provide the backbone for the world's mapping and spatial analysis. Stone's partnership with Esri ensures that we have access to the latest technologies and training, so we can bring the latest innovations to bear for our clients.

esri Partner Network Silver

### What we Do

We help clients make decisions driven by science and data by building tools that :

- Improve understanding of erosion and stormwater risks for infrastructure
- Prioritize infrastructure maintenance and updates
- Evaluate impacts of climate change and extreme precipitation
- Understand uncertainty in future climate outcomes
- Promote communication among stakeholders through web access
- Integrate with asset management systems
- Use advanced hydrologic and hydraulic modeling

# APP FOCUS: Modeling Community Erosion from Climate Change

*Stone's Entry in the Esri Climate Resilience App Challenge, June 2014*

**Project Location:**
United States

**Project Duration:**
June 1-15, 2014

**Stone Core Capabilities Used in this App:**
- GIS/Modeling Web Application
- MUSLE erosion modeling
- Climate change analysis

**Result:**
Awarded Runner up

**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

***"The technical and scientific judges raved about this app, in particular its nationwide scope in using data that provided for "large scale analysis in many areas". One judge noted that in terms of "scientific vigor", this was the strongest app we received. "***

*- John Yaist,*
*Technology Evangelist, Esri*

## Client Need / Problem Statement

In June 2013 as part of The Climate Action Plan, President Obama announced the Climate Data Initiative; an effort to encourage tech innovators to use spatial data about climate change risks and impacts in compelling ways to help citizens, businesses, and communities makes smart choices in the face of climate change.

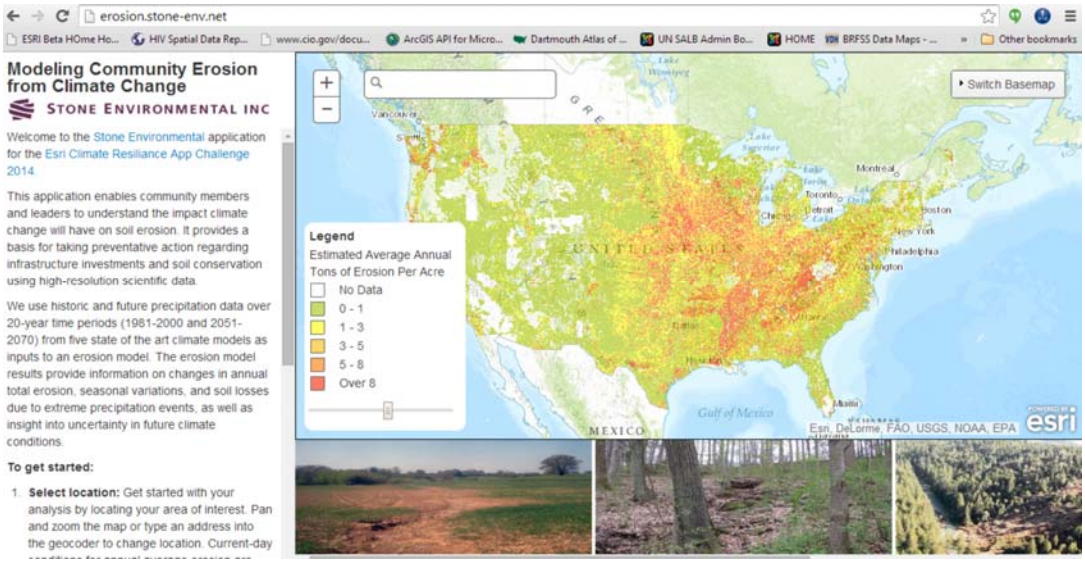
Esri responded to the Initiative with the Climate Resilience App Challenge calling on developers to create game changing apps that promote climate resilience.

Erosion is a critical issue for climate resilience because soil loss leads to decreased agricultural productivity, desertification, increased runoff leading to flooding and contamination of our waterways, and even hazardous landslide events such as the major flooding in Colorado's Front Range in the fall of 2013 and the devastating landslide in Oso, Washington in March of 2014. Under climate change, storm intensity is predicted to increase in some locations throughout the US, resulting in increased runoff intensity and erosion. The effects of increased erosion rates are likely to impact every American in the future, and an increased frequency of extreme precipitation events resulting from climate change may lead to significant short term damages. Information providing insight into possible erosion outcomes and associated uncertainties is needed for future decision-making.

