



CIRCA Research Projects:

Coastal Flooding and Waves, Inland Flooding, Sea Level Rise, Critical Infrastructure Resilience, Living Shorelines, and Policy and Planning

January 2019



Acknowledgements

The development of this report was funded by a Project Agreement between the Connecticut Department of Energy and Environmental Protection and the University of Connecticut Cooperative Projects for the project entitled, “Creation of the Connecticut Institute for Resilience and Climate Adaptation.”

About CIRCA

CIRCA is a multi-disciplinary, center of excellence that brings together experts in the natural sciences, engineering, economics, political science, finance, and law to provide practical solutions to problems arising as a result of a changing climate. The Institute helps coastal and inland floodplain communities in Connecticut and throughout the Northeast better adapt to changes in climate and also make their human-built infrastructure more resilient while protecting valuable ecosystems, and the services they offer to human society (food, clean air and water, and energy). The Institute combines the world-class research capabilities of the University of Connecticut and the progressive policies and practical regulatory experience of the Connecticut Department of Energy and Environmental Protection (CT DEEP) to translate sound scientific research to actions that can ensure the resilience and sustainability of both the built and natural environments of the coast and watersheds of Connecticut.

In collaboration with local, regional, and national partners, the Institute’s multi-disciplinary research, outreach, and education programs will strive to:

- Improve scientific understanding of the changing climate system and its local and regional impacts on coastal and inland floodplain communities;
- Develop and deploy natural science, engineering, legal, financial, and policy best practices for climate resilience;
- Undertake or oversee pilot projects designed to improve resilience and sustainability of the natural and built environment along Connecticut’s coast and inland waterways;
- Create a climate-literate public that understands its vulnerabilities to a changing climate and which uses that knowledge to make scientifically informed, environmentally sound decisions;
- Foster resilient and sustainable communities – particularly along the Connecticut coastline and inland waterways – that can adapt to the impacts and hazards of climate change; and
- Reduce the loss of life and property, natural system and ecological damage, and social disruption from high-impact events.

Preface

This report provides an update on completed and ongoing projects that are supported by CIRCA funding or involve collaborations with CIRCA-affiliated faculty and staff. Completed projects contain links to products, tools, and findings that can be used by Connecticut communities as they plan for and adapt to the impacts of climate change and severe weather. Some projects may have presentations or posters with information that can also be referenced. Projects cover the CIRCA research and engagement focus areas of coastal flooding and waves, inland flooding, sea level rise, critical infrastructure resilience, living shorelines, and policy and planning.

For regular updates on CIRCA projects please refer to the CIRCA website: circa.uconn.edu.

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Completed Research Projects

Advancing High Resolution Coastal Forecasting and Living Shorelines Approaches in the Northeast

UConn CIRCA 'What We Do' Areas:

- *Coastal Flooding and Waves*
- *Sea Level Rise*
- *Critical Infrastructure Resilience*
- *Living Shorelines*
- *Policy and Planning*

UConn CIRCA faculty are partnering with researchers from across New England to advance the development and implementation of a comprehensive, regional coastal and riverine inundation observation and modeling system. This project will result in the creation of a real-time inundation forecast system that will be housed with the Northeast Regional Association of Coastal and Ocean Observing Systems (NERACOOS) and 100-year return interval (1% annual chance) online maps.

UConn CIRCA, working in conjunction with five New England states and several regional organizations, will collaboratively analyze living shorelines applications in Connecticut and the Northeast region. New England has a varied coastline and dually varied utilization rates for living shorelines projects. Under this cooperative effort, UConn CIRCA will assist the region as it develops a 'state-of-the-science' analysis of living shorelines and coastal green infrastructure, identify barriers and potential solutions to increase the deployment of living shorelines, and develop and disseminate educational materials and workshops for the public regarding living shorelines and coastal green infrastructure.

Funding for this project is provided by the NOAA Regional Coastal Resilience Grants under the NOAA Office for Coastal Management.

