RESULTS FROM A VCAPS PLANNING WORKSHOP FOR EXTREME WEATHER AND CLIMATE CHANGE IN NEW BEDFORD AND FAIRHAVEN, MASSACHUSETTS: FINAL REPORT

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MITSG 12-17

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NOAA Grant No. NA10OAR4170086 Project No. 2011-R/RCM-32

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Social and Environmental Research Institute

December 2012

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ACKNOWLEDGMENTS

This material is based upon work supported by MIT Sea Grant and the National Oceanic and Atmospheric Administration. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of MIT Sea Grant or the National Oceanic and Atmospheric Administration (NOAA).

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RECOMMENDED CITATION:

Webler, T., Tuler, S.P., and Pignatelli, T. M. (2012). *Results from a VCAPS planning workshop for extreme weather and climate change in New Bedford and Fairhaven, Massachusetts: Final report.* Social and Environmental Research Institute: Greenfield MA. Available at: www.seri-us.org/content/MA-Coastal-Hazard-Mitigation-Planning

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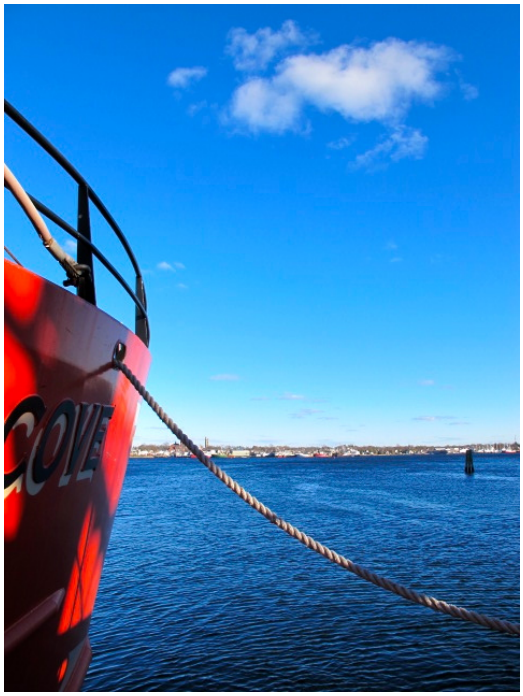
Introduction

Like most coastal communities, New Bedford and Fairhaven, Massachusetts have experienced extreme weather events, including severe coastal storms. Expectations are that they will face increased exposure to extreme weather in years to come from changes in the climate that will have a profound effect on the economy, public health, coastal resources, natural features, water systems, and infrastructure. Situated on the south coast of Massachusetts in Buzzards Bay, the New Bedford and Fairhaven share a narrow bay at the mouth of the Acushnet River. This location renders them vulnerable to severe coastal storms. The presence of a large hurricane barrier spanning the harbor provides some protection against storm surge, but does not prevent frequent flooding. Flooding has been a major problem. Both communities face challenges in preparing for severe coastal storms, including hurricanes, and in mitigating the impacts of storms. In addition, extreme heat events are projected to become more frequent.



To better understand and mitigate the impacts of extreme weather events and especially flooding from severe rainfall and coastal storms, city officials in New Bedford and Fairhaven organized two workshops on 2 and 11 October 2012. With funding from MIT Sea Grant and with the cooperation of the City governments, the Social and Environmental Research Institute (SERI) led the workshops that used a mediated modeling process called Vulnerability and Consequences Adaptation Planning Scenarios (VCAPS). SERI developed VCAPS with funding from the National Oceanic and Atmospheric Administration (NOAA). The purpose of the workshops was to document the vulnerability of New Bedford and Fairhaven to extreme weather events, exacerbated by future climate change, and to identify actions that the communities could undertake to increase their resilience. More immediately, the intent was to identify actions that New Bedford could include in a revision to its hazard mitigation plan and that Fairhaven could include in general planning activities.