However, information about extreme erosion rates from current and future precipitation events is either currently missing or not easily available to the public. A web-based geospatial erosion hazard information system driven by Esri's ArcGIS Platform was developed to spread awareness and help communities build resilience from this important impact of climate change. Stone's app was one of the finalists in the competition, earning recognition as one of the best scientific entries.

## Application

The ***Modeling Community Erosion from Climate Change App*** enables community members and leaders to understand the impact climate change will have on soil erosion. It provides a basis for taking preventative action regarding infrastructure investments and soil conservation using high-resolution scientific data.



The App helps stakeholders locate sites that are vulnerable to erosion including public, private, and agricultural lands, and roads. At user-selected sites, the App models present-day and future predictions of soil loss driven by climate change. Based on the type and severity of erosion, users are directed toward different soil conservation resources. The App also allows users to investigate erosion risk for a variety of future land covers. The modeled data provides information on changes in annual total erosion, seasonal variations, and soil losses due to extreme precipitation events, as well as insight into the uncertainty associated with the predictions by incorporating data from multiple climate models.

The underlying erosion model is the Modified Universal Soil Loss Equation (MUSLE, Williams 1975, Williams et al. 2008). Erosion is calculated on a daily-event basis using MUSLE. Key drivers in MUSLE are land use, soil characteristics, topography, crop management practices, and precipitation (from which runoff volume and peak runoff rate are calculated). At selected locations, MUSLE is evaluated using high-resolution precipitation data for historic (1981-2000) and future (2051-2070) time periods. Future precipitation data come from regionally-downscaled predictions made by five global climate models assuming greenhouse gas concentrations in the atmosphere continue to rise throughout the 21st century, the scenario known as RCP 8.5 in the Coupled Model Intercomparison Project (CMIP5).

## Extending the App

The application could be extended to include geographical area summations such as, county, watershed, neighborhood, or farm. Additional tools could be developed for more reporting and graphing. Modeling of sediment routing could be added to show the transport and ultimate accumulation of sediment in water bodies and stormwater systems.

# APP FOCUS: Modeling Resilience to Stormwater During Extreme Events

***Stone's Entry in the Esri Global Disaster Resilience App Challenge, Aug 2014***

## Client Need / Problem Statement

In collaboration with The United Nations Office for Disaster Risk Reduction (UNISDR) Making Cities Resilient Campaign, Esri called on the developer community to use the ArcGIS Platform in the development of new apps for urban resilience.

Developed entirely for and during the Esri Global Disaster Resilience App Challenge 2014, Stone's application was designed to help communities evaluate their resilience to stormwater during extreme weather events. The Stone team targeted stormwater issues because precipitation from extreme events and associated damage are forecast to increase throughout the world, leading to increases in damage to infrastructure, personal property and normal operation of cities. Changes in precipitation patterns because of climate change are already evident, and a much greater than normal portion of total annual precipitation is coming from extreme single-day precipitation events. However, aging infrastructure has not been designed for potential future climate conditions. There is a need to understand critical areas of stormwater accumulation during potential extreme events and to identify nearby infrastructure, and public and residential buildings that may be impacted to improve urban resilience.

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**Project Location:**
Barre, Vermont

**Project Duration:**
August 15-27, 2014

**Stone Core Capabilities Used in this App:**

- GIS/Modeling Web Application
- Stormwater modeling
- Extreme precipitation analysis