Researchers and Staff Supported on Project:

- James O'Donnell, UConn Marine Sciences
- Rebecca French, UConn CIRCA
- Alejandro Cifuentes-Lorenzen, Postdoctoral Fellow, UConn Marine Sciences
- Todd Fake, Research Associate, UConn Marine Sciences

Connecticut Physical Climate Science Assessment Report

UConn CIRCA 'What We Do' Areas:

- *Policy and Planning*

Researchers are reviewing the current state of scientific knowledge of recent trends and projections of local climate (temperature and precipitation), with a purpose to inform planning and adaptation by the state, municipalities and local governments, commercial enterprises and NGOs. The review is being conducted by University of Connecticut faculty with expertise in climate related sciences. In addition to reviewing existing literature, new analysis will be conducted and new data will be produced focusing specifically on Connecticut. This review will result in a written report, *Connecticut Physical Climate Science Assessment Report (CT-PCSAR)*.

Researchers and Staff Supported on Project:

- Anji Seth, UConn Department of Geography
- Scott Stephenson, UConn Department of Geography
- Guiling Wang, UConn Civil & Environmental Engineering
- Christine Kirchhoff, UConn Civil & Environmental Engineering
- Richard Anyah, , UConn Natural Resources and the Environment
- Kelly Lombardo, UConn Marine Sciences

Demonstrating a Coastal Flood Risk Analysis Framework in the Mystic River

UConn researchers are working to estimate the flood risk of areas along the Mystic River. This pilot project simulates the effect of large rainfall events on the Mystic River to improve flood vulnerability mapping. Specifically, this research will; 1) simulate the river and watershed flow over the last 38 years; 2) construct a synthetic hydrograph of inland flow at given return periods as well as the combination of low/high tide and no surge/surge conditions on the Mystic River; and 3) map the extent of flood inundation as well as depth. Using municipal reports and photos showing flood control structures and water marks from previous flood events, researchers will calibrate the model to better simulate the effect of large rainfall events on the river to show more accurate information about flood conditions and vulnerability.

Researchers and Staff Supported on Project:

- Emmanouil Anagnostou, UConn Civil & Environmental Engineering, UConn CIRCA
- Xinyi Shen, UConn Civil & Environmental Engineering
- Mariam Khanam, UConn Civil & Environmental Engineering
- Scot Deledda, Stonington Engineer and Floodplain Manager
- Rick Norris, Groton Planner

Developing Location-Based Communication and Public Engagement Strategies to Build Resilient Coastal Communities

This project assesses communication and engagement strategies from two ongoing resilience projects in different locations on the Connecticut coast. The City of Bridgeport's National Disaster Resilience Competition pilot project activities are being assessed since they have a robust process of public outreach and engagement. The second site focuses on coastal resilience communication strategies being used in the town of Fairfield. Goals of this CIRCA funded UConn research project include:

1. Evaluate community stakeholder response to the planned resilience project as the basis for developing and assessing recommended communication and engagement strategies.
2. Recommend tailored communication strategies aimed at motivating community stakeholders to support the planned resilience projects.
3. Recommend tailored engagement strategies aimed at empowering community stakeholders.

Deliverables of the project will include a set of tailored communication strategies for promoting community support for planned projects via targeted interactive informational and experiential learning.

Researchers and Staff Supported on Project:

- Carolyn Lin, UConn Department of Communication
- James O'Donnell, UConn Department of Marine Sciences, UConn CIRCA
- Katie Lund, UConn CIRCA
- Kimberly Bradley, UConn CIRCA
- Brian Thompson, CT DEEP
- Rebecca French, CT DOH
- David Murphy, Milone & MacBroom

Drinking Water Vulnerability Assessment and Resilience Plan

The Connecticut Department of Public Health (DPH) and the Connecticut Institute for Resilience and Climate Adaptation (CIRCA) will work together for the purpose of preparing a Drinking Water Vulnerability Assessment and Resilience Plan to assess, identify, and address vulnerabilities for community water systems in Fairfield, New Haven, New London, and Middlesex counties. The Plan will utilize spatial data, flood risk, climate information,

surveys and interviews with water utilities to ensure preparedness and resiliency of community water systems before, during, and after future storms and hazards, including the impacts of climate change and drought.

The project consists of four overall tasks:

- Vulnerability assessment of Connecticut community water systems in the four counties impacted by Super Storm Sandy to identify options and alternatives to mitigate the vulnerabilities identified and to improve resiliency and to compile the assessment into a comprehensive Public Water Systems resiliency plan.
- Review current practices, procedures, and requirements for emergency response at DPH and develop an emergency response plan, in collaboration with the Department.
- Use available GIS data layers and information from local health directors to assess the vulnerability of private wells and recommend actions to improve resiliency.
- Prepare a high-level comprehensive implementation plan that addresses identified community water systems' vulnerabilities and provides options and alternatives to improve resiliency.