Multiple city staff participated in the workshops, including staff from planning, fire, police, public works, and emergency planning departments, as well as the New Bedford Port. Nine people participated in the first workshop and 4 participated in the second workshop. The first workshop began with a presentation that provided a working definition of climate change and detailed regional climate projections through the end of the century. Following the presentation, SERI staff facilitated a group discussion of the localized impacts caused by severe coastal storms. Participants were asked to describe the fundamental cause-effect relationships in the system. SERI

staff diagrammed the participants' understandings of how these weather-related hazards created damaging consequences.

In the second meeting, stakeholders were invited to review and expand the diagrams and to identify specific management actions that could mitigate the impacts associated with severe coastal storms. The results of the workshops are presented here in both diagram and narrative-formats.

Coastal Storms and Climate Change in New Bedford and Fairhaven

The workshop began with a presentation by Paul Kirshen, from the University of New Hampshire and co-author of multiple reports on climate change in New England and Massachusetts, on the state of knowledge about climate change and its impacts in southeastern Massachusetts.

As part of this presentation he discussed recent predictions about future changes to sea level rise, coastal storm frequencies and intensities, season temperatures, and precipitation rates. He noted that flooding risks may increase.

The Cities of New Bedford and Fairhaven regularly experience flooding and other effects associated with coastal storms, including storm surges and inland precipitation. As storm frequency and intensity increases, flooding will become more severe and the costs associated with recurrent property damage more prohibitive.

To mitigate the impacts of severe coastal flooding, the Cities of New Bedford and Fairhaven have implemented a number of activities, including construction of a hurricane barrier, elimination of combined sewer overflows, improvements to stormwater drainage, and emergency preparedness planning. Despite these efforts, geographical areas of concern remain, gaps in preparedness persist, and opportunities for increasing resilience await exploration. The October 2012 workshops provided stakeholders the chance to reflect on the effectiveness of existing strategies and consider new strategies that could further insulate the cities from the impacts of severe coastal storms.

The VCAPS Process

The VCAPS (Vulnerability and Consequences Adaptation Planning Scenarios) process combines structured discussion with interactive concept mapping to create visual summaries of local knowledge about vulnerability and resilience. It helps government staff and stakeholders depict how a community is impacted by weather related hazards and the actions that could help reduce those impacts.

A VCAPS process begins by identifying a small set of concerns or hazards that the community would like to explore. This focuses and defines the boundaries of the discussion, ensuring that the exercise is relevant to decisions. The discussion centers on one concern at a time. During the discussion, a VCAPS diagram is constructed by the research team while

listening to the facilitated dialogue in the room.

The participants at a workshop choose which hazards to focus upon. Groups sometime define the hazards quite broadly (e.g. super storms) or quite narrowly (e.g. coastal erosion).

After selecting the hazard VCAPS diagramming progresses to trace pathways that describe how that hazard affects the community and its environment. A pathway model is made that documents the sequence of steps that lead to harmful consequences. For example, precipitation causes run-off, which leads to storm sewer overflows, which leads to flooding of underground transformers, which leads to electrocution. Each box in this diagram is called an "intermediary outcome." There are normally many intermediary outcomes in a pathway.

At some point, the pathway of outcomes ends in a consequence. A consequence is an outcome for which it is not necessary to ask the question, "Why do we care if this happens?" To take the example above about runoff, it is not obvious why we should care about run-off, the mobilization of debris, the clogging of a sewer drain, or flooding of basements. But if flooding leads to electrocution, then electrocution is a consequence, because it is obvious that we all care about loss of life.

Management actions are also identified in the diagram. These are actions that can be taken to change the way the stressor affects the community. VCAPS differentiates between actions taken by private individuals and groups and actions taken by public organizations or government. The diagrams can include actions that are already in place or those that are proposed by the participants.

Contextual factors are the final component in the VCAPS diagram. These are specific qualities associated with an intermediary outcome or consequences that amplify the effect of the hazard. For instance, the mobilization of debris by run-off is made worse when there is more debris on the streets, therefore an amplifying contextual factor might be: "time since last street sweeping." (For more details see Appendix A: How to Read a VCAPS Diagram.)

