OPALUCH, URI
DHS COASTAL RESILIENCE CENTER
RESEARCH PROJECT
YEAR 3 PERFORMANCE REPORT
AND
FINAL PROJECT REPORT

Project Title: Overcoming Barriers to Motivate Community Action to Enhance Resilience

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Project Start and End Dates: 1/1/2016 – 6/30-2018

Short Project Description ("elevator speech"):

This project is designed to improve our understanding of how to overcome the "adaptation deficit" (Burton, 2004) within the context of community preparedness for coastal storm hazards. To do so, we adopt a social science-based framework of the stages of behavior change to identify key barriers to progress through the stages and to design interventions to overcome these barriers. Our approach employs the following methods: (1) group decision processes, (2) individual interviews, (3) a retrospective review of public dialog and (4) policy simulation exercises.

Summary Abstract:

The goal of this research is to improve our understanding of how we can increase "whole community" preparedness for coastal storm hazards. To do so, we apply insights from social science models of behavior change to help better understand how to increase the adoption of protective actions by individuals and communities.

Our project combines the following methods for identifying these barriers and designing interventions:

(1) Observe group decision processes,
(2) Carry out semi-structured interviews of stakeholders,
(3) Carry out a retrospective analysis of news reports and policy actions associated with storm events,
(4) Text effectiveness of interventions, and refine in response to what we learn

The primary project output is a report that provides recommendations for policy actions that show potential to increase the adaptation rate for protective actions by individuals and communities. These recommendations will be targeted to specific DHS programs, and tailored to specific stages of behavior change

PROJECT NARRATIVE:

1. Research Need:

This research contributes to DHS programs by helping to improve the resilience of communities that face risks from coastal storm hazards. It is widely recognized that national preparedness for hazards is not simply the responsibility of the government, but rather preparedness is a responsibility that is shared by everyone—including citizens, the private sector, and communities (e.g., Department of Homeland Security, 2014; National Academy of Sciences, 2012). Yet recent studies have shown that individual preparedness has remained largely unchanged for at least a decade (e.g., FEMA, 2014).

Our project seeks to identifying the barriers that have impeded "whole community" preparedness, and to design interventions to help overcome those barriers. This research embodies the September 15, 2015 Executive Order "Using Behavioral Science Insights to Better Serve the American People" which encourages agencies to conduct behavioral research to "… review elements of their policies and programs that are designed to encourage or make it easier for Americans to take specific actions …" (White House, 2015).

The Behavioral Science literature demonstrates that simply providing information is not generally an effective means of bringing about behavior change (e.g., Velicer et al, 1998; Stern, 2000; Scott, 2002; Moser and Ekstrom, 2010), Rather, increasing the adoption rate of behaviors to mitigate storm effects is challenging (Kesete et al. 2014; Carson et al., 2013; Moser and Ekstrom, 2010). We adopt the lessons of theories of behavior change, that recognize the need for carefully planned and well-designed interventions that are tailored to the specific needs of various groups in order to help to expedite change (e.g., Velicer et al. 1998; Moser and Ekstrom, 2014; Lindell and Perry, 2012).

A key lesson of this scientific literature is that behavior change is not an event, but rather is a process that occurs over a series of stages. The most effective behavior-change programs will identify the specific barriers that impede progress through the various stages, and will apply interventions that are tailored to overcome these specific barriers.

The project outcomes also include development and testing of policy simulation tools, such as storm impact visualizations, that can be used to help improve decision making by helping end users better understanding the consequences action (or inaction). Our current project will test the potential of these policy simulation tools to help overcome barriers to increasing the adoption rate of protective actions. Note that development of some of the policy simulation tools are part of leveraged activities led by Dr. Austin Becker, and are being tested in this project, as discussed below.

Consistent with the spirit of the DHS "Whole Community" approach, we will disseminate project-related information as widely as possible. We will also transmit information to representatives of the private sector, and to federal, state, local government officials by leveraging ongoing planning activities in which project co-PIs routinely participate.

2. History:

In the first calendar year of the project, our goal was to participate in, and observe various group decision processes on coastal storm hazards with a goal of listening to the "conversation" about storm preparedness among various stakeholder groups, including federal, state and local government officials, representatives of NGOS and other interest groups (e.g., builder associations), as well as private citizens. A list of events in which we participated during year 1 is attached as Appendix I to this document. Note that we actually began this activity before funding of the project officially started, and continued to attend events as they were scheduled through June 2017.

As part of these events, we noted key points that participants made regarding barriers that impede Whole Community preparedness, and developed hypotheses on the kinds of interventions that could help overcome these barriers. Phase II of the project began in June 2016, which involved carrying out a series of one-on-one and small group interviews to serve as follow up to get more information on the barriers and interventions we heard in the group meetings. All participants in the interviews were assured that we would not release the name of those who participated in interviews, so confidentially precludes us from listing interviews. However, we carried out a total of 18 interviews with representatives of the same categories of stakeholder groups indicated above.

Starting in Summer 2017, we carried out a thorough analysis of news reports and policy actions regarding specific storm events. The goal here is to obtain information from print media to supplement what we heard orally in group meetings and individual interviews, and to document the institutional memory that has been accumulating over time in key organizations with respect to their understanding and use of putting science to action and into policy.