Researchers, Staff and Contractors Supported on Project

- James O'Donnell, UConn CIRCA and Department of Marine Sciences
- Christine Kirchhoff, UConn Department of Civil and Environmental Engineering
- Rebecca French, UConn CIRCA
- Guiling Wang, UConn Department of Civil and Environmental Engineering
- Amy Burnicki, UConn Department of Civil and Environmental Engineering
- David Murphy, Milone & MacBroom

Financing Resilience in Connecticut: Current Programs, National Models, and New Opportunities: Fact Sheet

UConn CIRCA 'What We Do' Areas:

- *Policy and Planning*

CIRCA developed a fact sheet that reviews existing resilience financing programs in Connecticut, as well as model programs that can be applied in the State. It aims to educate Connecticut's municipalities, regulators, policymakers, and legislators on the need to collaborate on developing financing methods for resiliency, including innovative public-private partnership models, and adaption of existing public and private finance models for resiliency. These actions will proactively address flood insurance affordability and promote voluntary climate adaptation measures to reduce and avoid future losses (to life, property/casualty, property tax, critical infrastructure and business continuity). Most importantly, Connecticut needs these financing methods in place prior to the next natural

disaster when motivation to rebuild resiliently is high. Developing effective financing methods for resiliency now will benefit vulnerable residents, natural ecosystems, businesses, and government (local, state, and federal). Investments in the short-term will create taxpayer savings for disaster recovery costs and lead to more affordable flood insurance over the long-term.

Fact sheet:

http://web9.uits.uconn.edu/circa/library/Final_ResilienceFinanceFactSheet.pdf

The fact sheet contains reviews of Shore Up Connecticut, Microgrids Program and Green Bank, Clean Water Revolving Loan Funds, Tax Increment Financing Districts, Connecticut Green Bank C-PACE and R-PACE, New Jersey Energy Resilience Bank, Energy Savings Performance Contracts (ESPCs) and Resilience Bonds.

Researchers and Staff Supported on Project:

- Rebecca French, UConn CIRCA supported
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Increasing Resilience and Reducing Risk Through Successful Application of Nature Based Coastal Infrastructure Practices in New England

(anticipated completion date: September 2020)

UConn CIRCA 'What We Do' Areas:

- *Living Shorelines*

Since the State of Connecticut has adopted regulations to limit further expansion of hard coastal protection structures (sea walls, revetments etc.) and to promote the use of “living shore line” approaches, tracking the effectiveness of demonstration sites is a priority activity. As a consequence of its geological setting and development history, the harbors of Connecticut require periodic maintenance dredging to ensure safe navigation. The State has also committed to expand the reuse of dredged sediments and the development of demonstration projects that also enhance coastal protection is also a priority. This project will advance both of these coastal research themes through a series of 6 tasks that include outreach and development of policy recommendations. Funding for this project is provided by the NOAA Regional Coastal Resilience Grants under the NOAA Office for Coastal Management.

Researchers and Staff Supported on Project:

- Jennifer Mattei, Sacred Heart University Department of Biology (Project Lead)
- James O'Donnell, UConn Marine Sciences, UConn CIRCA

Jarvis Creek Sea Level and Flooding Variability

UConn CIRCA 'What We Do' Areas:

- *Coastal Flooding and Waves*

UConn CIRCA performed an assessment of the effects of engineered tidal flow constrictions on the variability of the sea level in salt marshes and the frequency of flooding in upstream areas, focused on Jarvis Creek (Branford).

The Town of Branford, CT, and the Branford Land Trust have reported that high water levels at Jarvis Creek Marsh, CT, have led to flooding on Leetes Island Road (RT 146) and at a field adjacent to the marsh. Exchange of water between Long Island Sound and the marsh complex is currently influenced by a tide gate and a berm at the southern end of marsh and a railway bridge that crosses the middle of the marsh. The berm had been modified by the Land Trust with funds from a grant from the Connecticut Department of Energy and Environmental Protection as part of a marsh restoration program and to improve public access. This report describes observation and the development of a mathematical model that quantitatively assesses the influence of the tide gate and the berm on the exchange with Long Island Sound and the frequency of flooding.