**Result:**
Awarded top 5 Scientific/ Professional Application

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

**Key Tools**

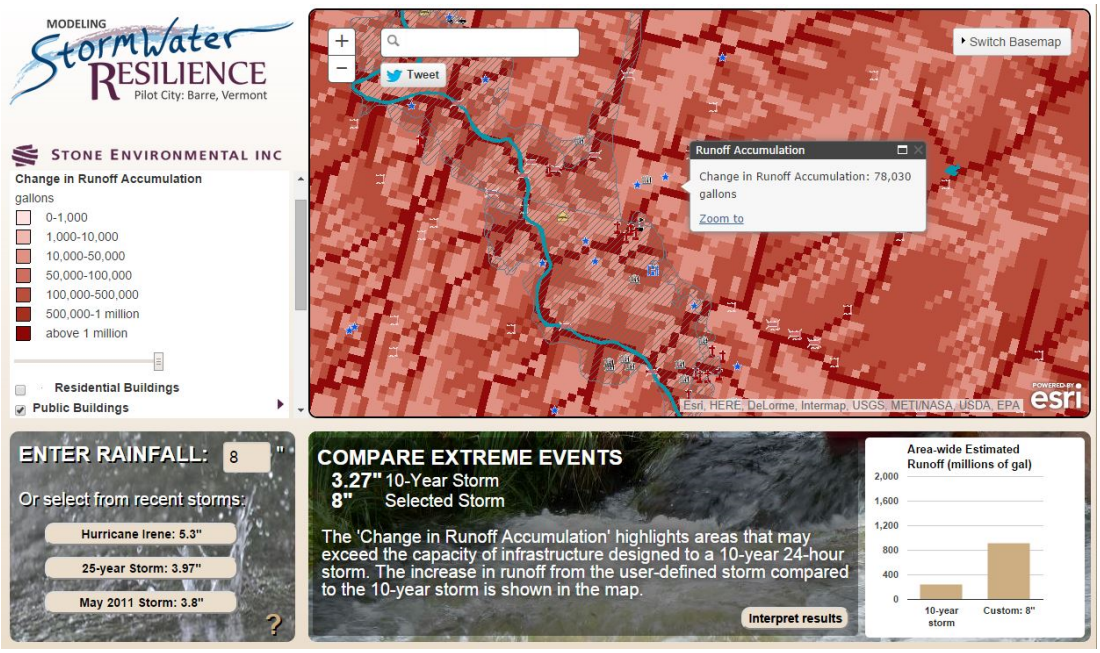
- ArcGIS Desktop
- ArcGIS Server (custom geoprocessing services, dynamic and cached map services)
- ArcGIS JavaScript API
- ArcSDE
- ArcPy Python libraries including Spatial Analyst
- ArcGIS REST API
- Google Charts
- jQuery
- json Python library
- numpy Python library

***"The judges felt the application did a fantastic job of explaining and interpreting the results, and a Disaster Manager would benefit from using this application."***

*- John Yaist, Technology Evangelist, Esri*

The Stone App was designed around two of the Essentials for Making Cities Resilient in the Ten-point Checklist of the United Nations Office for Disaster Risk Reduction (UNISDR):

- Essential 3: "Maintain up-to-date data on hazards and vulnerabilities, prepare risk assessments and use these as the basis for urban development plans and decisions. Ensure that this information and the plans for your city's resilience are readily available to the public and fully discussed with them."
- Essential 4: "Invest in and maintain critical infrastructure that reduces risk, such as flood drainage, adjusted where needed to cope with climate change."




Stone created a web-based scientific screening application for community leaders, urban planners, researchers, engineers and other professionals to help improve understanding of the impact of stormwater during extreme weather events

## Application

The ***Modeling Resilience to Stormwater During Extreme Events App*** supports the preparation of risk assessments as a basis for urban development plans and decisions by highlighting critical areas of accumulation of runoff during extreme weather that may be in excess of the runoff volume for which infrastructure was designed. Predictions of excess stormwater over land and historic flood zones are overlaid with infrastructure such as bridges, culverts, catchbasins, storm drains and storm lines to help identify system risks. Risk information in the app can help prioritize investment and maintenance of critical stormwater infrastructure.

Accumulated runoff from user-defined rainfall is compared to runoff generated by a baseline storm to estimate stormwater volume that may exceed the current capacity of city infrastructure. Predictions of vulnerable areas can then be used to prioritize investments to prevent flooding, road damage, and other consequences of infrastructure failure.

The App makes innovative use of data by merging information from a wide array of public-sponsored data sources to make runoff accumulation predictions at local scales. For runoff accumulation calculations, the app used high-resolution soils data (SSURGO), land use (NLCD), and flow direction (NHD) datasets. Additional data used in the app includes: stormwater infrastructure, bridge and culvert data, Flood Zone, and Vermont's Emergency E911 point database.

## Extending the App

While the app focuses on Barre, Vermont as the pilot community, this template can be recreated for any location in the world where the relevant spatial data sets are available.

More refined predictions of stormwater loading at specific infrastructure during extreme weather events requires advanced modeling techniques that account for topography and routing. With continued development the application could be advanced from a stormwater risk screening tool to a dynamic hydrologic and hydraulic modeling tool for predictions of peak flow rates in addition to volumes with accounting of flow diversions by routing through stormwater infrastructure. This information could be integrated with existing asset management systems.

## CONTACT US:

Do you have questions about these Apps? Are you interested in extending their functionality for your specific project? Call David Healy at 802.229.1879 or e-mail info@stone-env.com

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