Specifically, this analysis describes the findings gathered from the following methods of analysis: (1) an aggregate timeline of hazard events, studies, and plans and policies; (2) a database of RI Coastal Resource Management Council (CRMC) permits with illustrations, both geographically and over time by number and type of ascent to document coastal hazards policy implementation by the CRMC; (3) a social network map documenting RI engagement regarding resilience policy among state organizations and with stakeholders; and (4) vignettes describing selected cases of locations or policies significant to resilience policy in RI to provide context for connections between each of the products described above and to assist in identifying the "semantic language" in print and in speech used to describe barriers to action to enhance resilience.

The final phase of the project was to incorporate interventions into regional storm hazard planning processes, to test the effectiveness of interventions to the extent feasible, and to refine interventions in response to what we learned during testing. Several of the activities reported below involved supplementary funding that leveraged DHS Center activities.

This phase of the research included (1) advancing methods for creating data-driven visualizations of storm damages to help stakeholders better envision the consequences of storms, (2) carrying out a pilot survey to provide a preliminary test of the effectiveness of these storm visualizations, (3) creating a resilience planning exercise for port stakeholders, (4) carrying out a survey of 22 medium- and high-use ports of the USACE North Atlantic Division to assess level of agreement on the barriers to coastal hazard adaptation, (5) creating a decision support tool to help

communities better understand the consequences of actions to mitigate storm hazards (e.g., comparing flood and erosion control using sea walls vs. living shorelines)

3. Results:

Below is a listing of project results, outputs and outcomes, including a short explanation of each. The major project output is a report that provides details on each of these, that we provide as a separate stand-alone document.

(1) Listing of key barriers and interventions.

This project outcome lists the key barriers to adaption and the interventions that we have identified, with short explanations of each. Here we list each, but without substantive discussion.

1. Many community members do not see coastal storm hazards as high priories. Potential storm hazards are not viewed as urgent enough to command attention, as stakeholder have other items on their minds that they view as more urgent.
2. Related to item 1 above, storm hazards are often viewed as "theoretical" to respondents, and not "real" enough to command their attention adequately to motivate action until it is too late.
3. Opportunity: The immediate aftermath of storms has been described as the "window of opportunity" to elicit adaptation actions on the part of stakeholders. This is a time when storm hazards have people's attention, and are recognized as "real" hazards. Furthermore, in many cases repairs are needed, and it is less costly and more less of an inconvenience to take many of the actions necessary prepare for future storms. In an extreme case, if a building is totally destroyed, it needs to be rebuilt. This is the time to build a structure that is more storm resistant, or relocated further from storm hazards.
4. Barrier related to item 3 above: In the immediate aftermath of a storm people want to be life "back to normal" as quickly as possible. In some cases, building permits are needed to carry out repairs, and permits often are expedited if the structure is to be rebuilt exactly as it was before (Note, however, that in some cases if damage is greater than a stated percentage of the value of the structure, repairs are required to meet updated building codes, that often require a greater level of storm resistance).

   As a consequence, many community members may miss the opportunity provided by the immediate aftermath of a storm.

5. Intervention related to item 4 above: The immediate aftermath of a storm may be an opportunity to take action to increase preparedness for the next storm, but it is *not* the correct time to plan for future preparedness. Plans must be in place ahead of the storm, and rebuilding should be expedited when property owners are taking steps to improve storm resistance (including relocation).

   Property owners are not aware of property-specific storm hazard vulnerabilities they face, what actions to take, or even how to go about learning about how to improve preparedness. It is currently too inconvenient for many property owners to get this information, and as a consequence they do not seek out this information. Especially during the so-called "window of opportunity" in the immediate aftermath of a storm.

   Intervention:

- Develop free or required storm preparedness audits which provide property owners with information on their specific vulnerabilities, and how to go about addressing these vulnerabilities.
- Homeowners who take actions recommended in storm vulnerability audits might obtain tax credits, insurance discounts, cost sharing, and/or other financial inducements to take actions to reduce vulnerability. Certain actions might be required in order to get insurance, or insurance companies might finance actions that are paid back as part of annual insurance premiums.
- Permits required to repair after storm damage might be expedited, or permits might be denied altogether unless high priority recommendations from audits are undertaken.

(2) Aggregate timeline of hazard events, studies, and plans and policies:

This product documents the institutional memory that has been accumulating over time in key organizations with respect to their understanding and use of putting science to action and into policy. As indicate above, this product includes the following: (1) an aggregate timeline of hazard events, studies, and plans and policies; (2) a database of RI Coastal Resource Management Council (CRMC) permits with illustrations, both geographically and over time by number and type of ascent to document coastal hazards policy implementation by the CRMC; (3) a social network map documenting RI engagement regarding resilience policy among state organizations and with stakeholders; and (4) vignettes describing selected cases of locations or policies significant to resilience policy in RI to provide context for connections between each of the products described above and to assist in identifying the "semantic language" in print and in speech used to describe barriers to action to enhance resilience.

An Excel work book includes a chronological listing the set of documents and resources collected for the timeline provide the basis for understanding many of the federal, state, and municipal planning and decision-making responses along with hazard events. Many of the studies collected for the hazard events and hazards studies timelines have informed the construction of aggregate timeline inclusive of hazard plans and policies. The initial test of Timeline JS revealed that customized programming would have been required to accommodate the full layers of content so that outlet for the information was set aside.