Researchers and Staff Supported on Project:

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Municipal Resilience Planning Assistance for Sea Level Rise, Coastal Flooding, Wastewater Treatment Infrastructure, and Policy

UConn CIRCA 'What We Do' Areas:

- *Coastal Flooding and Waves*
- *Inland Flooding*
- *Sea Level Rise*
- *Critical Infrastructure*
- *Policy and Planning*

With a grant from the Connecticut DEEP, UConn CIRCA will develop tools (methodologies

and data) for municipalities in counties affected by Superstorm Sandy for the assessment of vulnerability of infrastructure (including waste water treatment plants, pump stations, roads, and public safety assets), to inundation by river flow and storm surge, now, and in the next 25 to 50 years, when it is likely that sea levels will be higher and precipitation statistics different; and provide policy and financing options for resilience projects for Connecticut's municipalities. Additionally, the use of these products will be piloted in communities. UConn CIRCA will produce the following products as a result of this project:

- Sea level rise projections for Long Island Sound
- Models and maps of the combined impacts of riverine flooding and storm surge
- Models and maps of inland flooding under current future climates
 - 20%, 10%, 5%, 2%, and 1% annual chance flood inundation from storms
 - Evaluation of extreme future climate storm scenarios (category II hurricane) against the current 1% (100-year) and 0.2% (500-year) flood inundation levels
- Vulnerability assessment process for wastewater treatment plants
- Policy and financing options for resilience projects that may be effective in Connecticut based on a survey of municipal needs

Researchers and Staff Supported on Project:

- James O'Donnell, UConn Marine Sciences, UConn CIRCA
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NOAA Coastal Resilience Networks: “Enhancing Coastal Resilience in Connecticut”

UConn CIRCA ‘What We Do’ Areas:

- *Coastal Flooding and Waves*
- *Living Shorelines*

The CREST Project, “Enhancing Coastal Resilience in Connecticut,” was funded by a two-year grant from the National Oceanic and Atmospheric Administration (NOAA) to the University of Connecticut. A team of research and extension faculty and staff from the departments of Civil and Environmental Engineering, Extension and UConn Marine Sciences, along with Connecticut Sea Grant, the Center for Land Use Education and Research and the Connecticut Department of Energy and Environmental Protection’s Office of Long Island Sound Programs worked on the following objectives.

- An assessment of existing patterns of coastal erosion;
- Identification of shoreline character and coastal protection approaches in-place;
- Determination of storm wave characteristics at the shoreline to provide information needed to create design guidelines for assessment of protection alternatives under current and likely future climate states;
- Review of available design guidelines for the deployment of “living shoreline” shore protection strategies and the development of a research agenda to enhance understanding of the effectiveness of the approach in Connecticut;
- Development of an online Map Viewer;
- Incorporation of the knowledge developed in the project in both coast-wide and in-depth community-level educational programs, targeted at local land use officials.

The website developed for the project contains a map viewer (<http://circa.uconn.edu/crest/maps/>) for site suitability for living shorelines, a description of the wave research model and findings (<http://circa.uconn.edu/crest/wave-research/>), and the results of a wave model (<http://circa.uconn.edu/crest/points/>) at five locations in Long Island Sound.

Researchers Supported on Project:

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- Sylvain De Guise, Pathobiology & Veterinary Science, CT Sea Grant
- Brian Thompson, CT DEEP Office of Long Island Sound Programs
- Chet Arnold, UConn CLEAR
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- Juliana Barrett, Extension, CT Sea Grant, UConn CLEAR
- Bruce Hyde, Extension, UConn CLEAR

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Real Estate Values, Tax Revenues, and Climate Change-Induced Retreat from Flood Zones

UConn CIRCA 'What We Do' Areas:

- *Policy and Planning*

What is the cost of preserving, maintaining, or restoring coast-front (vulnerable) properties? Casual observation suggests these questions cause many communities to hesitate when facing the expensive realities of changing flooding and storm frequency. This proposal outlines an approach to ascertain the value of oceanfront status for homes located near the coast. This research is an important, necessary but not sufficient, first step in a larger suite of research asking the most pertinent question of: Can there be “tax instrument financing” of a portion of the cost of retreat from the coastal margin? A final report will include case studies for a sample of Connecticut communities illustrating a selected range of coastal configurations and conditions for sites in which the retreat-relocate option might be a viable and cost-effective alternative for communities to consider for adapting to increased coastal flooding.