VCAPS in New Bedford and Fairhaven

At the start of the meeting on 2 October, 2012, Seth Tuler from SERI led a discussion about which weather related hazards the workshop would like to focus upon. In the first meeting, participants identified extreme coastal storms as the climate related stressor that would start the VCAPS diagram, and this was the hazard discussed at both meetings.

During the discussions at both workshops, SERI diagrammed the causal pathways and added contextual factors and management actions to the diagrams as participants mentioned them. These diagrams were projected onto a wall in front of the participants. The remainder of this report will be a summary of those results. For legibility, the single diagram that was created during the first workshop has been broken out into the following diagrams: inner harbor, City of New Bedford, and City of Fairhaven. VCAPS diagrams that relate to these abbreviated narratives are attached to this report as Appendices.

Inner Harbor

Stakeholders identified severe coastal storms, such as Hurricane Bob in 1992, as the climate related stressor that would precipitate the most significant impacts in the inner harbor, specifically the closure of the hurricane barrier and flooding. For the purposes of the VCAPS process, the inner harbor is understood as the areas north of the hurricane barrier.

Hurricane Barrier Closure

Wind, storm surge, and precipitation associated with a severe coastal storm could necessitate the closing of the hurricane barrier. While closing the barrier would aid in reducing storm damage, its closure could result in loss of economic activity and an increased burden on harbor staff who are responsible for accommodating boats seeking safety. When winds generate chop, damage to rafted boats and the docks and cleats that secure them may occur. Moor lines may also stress and break, leading to runaway vessels that could damage the bridge and cause oil to spill into the harbor. These issues are potentially exacerbated by confusion related to differing marina regulations in New Bedford and Fairhaven. To reduce confusion, harbor officials may want to review their protocol and consider adopting cross-harbor regulations for moorings and tie-ups.

Flooding

Storm surge and precipitation associated with a severe coastal storm would likely lead to flooding in both New Bedford and Fairhaven, overwhelming the capacity of some municipal infrastructure. In New Bedford, flooding north of the barrier is a concern. In Fairhaven, the Cushman Park area is most vulnerable. Ongoing work funded primarily with community block grants, has increased the capacity of wastewater pipes and culverts, reducing the severity of flooding in the Cushman Park area.

During storm events, street waste and contaminants are mobilized and deposited into the harbor. Such deposits may result in economic losses associated with shellfish bed contamination and damage to boats and hard infrastructure. Fortunately, the Environmental Protection Agency (EPA) has regulations that limit nitrogen and phosphorous pollution. The City of Fairhaven has adopted regulations that exceed those of the EPA and both New Bedford and Fairhaven require that development projects take action to improve the quality of water discharged into the harbor. A common water quality improvement action is the implementation of storm scepters. To ensure privately owned storm scepters effectively filter out pollutants, municipalities could require maintenance through the enforcement of

special zoning permits.

In New Bedford, the sewage treatment plant may become overwhelmed during a flood event. This could back sewage into the combined sewer system, leading to the release of untreated waste into the harbor. Increased algae blooms are an environmental impact of this release. Algae blooms are associated with shellfish bed closures and damage to boat engines.

City of New Bedford

In the outer harbor and streets of New Bedford, a severe coastal storm would generate high winds, storm surge, and precipitation that could cause flooding, combined sewer overflow (CSO), downed trees, and necessitate either a voluntary or mandated evacuation of the area.

Flooding

Storm surge and precipitation are associated with flooding in the south and east of the City and throughout the peninsula. South of the hurricane barrier, flooding has the potential to damage artifacts in the Military Museum. Consideration may want to be given to flood proofing the door of the museum or removing artifacts in the period leading up to a storm.