Public information and policy accompanies the unfolding of storm events and other processes such as shore erosion and accretion and runoff from storms. The bibliography of over 1,000 entries includes pure hazard studies, mixed documents with some technical analysis and planning or policy recommendations, and adapted legislation and regulation. Entries range from National Weather Service's coverage of a flood in March 1936 resulting from melting of larger than normal snowmelt combined with rainfall that affected all of New England to an article in ricentral.com (a collection of media coverage for six Southern Rhode Island newspapers) of a planning board discussion about Transportation Improvement Program (TIP) application priorities. The review of policy covers federal, state and municipal planning and decision-making responses aligned with storm events and studies.

(3) Barriers to Port Preparedness

This research effort provides empirical data supporting the notion that a void in leadership serves as a significant barrier to resilience planning, at least in the case of the Port of Providence (Rhode Island, USA). The project proposes a definition of leadership within the context of port

resilience, and identifies commonalities and differences in port stakeholder perceptions regarding port leadership in adaptation to flooding hazards.

First, the research activity participated in workshop of stakeholders in port resilience planning, and participants in the workshop were recruited to complete an online survey. The goal of the survey was to compare perceptions of different stakeholders regarding leadership responsibility. The results of this survey were used as a starting point in conducting personal interviews with representatives of the organizations identified as having leadership responsibility. This study finds stakeholder perceptions of leadership responsibility contribute to an institutional void, in which it is unclear who is responsible and who should pay for resilience investment. This research emphasizes the need for pre-planning dialogue to develop consensus and build momentum for resilience investment strategies. The specific findings are outlined below.

Survey findings:

Stakeholders see a collaborative effort as responsible to implement resilience strategies and believe planning should begin now. But the survey indicated that this is no clear consensus among respondents on who is responsible for providing leadership. Private sector respondents indicated that public leadership is required, while representative of the public sector indicated the business community should take the lead.

Private and public stakeholders also disagreed on who should pay for specific resilience actions. Over 50% of the private sector respondents felt that they had little or even no financial responsibility for resilience investments and the majority felt that state and federal governments were the most responsible. Public sector respondents, on the other hand, tended to favor more of a shared approach. This might take the form of public/private partnerships, for example, or other strategies that involve private sector funding for resilience.

Interview Findings:

We conducted interviews with seven of the nine organizations most frequently mentioned as having leadership responsibility in the online survey. Interview results showed that six of the seven interviewees stated that their organization is (or should be) a leader in resilience implementation. But they also indicated barriers that limit their ability to implement resilience planning. Three main barriers that limit the ability to provide leadership are (1) lack of expertise, (2) lack of jurisdiction or mandate, and (3) lack of resources. Also, many of those who perceived of themselves in a leadership role, indicated they should be a partner or supporter, not as the "main" leader. The interviews also found that there is a need for dialogue among all stakeholders to help motivate organizations into a leadership role.

(4) Agreement on barriers to port adaptation to storm hazards

This research component employs a cultural consensus model (CCM) to assess the level of agreement among stakeholders

For the analysis, the researchers will use a cultural consensus model (CCM) to assess the three studies groups level of agreement on the barriers to climate change adaptation within the larger context of the port community's resilience.

Climate change investigations stress how decision-making barriers slow the development and implementation of needed adaptation strategies (Moser and Ekstrom, 2010). Although planning for adaptation is more prevalent today than 10 years ago (Becker et al., 2011), overall, the

implementation of risk adaptation measures is still scarce (Moser and Ekstrom, 2010, Biesbroek, 2011). Ports and critical coastal infrastructures are already being damaged by heavy rains, storms, sea level rise (SLR), and extreme heat damage (Melillo et al., 2014). It is imperative that as natural, unpredictable threats increase, our ability to strategically plan and respond to these threats is not challenged by not being informed, nor addressing the barriers to adaptation. In order to assist the Department of Homeland Security and other decision makers, to understand and prepare for coastal storm hazards and increase the port community's resilience, we propose an assessment of the decision-makers' barriers to climate change adaptation by surveying port directors/managers, safety officers and environmental risk officers in 22 medium and high-use ports of the USACE North Atlantic Division. For the analysis, the researchers will use a cultural consensus model (CCM) to assess the three studies groups level of agreement on the barriers to climate change adaptation within the larger context of the port community's resilience.

(5) Use of Visualizations to Motivate Storm Adaptation

As indicated above, an important barrier taking protective actions the fact that many stakeholders view storm hazards as "theoretical", and not of immediate priority. Visualizations have been shown to play an important role in making seemingly abstract risks like future sea level rise seem tangible in relevant local contexts (Sheppard, 2015). We find that visualizations of storm damages have become an important part of engaging the public and communicating risks, and are often used in combination with other exhibits and interactions in workshop processes (e.g., Becker 2016). Visualizations of damages in the stakeholders' own community can help communicate risks by demonstrating that "it can happen here" (Sheppard, Shaw, Flanders, & Burch, 2008).

At the same time, concerns have been raised regarding some effects of visualizations. For instance, compelling visualizations of sea level may cause people to focus on their exposure to that risk and discount other risks that are more difficult to model and visualize (e.g., wind, precipitation) (Moser & Dilling, 2011). Visualizations have also been criticized for potentially overstating the resolution and certainty of predictions (Kostelnick et al., 2013).

Given these concerns, the project tested the effects of visualizations to determine whether these phenomena are taking place, and, whether visualizations are in and of themselves having positive effects on overcoming barriers to community preparedness.