Researchers and Staff Supported on Project:

- Stephen Swallow, UConn Agricultural and Resource Economics and Center for Environmental Sciences and Engineering
- Charles Towe, UConn Agricultural and Resource Economics and Center for Environmental Sciences and Engineering

Real-time Flood Prediction and Vulnerability Analysis of Connecticut's Inland River Network

UConn CIRCA 'What We Do' Areas:

- *Inland Flooding*
- *Critical Infrastructure*

UConn CIRCA researchers are developing an integrative hydrologic and flood inundation modeling system for Connecticut's inland river network, and using the system for conducting flood vulnerability analyses statewide to identify critical areas/infrastructures (e.g. bridges,

road network, power stations, waste water treatment facilities) and issues related to flooding and erosion from extreme precipitation (1% annual chance storms) in current and end-of-century climate.

Researchers and Staff Supported on Project:

- Manos Anagnostou, UConn Civil & Environmental Engineering, UConn CIRCA
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- Yagmur Derin, Graduate Student, UConn Civil & Environmental Engineering
- Jason Parent, UConn Natural Resources and the Environment

Restored vs. Natural Living Shorelines: Comparison of Ecosystem Services, Erosion Control, and Habitat Use

UConn CIRCA 'What We Do' Areas:

- *Living Shorelines*

Tidal wetlands provide a wealth of ecosystem services, including erosion control, storm protection, sequestration of carbon and other nutrients and habitat vital to various life stages of commercially and ecologically important fish and wildlife. Restoration of tidal wetlands adds to our economy and increases coastal resilience. The key question is: “Do living shorelines provide similar ecosystem services to naturally established estuarine habitats in Connecticut?” A recently established living shoreline in Stratford, CT provides a unique opportunity to compare the ecosystem services of two newly planted saltmarshes to nearby established marshes in the same estuary of the Housatonic River. Indicators of ecosystem services for this project will include measures of sediment deposition, carbon sequestration rates and fish and bird diversity.

Researchers and Staff Supported on Project:

- Jamie Vaudrey, UConn Marine Sciences
- Jennifer Mattei, Sacred Heart University

Road Flooding in Coastal Connecticut

UConn CIRCA 'What We Do' Areas:

- *Critical Infrastructure Resilience*
- *Coastal Flooding and Waves*

The coastline of Connecticut is characterized by numerous inlets where the rivers and streams carrying runoff from land towards the ocean and the saline tidal waters of Long

Island Sound intrude into the channels. Salt marshes have formed in many of these inlets and have become critical habitat for numerous species of insects, birds and fish. Routes between coastal settlements have generally skirted the northern boundaries of these marshes and many bridges and culverts have been constructed to allow the water and roadways to co-exist. Rising sea levels, and some marsh restoration projects, have made segments of roadways more vulnerable to flooding. This project will assess the most cost effective and appropriate adaptation strategy to reduce the frequency of flooding to an acceptable level, requiring the analysis of the flow of water through the inlets.

A demonstration project will be conducted to provide estimates of the frequency of flooding at two sites on RT 146 in Guilford and two sites in Branford. The model to be employed will require the analysis of observations, LIDAR surface elevations, GPS surveys and water level observations. The end goal is to have the model and data provide:

- a) current flooding frequency statistics;
- b) future flooding frequency statistics; and
- c) the effectiveness of road elevation options on reducing the flooding frequency.

Researchers and Staff Supported on Project:

- James O'Donnell, UConn CIRCA and Department of Marine Sciences
- Michael Whitney, UConn Department of Marine Sciences

SAFR Connecticut Connections Vulnerability Assessment and Resilience Concept – National Disaster Resilience Competition (NDRC)

UConn CIRCA 'What We Do' Areas:

- *Policy and Planning*

CIRCA led the research, outreach, and collaborative efforts of several state agencies to develop a regional vulnerability assessment and conceptual framing of coastal resilience for the NDRC, a billion-dollar competition sponsored by the U.S. Department of Housing and Urban Development. The concept of connecting adapted coastal communities, through safe resilience corridors, to resilient transit-oriented development along Metro-North advanced the State to the current design phase of the competition. In January 2016, Connecticut was announced as the winner of \$54.3 million to implement a pilot project in Bridgeport based on the concept and funds to develop a regional *Connecticut Connections Coastal Resilience Plan* for New Haven and Fairfield Counties.

