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Assessment of Adaptation, Policy, and Capacity Building Outcomes from Fourteen Community Vulnerability, Consequences, Adaptation Scenario (VCAPS) Processes

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Contents

Abstract

The Vulnerability, Consequences, and Adaptation Planning Scenarios (VCAPS) process is a dialogue-based diagramming method that helps communities assess their vulnerability to hazards associated with climate variability and change. Since 2008 VCAPS has been implemented in 13 communities. This assessment, begun in 2017, seeks to understand the value of the VCAPS process for communities' climate adaptation processes and considers how VCAPS informed adaptation planning and decision making, as well as learning among participants and how people worked together. These findings are based on interviews with a limited number of key informants from every VCAPS community, except Plymouth, MA.

This document introduces the VCAPS process, the assessment method, and provides a detailed summary of the experiences reported by communities organized around 10 consistent themes emerging from the interviews and concludes with thoughts on how to advance the process to better serve communities and practitioners interested in the approach.

Looking back up to 11 years, this set of interviews provides a relatively rare view of the use of a particular decision support and planning tool in multiple contexts and longer-term impacts of community dialogue. Interviews indicate that VCAPS has had positive impacts on communities in that it has:

- proven to be flexible and responsive to community preferences for process design
- informed local plans and decisions
- informed individual plans and decisions
- helped generate broader support for subsequent actions
- contributed to local resources and efforts to seek funding
- promoted learning among participants, and
- can inform adaptation planning at multiple points as municipalities grapple with the long-term process of confronting climate stressors

Commonalities in responses also showed limitations to the process including:

- Diagramming is effective as a process facilitating the conversation and for recording and generating knowledge, but the diagrams themselves were not always liked by participants
- When VCAPS is applied within broader long-term contexts of climate and hazard planning, outcomes may be significant, but not readily apparent in the short term
- VCAPS impact is limited when process does not include or not linked to governance (including people and specific processes)

Based on these interviews, fruitful directions for increasing the ease of use and range of applicability for VCAPS include:

- Providing more guidance about how to use VCAPS at different stages of planning
- Providing guidance about how to integrate VCAPS with other tools (e.g., systems dynamics modeling, mapping)
- Developing a process for assessing context and purpose of VCAPS to improve design and to better connect VCAPS with ongoing and future activities

Introduction

The Vulnerability, Consequences, and Adaptation Planning Scenarios (VCAPS) process is a dialogue-based diagramming process that helps communities assess vulnerability to natural hazards. Decision makers, technical experts, and residents come together to document the state of local and expert knowledge about the consequences of climate-related stressors in a specific municipality. Participants explore how contextual factors of coupled human and natural systems influence the dynamics and impacts of stressors, and the effectiveness of potential management actions. Contextual factors include behavioral, social, cultural, economic, institutional, and environmental features of the local community that may impact vulnerability and risk. The process supports local vulnerability assessment and climate adaptation planning (Kettle et al. 2014; Webler et al. 2014). Our development of VCAPS draws on the intellectual history of hazard management (Clark et al. 1998; Kates et al. 1985), climate vulnerability assessment (Dow and Carbone 2007; Kasperson et al. 2005; Smit and Wandel 2006), and analytic-deliberation (National Research Council 1996; National Research Council 2008b; Webler and Tuler 2008).

Since 2008 VCAPS has been implemented 14 times, in 13 communities and 6 states (Figure 1), with a series of publications (Kettle et al. 2014; Webler et al. 2014, Tuler et al. 2016, Tuler et al. 2016, Webler et al. 2016) and conference presentations (See Appendix A) reporting on various cases. Five of the VCAPS processes occurred in South Carolina and North Carolina. VCAPS was used to consider hazard management and adaptation related to:

- Hazard mitigation planning
- Local comprehensive planning
- Fisheries management
- Storm water management
- Community adaptation to climate stressors, including sea level rise, severe storms, heat waves, etc.