Findings

Among key findings regarding the perceptions of visualizations are results that specifically relate to overcoming barriers. Evaluations of effects on risk perception suggest that individuals are more likely to discount highly personal risks (e.g., effects to their individual property) as opposed to risks that impact communities more generally (e.g., depictions of adjacent communities or publicly recognizable locations). Results also suggest that disbelief and discounting increases as scenarios diverge from what audiences already expect.

This research also finds that both experts and the public expect that historic storms are the most robust basis for projections of future inundation. This is potentially problematic in situations where probabilities of higher impact storm events are increasing, for example where a hundred year historic storm might now be more like a 20-year storm. This suggests that visualizations might be effective by indicating impacts of likely future storms. Providing this context will

signal credibility by acknowledging existing expectations and may thus increase acceptance of the projections together.

Other results suggest that concerns over misleading characteristics of 3d visualizations may be over-stated. The use of these visualizations in risk communication has been limited by concerns that by being detailed and evocative, they overstate the certainty of a risk and therefore be misleading. These and other effects suggests that modest, semi-realistic visualizations may be able to combine the positive orienting effects of 3d visualizations without diminishing authority to the point that they are ineffective.

This research strongly suggests that overcoming barriers to improved risk communication hinges on understanding audience expectations and avoiding "fear appeals" that emphasize extreme scenarios or that seek to shock audiences. This research reinforces these findings that the ineffectiveness of fear appeals potentially introduces problems where probabilities of storms are increasing. These tools will maximize engagement and acceptance, and thus aid in overcoming barriers.

Impacts

4. End Users and Transition Partners:

Models and Visualizations:

The project created visualizations that contribute to planning for coastal hazards. The visualizations have received a great deal of attention, and have been used, or will be used, as part of the following planning processes:

Rhode Island Coastal Beach Special Area Management Plan (RI Beach SAMP):
- Matunuck (South Kingstown) Rhode Island
- Misquamicut (Westerly) Rhode Island
- Charlestown Rhode Island
- Warwick, Rhode Island
- Barrington, Rhode Island (in progress)
- Warren, Rhode Island (in progress)
- Bristol, Rhode Island (in progress)

Federal Emergency Management Agency Integrated Emergency Management Course (FEMA IEMC), June 2017:
- Pawtucket Rhode Island (maps)
- Providence Rhode Island (community wide 3d)
- Middletown Rhode Island (community wide 3d)
- Westerly Rhode Island (community wide 3d)

Port Planning for the following entities:
- Port of Providence, Providence Rhode Island
- Port of Davisville, Rhode Island (in development)
- Port of Galilee, Rhode Island

Analysis of 25-Year History of Coastal Management in Rhode Island:

The project developed an analysis of news media, government reports, legislative actions, coastal management permits and other public documents to provide an analysis that compiles: (1) an aggregate timeline of hazard events, studies, and plans and policies; (2) a database of RI Coastal Resource Management Council (CRMC) permits with illustrations, both geographically and over time by number and type of ascent to document coastal hazards policy implementation by the CRMC; (3) a social network map documenting RI engagement regarding resilience policy among state organizations and with stakeholders; and (4) vignettes describing selected cases of locations or policies significant to resilience policy in RI to provide context for connections between each of the products described above and to assist in identifying the "semantic language" in print and in speech used to describe barriers to action to enhance resilience.

The information presented here has been requested by end users to provide documentation of the institutional memory that has been accumulating over time in these organizations with respect to their understanding and use of putting science to action and into policy. A final version of the technical report will be provided to the CRMC taking into account a selection of additional information to complement the findings and recommendations of the Shoreline Change SAMP.

Adaptation Strategies:

Cape Cod Commission will use project-generated data to develop a decision support tool to help government officials and private parties better understand the intended and unintended consequences of different strategies to adapt to coastal flooding and other coastal storm hazards. Adaptation strategies include actions such as the following:

- Beach Nourishment
- Artificial Sand Dunes and Dune Nourishment,
- Salt marsh creation and restoration on coastal beaches
- Planting Vegetation to Reduce Erosion and Storm Damage,
- Living Shoreline
- Sand fencing
- Seawall
- Rip Rap
- Managed Realignment
- Coastal Setbacks
- Elevating and relocating buildings

5. Project Impact:

The outputs from this work have supported resilience and risk communication efforts in 14 specific communities, and across the State of Rhode Island, this has included the training of emergency managers and first responders in collaboration with the Rhode Island Emergency Management Agency and the Coastal Resources Management Council. Visualizations were created for the Beach Special Area Management Plan (Beach SAMP) to be used in local public engagement processes in Matunuck, Misquamicut (Westerly) Warwick, Charlestown, Barrington, Bristol, and Warren Rhode Island. These visualizations have become essential parts of the engagement processes conducted by the SAMP. Integration of visualizations into the SAMP process suggests that there are some issues surrounding the depiction of specific damages

to individual structures. To the extent that there are no regulatory structures or means to address the specific impacts or vulnerabilities revealed there is discomfort with their publication or distribution. These experiences lend credence to the approach of placing emphasis on qualitative impacts identified by stakeholders: identifying specific concerns that are relevant and actionable. Additional collaborators include: University of Rhode Island, Coastal Resilience Center (CRC) and the State of Rhode Island, Coastal Resources Management Council (CRMC).

