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Rhode Island: the fun-sized state

• With over 400 miles of coastline and more than 100 beaches, Rhode Island’s shores and coastal waters are central to the state’s cultural, environmental, and economic interests.

• Narragansett Bay is an estuary of “national significance” and a focus of water quality restoration and climate change resilience projects.

• Tourism is one of Rhode Island’s most important economic sectors and the state is increasingly a foodie destination.
South Kingstown Town Beach: Today
In September 2017, Governor Gina M. Raimondo signed an Executive Order appointing a Chief Resilience Officer to drive climate resilience efforts across the state with the mission to develop a statewide action strategy by July 2018.

Narrow River in Narragansett
In September 2017, Governor Gina M. Raimondo signed an Executive Order appointing a Chief Resilience Officer to drive climate resilience efforts across the state with the mission to develop a statewide action strategy by July 2018.

Changing Landscape Narrow River in Narragansett: After Superstorm Sandy
Johnston RI: Repetitive inland flooding
In September 2017, Governor Gina M. Raimondo signed an Executive Order appointing a Chief Resilience Officer to drive climate resilience efforts across the state with the mission to develop a statewide action strategy by July 2018.

Changing Landscape

West Warwick Wastewater Treatment Facility
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Changing Landscape

West Warwick Wastewater Treatment Facility: March 2010
THE UNIVERSITY OF RHODE ISLAND

Development of an Integrated Watershed/River Model for Flood Management: Assessment of a Record Breaking Event in March 2010 in the Pawtuxet River, RI.

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Introduction

A record breaking flood event (about 340% return period) that occurred in March 2010 in Rhode Island (Figure 1), initiated several studies to understand and develop mitigation strategies to address flood impacts along the Pawtuxet River. We have developed a spatially distributed hydrological/hydraulic modeling system for the entire watershed and river using the state of the art GIS based numerical models, and the most recent watershed and river data.

Objectives

- Developing a webGIS based flood model for the Pawtuxet watershed to predict flooding along the river floodplains.
- Assessment of the watershed’s response using the developed model: impact of the Sustine Reservoir on flooding, effects of historical dams on flooding, data research, design, and water heights.
- Building the way for a real-time forecasting system for this river, and other rivers in RI.

Study Area

The Pawtuxet River is located on the western side of Narragansett Bay in RI. The geophysical form area in this study is the Pawtuxet River watershed, encompassing the Main, North, and South Branches Pawtuxet River. Inside the watershed are two main reservoirs: the Sustine and the Flat River Reservoirs, as well as several structures (historical dams and bridges) along the river (Figure 2).

Table 1 shows an overview of the drainage area of subcatchments in this watershed. Figure 3 shows the peak discharges for three, May, July, and Sep return periods in the Main, North, and South branches of the Pawtuxet River [1]. The drainage area rates higher for the North Branch than for the South Branch. It is interesting to note that the ratio of flow peaks are very close to the ratio of drainage areas.

Simulation Methods

The methods used in the rainfall-runoff calculations in HEC-RAS were SCS for surface runoff calculation, monthly constant method for the baseflow calculation, HEC unit hydrograph for subbas flow routing, and lag time method for each routing calculations. SCS runoff is mostly based on the similar studies in the United States and other countries. The method has been validated by local authorities and has been accepted. The method has been used with some variations. The model is used for this application with a modified SCS runoff model.

The Effect of Sustine Reservoir on Flooding

The Sustine Reservoir is located in the middle of the northern part of the Pawtuxet River watershed. The Sustine Reservoir covers over 60% of the Rhode Island draining water. The cutoff point of the spillway in the Sustine Reservoir was computed in Table 3. Figure 9 shows the relationship between the discharge and water elevation for the spillway. The Sustine Reservoir has the capability to retain rainfall during high flow periods as it has a very large reservoir (HSR). Figure 9 plots the modeled flow and runoff into the spillway in the Sustine Reservoir when the reservoir is at full capacity, and also shows the water elevation curve at 1, 2, and 3 before the spillway crest elevation. During March 28 - April 4, 2010, the reservoir was almost full, but if the Sustine reservoir was just 1 ft below the spillway crest elevation, the peak flow discharge would decrease 50%. Adding this flood capacity would be potentially beneficial to the flood management activities.
In September 2017, Governor Gina M. Raimondo signed an Executive Order appointing a Chief Resilience Officer to drive climate resilience efforts across the state with the mission to develop a statewide action strategy by July 2018.
Westerly inundated with flood waters in 2010.

**RHODE ISLAND MANIFESTATIONS OF CLIMATE CHANGE**

1. Sea Level Rise
2. Warming Air Temperatures
3. Warming Water Temperatures
4. Storm Frequency And Intensity
5. Changing Biodiversity
6. Precipitation and Inland Flooding
100% of state drinking water supply – 85% surface water

337 miles of state and municipal roadway are vulnerable to flooding in a 100 yr. storm surge event

The state’s 360,000 acres of forest land are being impacted by drought and invasive pests

Providence County has the worst air quality in the Boston-Worcester-Providence metro area and received an F for high ozone days (American Lung Foundation)
In September 2017, Governor Gina M. Raimondo signed an Executive Order appointing a Chief Resilience Officer to drive climate resilience efforts across the state with the mission to develop a statewide action strategy by July 2018.
Resilient Rhode Island Act established the Executive Climate Change Coordinating Council (EC4) in 2014.