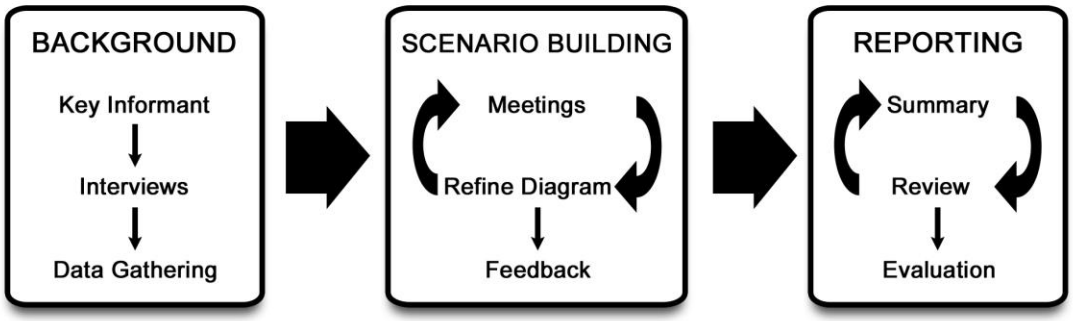
In 2017 we began an assessment of the 14 VCAPS processes implemented thus far. Assessments are based on a limited number of interviews with key informants from each case. We report on the key insights we have gained about the outcomes associated with VCAPS, with an eye toward improving this process and documenting how facilitated dialogues can support adaptation planning.

Figure 1. Implementations of VCAPS

Overview of the VCAPS process

Figure 2 summarizes the three basic phases in VCAPS: preparing, scenario building, and reporting. (See Webler et al. 2014 for more details.) The work usually begins with an invitation by local officials who want to sponsor a VCAPS process. In the preparing phase we identify and recruit participants and collect background information relevant to understanding past planning, hazard events, and ongoing concerns within the community. In interviews with key stakeholders and officials we learn about the history of the problem and the reason for the community's interest in examining their storm water problems in greater detail. We also discuss with the local officials sponsoring the process how best to implement the process. This includes defining the number of meetings, their timing, and the participants. We work collaboratively with the local sponsor to design the process in a way that is responsive to the community's need and preferences. This helps to promote legitimacy, build trust, strengthen motivation to participate, and enhance accessibility.

Fig. 2. Three phases of VCAPS



The second phase – scenario-building – involves participants discussing, exploring, and learning about climate change related risks, vulnerabilities, and adaptation strategies. In this phase the group defines scenarios and diagrams pathways through which, for example, precipitation produces storm water and storm water impacts the community. We usually start the first meeting with a presentation by a local climate expert to summarize regional climate trends, projections, and potential impacts to the community. The purpose is to help participants visualize how climate variability and change may impact infrastructure, community services, etc. We then facilitate a discussion among all participants and invited experts to clarify how the community may be impacted. Integrating and sharing information about local interactions between biophysical and social contexts is important in understanding local phenomena, balancing competing priorities and values, policy making, and managing coupled human-environment systems (Picketts et al., 2012; Berkes and Folke, 2002). We can also begin with discussions of what kinds mitigation and adaptation actions have been implemented previously or how the VCAPS process intersects with other planning activities (e.g., hazard mitigation planning).

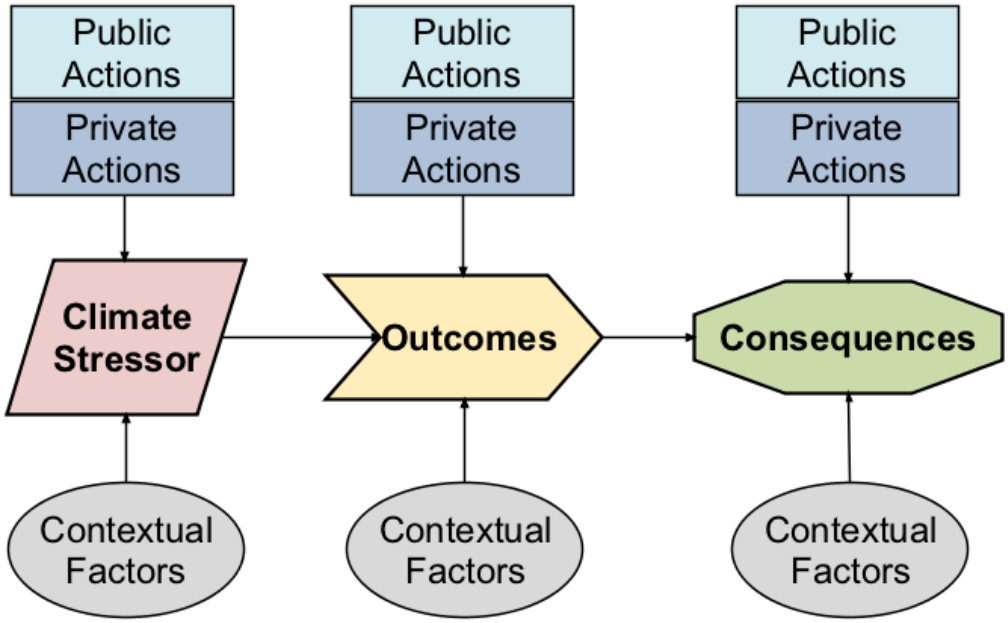
The main focus of the second phase is to introduce VCAPS and explain how the diagramming to represent scenarios works. Diagrams usually start by defining a *management concern*, which frames the issue the participants are examining in a decision-making context. Examples include, storm water management, coastal erosion, public health, or emergency management. These are represented by trapezoids in the diagram.