Hazard impact models and visualizations were deployed to support a Federal Emergency Management Agency Integrated Emergency Management Course (FEMA IEMC) in collaboration with the Rhode Island Emergency Management Agency, RIEMA. These included visualizations of Westerly, Providence, Middletown, and Pawtucket Rhode Island, and statewide assessment of damages. Additional support was provided by the Department of Homeland Security Office of Cyber and Information Security (DHS OCIS). Deployment included developing time incremented hazard impact models including qualitative impacts, and matching time incremented visualizations of inundation. The process of integrating the time incremented model into an existing simulation exercise made it immediately clear that many of the resources used in these kinds of training exercises (e.g. impacts derived from historic storms) were not well synchronized with the unfolding of the simulated storm. The use of the time incremented simulation made it possible to understand not only what happened, but when impacts occurred relative to other events. Given the significance of access to remote barrier islands for purposes for evacuation and the effects of wind on transportation, the timing of these effects has significant impact on response.

We have compiled a large database information from print media, government reports, legislative actions, etc. The product is a document that includes the following: (1) an aggregate timeline of hazard events, studies, and plans and policies; (2) a database of RI Coastal Resource Management Council (CRMC) permits with illustrations, both geographically and over time by number and type of ascent to document coastal hazards policy implementation by the CRMC; (3) a social network map documenting RI engagement regarding resilience policy among state organizations and with stakeholders; and (4) vignettes describing selected cases of locations or policies significant to resilience policy in RI to provide context for connections between each of the products described above and to assist in identifying the "semantic language" in print and in speech used to describe barriers to action to enhance resilience.

We have developed data and methods for assessing different coastal management adaptation strategies, such as building sea walls, living shorelines, beach nourishment, etc. This information is in the process of being incorporated into a decision support system being developed by Cape Cod Commission. The goal of this system is to serve as an education tool, to help inform communities, government officials and private parties of the likely intended and unintended impacts of these adaptation strategies.

6. Student involvement and awards:

In the spring 2017 semester we ran a Capstone Class with 27 students in the Department of Environmental and Natural Resource Economics. The Capstone is a senior-level class, in which students carry out a detailed case study of direct policy significance applying the methods that they learned throughout their undergraduate careers.

This Capstone focused on the issue of improving storm resilience in coastal communities, with a case study of Misquamicut, Rhode Island. Misquamicut is an excellent case study, as it is

coastal beach community that is extremely vulnerable to inundation by coastal storms, and as has a repeated history of hurricane devastation including the Great New England Hurricane of 1938, Hurricanes Carol in 1954, Gloria in 1985, Bob in 1991, Irene in 2011 and most recently Sandy in 2012.

The Capstone project was coordinated with Capstone classes in the Ocean Engineering Department and the Landscape Architecture Department to create an interdisciplinary collaboration that focused on increasing the resilience of Misquamicut to coastal storm hazards. The students in the three Capstone classes met periodically throughout the semester, and shared research plans, project data and research findings. At the end of the semester the students from the three Capstone classes hosted an event with public presentations of their findings to a set of "whole community" end users.

The Ocean Engineering Capstone project analyzed potential physical damages to properties in Misquamicut for scenarios of varying hurricane intensity and sea level rise. Landscape Architecture students created different designs for communities to improve storm resilience. Environmental Economics students in our Capstone carried out three sets of analyses:

(1) A cost-benefit analysis of alternative structural solutions, including shoreline armoring, beach renourishment, elevating structures and retreat from hazard zones;
(2) A housing value assessment to see whether coastal storm threats are reflected in housing prices;
(3) A survey of the local public on risk attitudes and willingness to take protective actions.

The survey was used as a pilot test of the effectiveness of storm visualizations. Roughly 110 respondents were assigned to two groups: a treatment group that was shown visuals of storm impacts and a control group that was not shown visuals. Aggregate survey responses were compared across the control and treatment group to test the hypothesis that visualizations of storm impacts affected the respondents' perceived risk of coastal storms, and to compare stated intentions to take protective actions with vs without storm visualizations. We found that the visualizations show promise in preparing communities to adapt to storm hazards, both in terms of an increased perception of storm risks, and in terms of a stated willingness to take protective actions.

7. Interactions with education projects:

We have funded Courtney Hill from Tougaloo College to serve as a summer intern for our project. The goal of the internship is to expose Courtney to rich and varied educational experience centered on adaptation to coastal hazards. The primary project-related activity is participating in our retrospective review and timeline of community response to storm events by analyzing the content of various types of reports, data bases, interviews and news coverage of coastal hazards. This activity will develop a timeline of coastal storms and associated community response to provide a longer terms perspective on barriers to adaptation and potential interventions. This review will utilize state agency permit data; reports of state and local policy responses; content analysis of newspaper coverage of post-storm events; and identification of patterns of decision making. The findings will be reported in the form of a timeline of events and associated responses. The student intern will participate in team meetings, and have the opportunity to engage in other coastal resilience meetings and activities of the URI-CRC project.

8. Publications:

Becker, A., (2016). "Findings from a port vulnerability assessment." Dept. of Homeland Security Center of Excellence for Coastal Resilience and University of North Carolina Maritime Risk Symposium University of North Carolina, Chapel Hill, North Carolina, Nov. 14-15, 2016, scheduled. (I).