On the east side of the City, the flooding of buildings has the potential to mobilize unsecured propane tanks and toxins housed in basements. These pollutants would likely discharge into the outer harbor and Clark's Cove, leading to shellfish bed closures. Public health outcomes associated with these impacts may be poisoning from shellfish contamination and air quality concerns related to mold growth. City officials may want to consider a campaign designed to educate the public on how to reduce the disbursement of toxins or implement regulations requiring that larger propane tanks be secured at all times.

Combined Sewer Overflow (CSO)

Storm surge and precipitation not only have the potential to inundate the sewage treatment plant, as mentioned earlier in the report; but, also have the potential to compromise the City's combined sewer system. While much work has been done to eliminate combined sewer overflow (CSO), the city continues to experience pollution and property damage that is related to the CSO flushing street waste into the outer harbor. To mitigate the impacts of CSO, the City may want to trace the source of contaminants, identify responsible parties, and request federal funds for cleanup.

Downed Trees

High winds associated with severe coastal storms have the potential to down trees, leading to road blockages and power outages. The impassability of roads decreases the mobility of residents and impairs responders' ability facilitate evacuation and address crises. Residential power outages often result in the use of home generators, which pose the threat of electrocution if they are operated incorrectly and back feed into a downed power line. At the municipal level, power outages could impair the sewer system if operation of pumping stations and storage plants cease.

City workers are responsible for mitigating the threats associated with downed trees.

Their responsibilities may include ensuring trees are healthy in advance of a storm in order to limit the likelihood of storm damage, ensuring roads are clear by collecting brush and conducting chipping in areas not prone to fire, replanting trees following the storm, and accompanying downed power lines until the power company is able to restore functioning. To ensure municipal resources are being used in the most effective way possible, the City may want to review existing policies that pertain to these responses.

Evacuation

In the event of a severe coastal storm, the City may either suggest or mandate evacuation of the peninsula and surrounding areas. Evacuation strains local resources and services, such as the hospital, and burdens city workers who are responsible for aiding residents in leaving their homes. To limit the negative impacts associated with evacuation, the city may want to review their evacuation protocol and consider coordinating efforts at the regional level. Such a review may also include consideration of the number of available ambulances and EMS staff, the existing relationship with private contractors, the effectiveness of pre-storm outreach and education to residents, the location of shelters based on climate change projections, the accessibility of pet shelters, and the training of shelter personnel.

City of Fairhaven

In the case of a severe coastal storm, participants identified flooding related to wind, storm surge, and precipitation as the impact that would most significantly affect the City. As flooding in the Cushman Park area was addressed earlier in the report, this section will focus on the following areas: the causeway to West Island, West Island, and buildings in all areas of the City.

Flooding of the Causeway

Flooding of the causeway may cause damage to the structure or utilities, which would require City funds for repair. If travel across the causeway is impeded, drivers could lose control of their vehicles and emergency vehicles may be unable to respond to calls for assistance. In both scenarios, the result could be serious injury or loss of life. In addition, when the causeway floods or in anticipation of flooding, the town may shut off water systems and moves its fire fighting trucks to the mainland. This impacts firefighting in two ways. First, water pressure can be inadequate to fight fires. Second, there may not be the right equipment for fighting structural fires.

Flooding of West Island

Due to the large number of year-round residents, flooding of West Island poses serious challenges when it comes to evacuation. The City's Police Department must assist the movement of residents off the island and ensure that evacuated homes are secured. In some instances, they are also responsible for retrieving medications left behind by residents or checking on pets that were left home.

Flooding of Buildings

The flooding of buildings can lead to costly structural damage, the growth of mold, and the mobilization of toxins, such as paint and propane, which may have been housed in basements or unsecured

on the property. If toxins penetrate the drinking water supply, this could endanger public health and result in the water supply system being shut down. Educating individuals about the ways in which they can prevent such impacts was a management action identified by participating stakeholders.

Further Discussion

The following issues arose during the two workshops, but were not necessarily connected to a particular climate related stressor or impact.