It also sets specific greenhouse gas reduction targets; establishes two advisory bodies, the EC4 Advisory Board and the EC4 Science and Technical Advisory Board, to assist the Council.
• Catalyze the planning and vulnerability studies already developed and move towards implementation
• Identify and prioritize resiliency actions the State can control to demonstrate progress and implementation
• Prioritize actions that promote cross-agency collaboration and support municipalities in resilience planning and project implementation
Timeline of natural disasters and select state agency reports and tools

2010
- Storm Event: Great Floods of 2010

2011
- Storm Event: Tropical Storm Irene

2012
- Storm Event: Hurricane Sandy
- Report: Ensuring Safe Water for Rhode Island’s Future

2013
- Record Warmth

2014
- Nor’Easter, Flooding
- Record Cold
- Report: A Resilient Rhode Island: Being Practical About Climate Change
- Action: Resilient RI Act Establishes EC4

2015
- Record Warmth
- Action: StormTools Online Map Launched
- Report: Climate Change & Health Resiliency
- Report: Vulnerability of Municipal Transportation Assets to Sea Level Rise & Storm Surge

2016
- Record Warmth
- Report: State of Narragansett Bay and Its Watershed
- Action: Executive Order Appoints Chief Resilience Officer to Develop a Comprehensive Climate Preparedness Strategy

2017
- Coastal Flooding
- Report: Implications of Climate Change for RI Wastewater Collection & Treatment Infrastructure
Resilient Rhody framework

Making the Case for Climate Resilience

RESILIENCE THEME: Emergency Preparedness

RESILIENCE THEME: Critical Infrastructure and Utilities

RESILIENCE THEME: Natural Systems

RESILIENCE THEME: Community Health and Resilience

Financing Climate Resilience Projects
RESILIENCE THEME: Financing Climate Resilience Projects

Communities across Rhode Island face an urgent need to build climate resilient infrastructure that will survive extreme weather events.

There are several existing loan, bond, and grant programs for addressing climate resilience, and many new financing mechanisms currently under development by state and local agencies based on successful programs around the country.
## Existing Climate Financing Mechanisms

### Critical Infrastructure and Utilities

<table>
<thead>
<tr>
<th>Finance Tool</th>
<th>Water</th>
<th>Power</th>
<th>Transportation</th>
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<tr>
<td>Clean Water State Revolving Fund</td>
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<td>USDA Rural Development Loan Program</td>
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<td>Bonds</td>
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<td>Power Purchase Agreements</td>
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<td>Property Assessed Clean Energy</td>
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<tr>
<td>Municipal Road and Bridge Revolving Fund</td>
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### Natural Systems

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<td>Bonds</td>
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### Emergency Preparedness

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### Community Resilience

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Rhode Island Infrastructure Bank

Groundbreaking of the Warren Wastewater Treatment Facility

- Centralized hub of local infrastructure investment in Rhode Island
- Our mission is to support and finance investments in the State's infrastructure. Through its activities the Bank fosters infrastructure improvements that enhance the environment, create jobs, and promote economic development.
Resilient Rhody Implementation
Town of Warren Wastewater Treatment Facility Upgrade
2011 - Consent Agreement

2015 – Design Basis Report
FEMA Flood – 11.4' 

2016
Stormtools Analysis
12' projected Stillwater
3' SLR (NOAA 2065)
1' wave based on STWAVE

2017
Final Design Permitting
Bid Process
-$20mm total
-$450 PF from RIIB

May 2018
Groundbreaking
-First WWTF to integrate DEM study recommendations
Current Conditions
MHHW with 3’ Sea Level Rise
MHHW with 5’ Sea Level Rise
Resilience Improvements

- Submersible Pumps
- Collector Drives
- Motor Controls & Switch Gear
- Backup Generator
Resilient Rhody Implementation Priorities

• Assigned leadership across EC4 agencies

• Ownership of all 61 actions and aligning achievable 1, 3, 5 year goals

• Establish and accelerate funding and financing for resilience
  • Resilient Rhody has been a catalyst for $13mm in new climate resilience funding

• Evaluate sustainable revenue streams for climate resilience
Resilient Rhody Municipal Resilience Program

- Developed in partnership between Rhode Island Infrastructure Bank and The Nature Conservancy
- The MRP is open to all 39 municipalities in Rhode Island
- The MRP provides technical assistance to selected municipalities to complete the “Community Resilience Building” process
- Municipalities will identify priority climate resilience projects and action grant funding is available
This bond invests in water quality, land cleanup, farmland, recreational facilities, and open space to ensure Rhode Island remains a wonderful place to live, visit, and raise a family.

Rhode Island’s vibrant green economy accounts for more than 15,000 jobs and adds $2.5 billion to the economy each year.

- 2016 URI study
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