Becker, A, (2016). "Adapting ports to climate change: Providence (RI) Case Study," AIVP Ports and Cities Conference, Netherlands, Oct 10-12, scheduled.(I)

Becker, A., (2016). "Inspiring leadership for Adaptation," North American Symposium on Climate Adaptation, New York, New York. Aug. 16-18, scheduled. (I)

Becker, A., (2016). "Inspiring resilience thinking for seaport systems." Transportation Research Board Conference for Committee on Maritime Transportation System (CMTS), National Academy of Sciences, Washington, DC, June 21-22, scheduled.

Becker, A, (2016). "Adapting ports to climate change: Providence (RI) Case Study," Adaptation Futures 2016, Rotterdam, Netherlands May 11-13.

Becker, A., (2016). "Inspiring resilience thinking for seaport systems." Green Ports for Blue Waters Conference, University of Rhode Island April 4-5, (I)

Green, W., Becker, A., (2016). "Built environments and rising seas: Service learning recommendations for the future of the Port of Galilee." A presentation of student work resulting from a course on resilient planning, policy, and design. Keeping History Above Water Conference, Newport, Rhode Island, April 10-13 .

Becker, A. (2016). "Hurricane Resilience and Impacts to Seaport Supply Chains." Invited Speaker for the 2016 Stu Clark Speaker Series at the University of Manitoba. March 4 (I,E)

McIntosh, R.*, Becker, A. (2016). "Towards a Comparative Index of Seaport Climate-Risk: Development of Indicators from Open Data." Poster presentation at American Geophysical Union 2016 Ocean Sciences Meeting, New Orleans, LA, Feb. 21-26.

Kretsch, E.*, Becker, A. (2016). "Leadership and Responsibility for Long-term Hurricane Resilience: Stakeholder Perceptions in the Port of Providence, RI." Social Coast Conference. Charleston, SC, Feb. 11.

Becker, A., Burroughs, R. (2016). "More holistic planning for long-term coastal resilience? Port of Providence Demonstration Project." Social Coast Conference. Charleston, SC, Feb. 10.

Becker, Austin, Pamela Matson, Martin Fischer, and Michael D. Mastrandrea, Forthcoming. "Towards Seaport Resilience for Climate Change Adaptation: Stakeholder Perceptions of Hurricane Impacts in Gulfport (MS) and Providence (RI)" *Progress in Planning*. Status: Accepted for Publication. Anticipated Publication Date November 2017.

Zhang, H., Ng, A., Becker, A. (In Press), "Institutional Barriers in Adaptation to Climate Change at Ports, Regions, and Supply Chains." North American Symposium on Climate Adaptation, New York, New York. Aug. 16-18, 2016. (Refereed Conference Paper)

Touzinsky, K, Rosati, J., Fox-Lent, C., Becker, A., Luscher, A., 2016. "Advancing Coastal Systems Resilience Research: Improving Quantification Tools through Community Feedback" *Shore and Beach* Vol. 84 No. 4 · November 2016.

Kuffner, A. (2016, November 20, 2016). Rising Seas, Rising Stakes. Providence Journal.

Spaulding, M. L., Grilli, A., Damon, C., Crean, T., Fugate, G., Oakley, B., & Stempel, P. (2016). Stormtools: Coastal Environmental Risk Index (CERI). Journal of Marine Science and Engineering, 4(3).

Stempel, P. (2016). Data Driven Visualization. Paper presented at the ECM14, Estuarine and Coastal Modeling Conference, South Kingstown, RI, June 14-17.

Stempel, P. (2018). Are visualizations scientific? How viewer expectations for scientific graphics shape perceptions of storm surge visualizations. Technical Communication Quarterly (In press).

Stempel, P., Ginis, I., Ullman, D. S., Becker, A., & Witkop, R. (2018). Real-Time Chronological Hazard Impact Modeling (In preparation).

Stempel, P, Becker, A. (2018). Visualizations out of context. Implications of using simulation based 3d hazard visualizations (submitted).

Stempel, P., Becker, A. (2018). Perceptions of risk and legitimacy: how scenario selection and presentation of ocean models undermines disaster risk reduction. Paper to be presented at the ECM15, Estuarine and Coastal Modeling Conference, Seattle, WA, June 25-27.

Witkop, R., Stempel, P., Becker, A. (2018). “Incorporating facility manager knowledge into storm impact models: A case study of critical facilities in Westerly, Rhode Island.” Oral presentation. 2018 Rhode Island Flood Mitigation Association Annual Conference. Smithfield, RI. Apr. 5.

Witkop, R., Stempel, P., Becker, A., (2017). “Coupling local scale, high resolution, qualitative data to interface with numerical storm models.” Poster Presentation. American Geophysical Union Annual Conference, New Orleans, LA. December 12.

Robadue, Donald D. and Dawn Kotowicz, 2018. “Understanding resistance to resilience in coastal hazards and climate adaptation: three approaches to visualizing structural and process obstacles, opportunities and adaptation responses” Submitted to the 52nd Hawaii International Conference on System Sciences, Disaster Information, Technology, and Resilience Mini-Track of the Digital Government Track, June 16.