The vulnerability assessment that includes maps of flood risk and social vulnerability and the conceptual resilience framework for the Connecticut coast are included here: <http://web9.uits.uconn.edu/circa/ndrc/pubs/FinalSAFRConnecticutConnectionsJune22.p>

df. Funding to develop the proposal was provided by a grant from the Connecticut DEEP.

Researchers and Staff Supported on Project:

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- Kara Bonsack, UConn CLEAR
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- Ralph Lewis, UConn Marine Sciences
- Katherine Hagemann, UConn CIRCA
- Beth Greenleaf, UConn CIRCA
- Alex Felson, Yale UED Lab

Scoping of Dredge Material Islands and Wetlands for Green Infrastructure Resiliency Projects Along the Connecticut Shoreline in Fairfield and New Haven Counties

UConn CIRCA 'What We Do' Areas:

- *Critical Infrastructure*
- *Living Shorelines*
- *Policy and Planning*

The shorelines of Fairfield and New Haven Counties were among the most heavily impacted by Superstorm Sandy. If Connecticut had more marshland along its coast, it is possible that some of those impacts could have been avoided; studies show that wetland habitats act as natural buffers against waves and powerful storm surges. With funds from the Connecticut Department of Housing CDBG-DR Sandy Recovery Program, this project aims to determine the feasibility of the process of utilizing dredge materials to construct artificial marshes and islands to decrease erosion and improve drainage. Creating marshes along shorelines may increase an area's resilience to sea level rise and severe storms, and has a dual benefit of providing public access to natural amenities and maintaining or increasing ecosystem services. This project will result in a feasibility assessment, design parameters, a regulatory framework, and an evaluation of the impact of the creation of wetlands on the health and safety of vulnerable populations.

Researchers and Staff Supported on Project:

- Jennifer O'Donnell, UConn Marine Sciences
- Jamie Vaudrey, UConn Marine Sciences
- Craig Tobias, UConn Marine Sciences
- Rebecca French, UConn CIRCA

- Carolyn Lin, UConn Communications
- Paula Schenck, UConn Health

Stratford Point Living Shoreline: Restoring Coastal Habitats to Maintain Resiliency and Function

UConn CIRCA 'What We Do' Areas:

- *Living Shorelines*
- *Sea Level Rise*

Primary Funding: U.S. Army Corps of Engineers Connecticut In-Lieu Fee Program

Led by researchers at Sacred Heart University, this project expands an existing living shoreline project at Stratford Point, Fairfield County, Connecticut. On-going coastal restoration efforts and research at the site consist of an artificial reef, smooth cordgrass (*Spartina alterniflora*) marsh, high marsh, coastal dune and upland woody/grassland mosaics. In total, the project will provide an additional 750 feet of coastal erosion control, 4.5 acres of intertidal habitat, 1.5 acres of coastal dune habitat and 25 acres of woodland/meadow mix. Subsequent monitoring will provide additional understanding regarding the potential effectiveness of living shorelines as a means to increase coastal resilience and will inform future designs/guidelines for Connecticut and coastal communities in New England.

Researchers Supported on Project:

- Jennifer Mattei, Sacred Heart University Department of Biology

Matching Funds for Research Projects Supported by UConn CIRCA

UConn CIRCA provides matching funds to projects that advance the goals and mission of UConn CIRCA and that are supported by a primary sponsor.

Public Support for Adaptation to Sea Level Rise

(anticipated completion date: January 2019)

UConn CIRCA 'What We Do' Areas:

- *Policy and Planning*

Primary Funding: Connecticut Sea Grant

This project is intended to provide insight about the public value of gains and losses in both natural and built assets maintained in the face of a dynamic, changing coastal environment. The project will develop and implement a survey, drawing on established tools of environmental economics to gather knowledge about factors affecting the willingness of Connecticut coastal residents to support incentives or programs that lead coastal landowners and decision makers to alter plans for climate adaptation to better reflect the value of public trust resources that may be lost as a result of a narrow focus on defense of built assets.