Vulnerable Populations

During the VCAPS process, stakeholders identified populations in both New Bedford and Fairhaven that are potentially more vulnerable to climate change than the general population. In New Bedford, undocumented workers and those for whom English is a second language may have trouble accessing resources and information that could protect them in the case of an extreme coastal storm. In both New Bedford and Fairhaven, the elderly population was identified as potentially more vulnerable, due to concerns regarding lack of mobility and access to resources and information.

Regional Coordination

Throughout the VCAPS process, stakeholders regularly addressed the importance of mitigating the impacts of flooding and pollution related to storm-water runoff. These issues are often most effectively addressed with regionally coordinated strategies. The reason for this is that watersheds cross town, state, and national boundaries. In New Bedford and Fairhaven, the risk of flooding and associated water contamination is exacerbated by inland water that flows down the Acushnet River and discharges into the shared harbor. Consideration of hydrology at the level of the watershed can help identify regional strategies that will most effectively address these shared concerns.

Discussion of Management Actions

After completing the severe storm diagram, SERI encouraged the group to discuss management actions that could be promoted now and that would increase resilience to storms events. A significant number of management actions were identified by the group. These are listed in a table in Appendix A of this report.

The group identified three general types of actions: actions taken as part of routine planning activities (preparatory actions), actions taken in response to specific storm threats or events (pre-storm/event actions), actions taken during an event (during storm/event actions), and actions taken to recover from the impacts of storms (post-storm/event actions). An example of a preparatory action is New Bedford's hazard mitigation planning process.

The group also indicated as part of the discussions the relevance of the actions for different locations (Fairhaven, New Bedford, or the inner harbor area) and the kind of impact that would be averted by taking the action, such as economic, health risks, etc. Finally, the participants indicated whether the action was already being done, was a new strategy worthy of

further consideration, or has already been implemented.

This information provides a picture of the full range of management actions that can be taken by the cities, either separately or together. In some cases, coordination among the cities is necessary to tackle issues in the inner harbor.

Conclusion

Examination of local hazards with city and state officials, interested citizens and members of the private sector can illuminate vulnerabilities and highlight potential mitigation projects for municipalities to adopt.

VCAPS is one approach to help elicit and organize this knowledge in a format that can empower local action. This workshop drew upon local experience to document vulnerabilities and mitigation actions.

Like other municipalities across the country, New Bedford and Fairhaven will continue to experience increased exposure to extreme weather. The state, county, and city systems that are in place to manage, cope, and adapt to this weather can be improved upon and will need to innovate more efficient and effective systems to prepare for storms and to restore services. Such systems ought to be informed with the knowledge and experience of city employees and local stakeholders. VCAPS is one tool to bring this is to fruition.

Appendix A

Management Actions	Status	Category of Impact Averted								Location		
		Economic	Leisure Recreation	Governance	Health Safety	Culture	Ecology	Communication	Property	Inner Harbor	New Bedford	Fairhaven
PREPARATORY ACTIONS:												
Develop effective and uniform requirements for moorings, marinas, tie-ups.	New				X				X	X		
Build more docks	New	X			X				X	X		
Hurricane barrier maintenance	Ongoing	X	X	X	X	X	X		X	X		
Educate about storm preparedness on public access cable	Ongoing	X			X	X			X		X	
Outreach and education for the ESL population on storm preparedness	Ongoing			X							X	
Annual community meeting to discuss storm preparedness	Ongoing	X			X				X			X
Regionally coordinated evacuation strategies	New	X		X	X			X	X		X	
Review evacuation routes	New			X							X	X
Secure access to more ambulances	New			X							X	X
Fire truck located out on neck	No longer Viable	X			X				X			X
Use flood projections maps to identify safe locations for shelters	New			X	X				X		X	