9. Tables:

Table 1: Documenting CRC Research Project Product Delivery

Product Name	**Product Type** (e.g., software, guidance document)	**Delivery Date**	**Recipient or End User**
Decision Support System for Coastal Hazard Mitigation Actions	Data and Software to Integrate into Decision Support Tool	April 2018	Cape Cod Commission
Data-Driven Visualizations of Storm Impacts	Images to Communicate Storm Impacts	June 2017	Federal Emergency Management Agency Integrated Emergency Management Course (FEMA IEMC) in collaboration with the Rhode Island Emergency Management Agency, RIEMA.

Table 2A: Documenting External Funding

Title	PI	Total Amount	Source
Assessing Coastal Hazard Mitigation Strategies	James Opaluch	$75,000	Cape Cod Commission

Table 2B: Documenting Leveraged Support

Description (e.g., free office space; portion of university indirects returned to project; university-provided student support)	**Estimated Total Value**

Table 3: Performance Metrics: OPALUCH

Metric	Year 1 (1/1/16 – 6/30/16)	Year 2 (7/1/16 – 6/30/17)	Year 3 (7/1/17-6/30/18)
HS-related internships (number)			1
Undergraduates provided tuition/fee support (number)			
Undergraduate students provided stipends (number)			
Graduate students provided tuition/fee support (number)			
Graduate students provided stipends (number)		1	
Undergraduates who received HS-related degrees (number)			
Graduate students who received HS-related degrees (number)			
Graduates who obtained HS-related employment (number)			
SUMREX program students hosted (number)		1	1
Lectures/presentations/seminars at Center partners (number)	2	3	
DHS MSI Summer Research Teams hosted (number)			
Journal articles submitted (number)	2	9	6
Journal articles published (number)		3	3
Conference presentations made (number)	13	18	7
Other presentations, interviews, etc. (number)	5	4	4
Patent applications filed (number)			
Patents awarded (number)			
Trademarks/copyrights filed (number)			
Requests for assistance/advice from DHS agencies (number)	2		
Requests for assistance/advice from other agencies or governments	5		
Total milestones for reporting period (number)	26	38	22
Accomplished fully (number)	20	36	22
Accomplished partially (number)	6	2	0
Not accomplished (number)		0	0

1. Year 3 Research Activity and Milestone Achievement:

Research Activities and Milestones: Final Status as of 2018
Reporting Period 7/1/2017 – 6/30/2018

Research Activities	Proposed Completion Date	% Completed	Explanation of why activity/ milestone was not reached
Group Decision Processes	9/30/2017	100%	
Pretest and Revise Policy Simulation Tools	12/31/2017	100%	
Research Milestone			
Updated List of Barriers and Interventions for Behavior Change	9/30/2016	100%	
Draft Policy Simulation Tools (updated quarterly)	10/1/2017 & 12/31/2017	100%	

2. Year 3 Transition Activity and Milestone Status:

Transition Activities and Milestones: Final Status as of 2018
Reporting Period 7/1/2017 – 6/30/2018

Transition Activities	Proposed completion date	% completed	Explanation of why activity / milestone was not reached
Continue updates/newsletter and/or periodic virtual meetings to remain fully connected with the end-users.	12.31/2017	100%	
Barriers and Interventions for Actions to Mitigate Storm Damages	12/31/2017	100%	
Design, Pretest and Revise Policy Simulation Tools	12/31/2017	100%	
Organize a Northeast / Mid-Atlantic regional workshop to demonstrate, train and utilize the tools that have been developed. Logistics and resource support for this workshop will be coordinated with the Transition Director, Tom Richardson as appropriate.	Fall 2017	100%	
End of period report out to end-users	Dec 31, 2017	100%	
Transition Milestone			
Training workshop for DHS, NOAA/NWS and RI stakeholders.	July 2017	100%	

Appendix A Summary of Group Decision Meetings[1]

Meetings to Date

1. Rhode Island Legislative Commission on Economic Impacts of Sea Level Rise and Coastal Flooding. (September 24, 2015) Legislative Hearings on economic threats of sea level rise and coastal flooding.
2. Rhode Island Legislative Commission on Economic Impacts of Sea Level Rise and Coastal Flooding. (Oct 15, 2015) Legislative Hearings on economic threats of sea level rise and coastal flooding.
3. Municipal Adaptation Work Session, New Shoreham. (Oct 22, 2015). Purpose: Assist communities to understand exposure to coastal storm hazards, plan for action to reduce risk and implement plans. Increase awareness of tools, planning requirements and adaptation strategies.
4. Municipal Adaptation Work Session, Westerly. (Oct 29, 2015) Purpose: Assist communities to understand exposure to coastal storm hazards, plan for action to reduce risk and implement plans. Purpose: Assist communities to understand exposure to coastal storm hazards, plan for action to reduce risk and implement plans. Increase awareness of tools, planning requirements and adaptation strategies.
5. Municipal Adaptation Work Session, Charlestown. (Oct 29,2015) Purpose: Assist communities to understand exposure to coastal storm hazards, plan for action to reduce risk and implement plans. Purpose: Assist communities to understand exposure to coastal storm hazards, plan for action to reduce risk and implement plans. Increase awareness of tools, planning requirements and adaptation strategies.
6. Municipal Adaptation Work Session, North Kingstown. (Nov 11, 2015) Purpose: Assist communities to understand exposure to coastal storm hazards, plan for action to reduce risk and implement plans. Purpose: Assist communities to understand exposure to coastal storm hazards, plan for action to reduce risk and implement plans. Increase awareness of tools, planning requirements and adaptation strategies.
7. Rhode Island Legislative Commission on Economic Impacts of Sea Level Rise and Coastal Flooding (Nov 19, 2015) Legislative Hearings on economic threats of sea level rise and coastal flooding.
8. Rhode Island Legislative Commission on Economic Impacts of Sea Level Rise and Coastal Flooding. (December 17, 2015) Legislative Hearings on economic threats of sea level rise and coastal flooding.
9. Town of South Kingstown, Municipal Adaptation Work Session. (January 20 2015) Purpose: Assist communities to understand exposure to coastal storm hazards, plan for action to reduce risk and implement plans. Increase awareness of tools, planning requirements and adaptation strategies.
10. Rhode Island Legislative Commission on Economic Impacts of Sea Level Rise and Coastal Flooding. (January 21, 2016) Legislative Hearings on economic threats of sea level rise and coastal flooding.
11. #ResilientPVD Community Workshop. A team of experts from around the country come to Providence for three days of charrettes, workshops, and community meetings to explore how Providence's infrastructure, buildings, and neighborhoods can prepare for the impacts climate change. (February 1- 3, 20016)
12. Beach SAMP meeting, Meeting of State and Town leaders to discuss adaptation to sea level rise and coastal flooding threats. (February 4, 2016)
13. Meeting of Community Leaders to Discuss historic and potential future impacts of coastal flooding, and actions to mitigate impacts. (February 16, 2016)