A spreadsheet-based tool will be created that decision-making advisors could use to evaluate the relative value of climate adaptation scenarios in the context of landowners in a position to propose adaptation actions using conventional coastal armoring or green(er) options. The project will also contribute:

- Knowledge regarding how coastal stakeholders identify the relative value of critical coastal habitats in the context of their desire to sustain services of developed land-uses while protecting ecosystem assets affecting human well-being;
- Quantitative and qualitative evaluation of public priorities for rational use of coastal and marine space;
- Economic and social science-based information to aid communities developing plans for coastal resilience to be better able to identify policy or incentive alternatives that balance human-built and natural assets;
- Foundations for policy decisions that better align economic incentives with such public priorities.

Beneficiaries will include policy and legislative officials (through our outreach involvement), residents of coastal communities needing to understand the priorities of

their neighbors, and conservation organizations attempting to sustain ecosystem services.

Researchers and Staff Supported on Project:

- Stephen Swallow, Agricultural and Resource Economics and Center for Environmental Sciences and Engineering (Project Lead)
 - Christopher Elphick, Ecology and Evolutionary Biology
 - James O'Donnell, UConn Marine Sciences
 - Eric Schultz, Ecology and Evolutionary Biology
 - Jennifer O'Donnell, UConn Marine Sciences
 - Juliana Barrett, CT Sea Grant, Extension

How Will Sea Level Rise-Driven Shifts in Wetland Vegetation Alter Ecosystem Services?

(anticipated completion date: January 2019)

UConn CIRCA 'What We Do' Areas:

- *Living Shorelines*
- *Sea Level Rise*
- *Coastal Flooding and Waves*

Primary Funding: Long Island Sound Study – CT Sea Grant

This project examines how sea level rise (SLR) - induced shifts in vegetation will mediate ecosystem service provision by LIS coastal wetlands. Specifically, the project will: 1) quantify the delivery of ecosystem services associated with dominant tidal wetland plant species of the LIS; 2) examine impacts of SLR and interactions; 3) forecast how shifts in dominant tidal wetland species will alter ecosystem service provision of LIS coastal wetlands; 4) promote understanding of the complex interactions among SLR, coastal wetlands, and ecosystem services among diverse audiences in the LIS region.

Researchers and Staff Supported on Project:

- Beth Lawrence, UConn Natural Resources and the Environment (Project Lead)
 - Christopher Elphick, UConn Ecology and Evolutionary Biology
 - Ashley Helton, UConn Natural Resources and the Environment

Resilient Coastal Communities under Wind and Flood Hazards

(anticipated completion date: January 2019)

UConn CIRCA 'What We Do' Areas:

- *Coastal Flooding and Waves*
- *Policy and Planning*

Primary Funding: Connecticut Sea Grant

This project seeks to improve the resiliency of coastal communities by better understanding the trade-offs in single family residential (SFR) building design that is preferred for reduction of flood hazard exposure (via elevation) but, simultaneously, increasing exposure to wind-related hazards. Because flooding caused so much damage during Sandy, the adaptive response has been to change zoning regulations and building codes to require, in certain locations, elevation of single-family homes above new higher flood levels. For example, in Fairfield where flooding damaged thousands of homes, 48 single-family residences are now elevated with additional SFR elevations already in the planning stages. While elevating homes minimizes flood risk, these newly elevated homes may now be at greater risk from exposure to damaging winds.

Complicating wind hazard exposures in Connecticut and other New England regions are SFR building designs which tend to be multiple stories high (e.g., typical colonial) with steeply sloping roofs. These typical design elements exacerbate the potential risk from wind damage because building height and roof slope increase wind loads. And, while existing SFR homes must be elevated, no wind retrofit design elements are required to be installed during the elevation process. The question coastal communities' must consider is, do SFR elevation requirements without consideration of additional wind load exposure make their community more (or less) resilient? This project aims to help coastal communities answer this question by exploring the tradeoffs between flood and wind risks.

To evaluate these trade-offs, damage assessment methodologies for coastal communities under wind and flood hazards will be built and applied to real-world residential buildings in Fairfield and Milford. Deliverables include: 1) geographical information systems (GIS) based community resiliency maps for wind and flood hazards; 2) maps showing potential reductions in separate and multi-hazard vulnerabilities; 3) design parameters for new and retrofit SFR, such as recommended elevation height of low rise buildings to avoid flood hazard, building type or roof type and slope, etc.; and 4) educational materials on wind/flood hazard and recommendations to improve coastal community resiliency.

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