Setup pet shelters	Ongoing			X	X						X	X
Inventory emergency shelters	New			X	X							X
Train shelter staff and other volunteers	New				X			X			X	
Requirements for securing propane tanks	New				X				X	X	X	X
Education regarding securing propane tanks	New				X				X	X	X	X
Gather propane tanks	Ongoing				X		X			X		X
Education regarding removal of toxic materials from basements	New				X					X	X	X
Eliminate CSOs	Ongoing	X	X	X	X	X	X		X	X	X	
Restore marshes	Ongoing	X	X		X		X		X			X
Apply for grants and/or raise taxes to generate revenue for infrastructure improvements	Ongoing	X		X			X		X			X
Install new infrastructure in the Cushman Park area (storm sewers)	Done	X	X	X			X		X			X
Install new infrastructure flood control infrastructure (pump stations)	Done	X	X	X			X		X	X		X
Maintenance of stormwater and pump systems	Ongoing	X		X						X		X
Local stormwater regulations for phosphorous and nitrogen	Ongoing	X			X		X			X		
Require stormwater septor installation and maintenance requirements	Ongoing	X			X		X		X	X		
Pollution discharge regulations (ConCom regs)	New	X			X		X		X	X		
Enforce stormwater septor requirements	New	X			X		X		X	X		

Trace sources of contaminants to find responsible parties	Ongoing	X			X		X			X		
Teach people to open the main breaker before starting the generator	New				X						X	
Tree maintenance program to prevent severe damage during storms	Ongoing				X					X		
Establish debris removal plan	New				X				X		X	
PRE-STORM/EVENT ACTIONS:												
Reverse 911 for storm warnings	Ongoing			X							X	
Remove boats from harbor (assign each vessel to a boat ramp)	Ongoing				X				X	X		
Reduce water inside harbor	Ongong	X			X				X	X		
Close hurricane barrier	Ongoing	X	X	X	X	X	X	X	X	X		
Close access roads	Ongoing	X		X	X				X		X	
Close causeway	Ongoing	X		X	X				X			X
Voluntary evacuation	Ongoing			X							X	X
Evacuation of high rises	Ongoing				X						X	
Harbor staff assists in harbor evacuation	Ongoing			X						X		
Harbor staff informs public they will not rescue people on the water during the storm	Ongoing				X					X	X	
Town has agreement with private company to assist with evacuation	Ongoing				X						X	X
Call in school buses to aid setup procedures	Ongoing			X							X	X

Open emergency shelters	Ongoing				X					X	X	X
Flood proof the Military Museum doors	New					X					X	
Remove culturally significant artifacts from flood zone	Ongoing					X					X	
Home generators used	Ongoing										X	
Ensure reliability of backup generators in high rise housing	New	X		X	X			X	X		X	
Provide residents of 24 hours notice regarding water supply shutoff	Ongoing	X										X
Pre-emptive shutdown of wastewater system	Ongoing										X	
DURING STORM/EVENT ACTIONS:												
Send out trained and prepared road crews to keep roads open	Ongoing	X	X	X	X			X	X		X	
Power company deals with downed electric lines	Ongoing	X			X			X	X		X	
Town workers accompany downed power lines	Ongoing			X							X	
Open up and free the flow at the sewage treatment station	Ongoing	X			X				X	X	X	
Turn on pumping stations to reduce flooding on land	Ongoing	X			X				X	X		X
Run private sump pumps	Ongoing	X			X		X			X		X
Pump water out of inner harbor	Ongoing	X			X				X	X		
Call on extra ambulances	Ongoing	X		X	X			X			X	
Require sticker for residents to return to evacuated areas (restrict access)	Ongoing	X		X	X				X			X

POST- STORM/EVENT ACTIONS												
Replant trees	Ongoing				X		X				X	
Open burning of debris	New	X		X	X		X		X		X	
Track down responsible party for spills, etc. Get federal funds for cleanup.	Ongoing	X		X	X				X	X		
Shutdown shellfish beds	Ongoing	X			X					X	X	X
Water lines shut off due to contamination	Ongoing				X					X	X	X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