[1] Note that some of these meetings are periodic events that involve attending multiple meetings.

14. Rhode Island Legislative Commission on Economic Impacts of Sea Level Rise and Coastal Flooding. Legislative Hearings on economic threats of sea level rise and coastal flooding. (February 25 2016)
15. BeachSAMP meeting. Meeting of State and Town leaders to discuss adaptation to sea level rise and coastal flooding threats. (April 6, 2016)
16. ANNUAL RIFMA CONFERENCE - "Incentivizing Actionable Resilience to Flooding" - Join floodplain management and hazard mitigation professionals as we explore implementation tools and techniques, and share experiences and lessons learned from the past to improve resiliency in the present and future. (April 7, 2016)
17. Keeping History Above Water Conference, Newport, RI. One of the first national conversations to focus on the increasing and varied risks posed by sea level rise to historic coastal communities and their built environments. This is not a conference about climate change, but about what preservationists, engineers, city planners, legislators, insurers, historic home owners and other decision makers need to know about climate change—sea level rise in particular—and what can be done to protect historic buildings, landscapes and neighborhoods from the increasing threat of inundation. (April 10-13, 2016)
18. RI Silver Jackets (RIEMA, Cranston) - Meeting of Interagency coalition to reduce flood risk. State-led teams, implementation of USACE National Flood Risk Program (April 14, 2016)
19. DC DHS Presentation and discussion with DHS HQ and others on how to link with their efforts. (April 14, 2016)
20. RI Coastal Erosion Control Workshop (April 21, 2016) http://www.crmc.ri.gov/news/pdf/2016_0421_Workshop_Flyer.pdf
21. Meeting with and presentation by NOAA's Joint Hurricane Testbed Director/Science and Operations Officer at the National Hurricane Center. Discussion of all three URI projects funded by DHS, and lecture "Inside the Eye: Improving Hurricane Forecasts". (May 3, 2016)
22. BEACHSAMP Stakeholder Meeting with presentation from Michael Oppenheimer, speaking about climate change and the IPCC. (May 3, 2016)
23. Estuarine and Coastal Modeling Conference (ECM14) at URI - Rick Luettich (UNC lead) will be a keynote, Meeting with Rick Luttich with our team and other key users, including Coast Guard, and possibly other DHS leaders. (June 12-15, 2016)
24. New England Climate Adaptation, Preparedness, and Resilience seminar - Organized by DHS Infrastructure Protection, EPA, FEMA, NOAA, NH Department of Safety. First in a series of New England seminars. (May 24 – 25, 2016)
25. Preparedness Conference (CCRI) - Series of presentations, trainings, and exhibits. http://www.riema.ri.gov/resources/government/prepare/preparednessconference/index.php (August 10-11, 2016)
26. RI Shoreline Change Special Area Management Plan Meeting, (August 25, 2016)
27. Presentations on Misquamicut Storm Vulnerability. Presentations by Rhode Island Officials to Capstone Classes. (Feb 3, 2017)
28. Coastal Storm Vulnerability Case Study. Misquamicut beach storm vulnerability site visit to led by RI Coastal Resources Management Council. (Feb 3, 2017).
29. Rhode Island Association of Emergency Managers (RIAEM) - Monthly meetings of local emergency managers, Red Cross, RIEMA, and Dept of Health. Identify tangible and useable products. Obtain feedback on prototypes of hazard management tools.

30. RI Annual Conference on Building Flood Resilience, (April 6, 2017)
31. Improving Resilience to Coastal Storms: Misquamicut Capstone Presentations, Reporting of findings of Capstone Classes to Stakeholder Groups. (May 5, 2017).
32. RI Executive Climate Change Coordinating Council Meeting, Council created by RI Legislation to coordinate planning for climate change impacts into the duties of all state agencies. (June 14, 2017)
33. FEMA Integrated Emergency Management Course/Community Specific Public officials and other leaders are placed in a realistic simulation of a hurricane disaster scenario to enhance storm preparedness. (June 19–22, 2017).