One of the unusual characteristics of VCAPS is that very detailed diagrams are built using only five components. The basic structure of a VCAPS diagram is shown in Figure 3.

The first element is *stressor*. Stressors are external forces that create change in the system. In the context of storm water management, stressors produce or modify storm

water flows. Examples include sea level rise, intense storms, temperature extremes, and drought. The choice of the stressors for the scenarios is made by the participants. Stressors can be defined generally or with greater detail (e.g., a winter storm with 24 inches of snowfall).

Fig. 3. Building blocks of a VCAPS diagram



The second element is the *intermediary outcome.* These help characterize the present state of the coupled human-environment system. Outcomes are represented by block arrows. This element includes a diverse set of features and is used to describe the state of any aspect of the system being studied. For example, the group may characterize the degree of flooding in roadways, the penetration of storm water into buildings, or the behavior of people, among any number of other aspects.

The third element in the VCAPS diagram is the *consequence*, and this is represented as an octagon. Consequences are a special set of system states. We distinguish consequences as system states for which it makes sense to ask the question: "Why do we care about this?" These are end states people care about. For example, storm water penetration into a building is an intermediary outcome, not a consequence, because it is not unreasonable to ask why we care about it. Consequences specified by participants in past VCAPS processes about storm water infiltration to buildings have included health effects from mold, costs associated with property damage, loss of tax revenue, and the trauma associated with losing personal items.

The fourth element is the *contextual factor*, represented by ellipses. These are characteristics of the local system that shape the way the stressor impacts the system. For example, storm water impacts depend on the community's physical location, features of the natural and built environments, infrastructure, regulatory systems, and demographics. During the process we elicit information about behavioral, social, cultural, economic, institutional, and both built and natural environmental factors that increase or decrease three dimensions often associated with vulnerability: exposure, sensitivity, and the capacity to act (Adger 2006; Kasperson et al. 2005).

We also encourage participants to think about how contextual features may change, and how climate change and variability can be one driver of change. For example, types of vegetation and disease vectors may shift with changing temperatures and rainfalls, which can alter the uptake of moisture from soils and shift drainage patterns; the permeability of soils may change during prolonged droughts; and sea level rise may impact groundwater tables and reduce marsh habitats that can act as filters of storm water.

The fifth element in a VCAPS diagram is the *management action,* represented at the top of the diagram as rectangles. We usually distinguish public from private actions. Typically, there are many public and private strategies and best management practices that communities may consider. Management actions can be implemented "upstream" (i.e. closer to the climate stressor) or "downstream" (i.e. closer to the consequences). Upstream actions include large-scale storm water conveyance infrastructure improvements and impervious surface regulations intended to help prevent problems from arising. Causal pathways linking stressors and consequences may be blocked by multiple management actions. For instance, infrastructure improvements may require public education, financing, or policy changes. Discussions about management actions informed by understanding of local contextual factors can highlight tradeoffs. For example, improved maintenance of culverts, drainage ditches, and stream beds can mitigate the severity of impacts, but also be difficult to implement if access is not available due to past development patterns. Public education about landscaping that reduces runoff and the need to improve infrastructure to accommodate climate change has proven useful in some cases, however, it may not have a large impact on overall volumes and flows. "Downstream" improvements in emergency management and insurance can reduce impacts and support more rapid recovery, but they do not necessarily prevent adverse impacts from happening. In some cases, management actions can lead to a new series of outcomes and consequences.

Facilitating discussions and mapping or diagramming the conversation using the six components occurs in real time using a laptop and a projector. We use freeware called Visual Understanding Environment (VUE) (available for free at http://vue.tufts.edu/), but other software can work just as well. As causal chains become developed, the facilitator encourages participants to identify management actions that could be taken by public and private entities. We ask participants to think about "no regret" strategies, which offer

immediate benefits whether or not projected climate/weather events occur, and "low regret" strategies, which present greater resilience at limited cost. We encourage participants to consider strategies of protection, accommodation, and retreat that can be implemented in different time scales. We also encourage participants to discuss trade-offs, local contextual features, and availability of resources that can facilitate or hinder implementation of management actions.

The third and final phase of the VCAPS process is the reporting phase. Here the team summarizes, reviews, and evaluates results from the meetings. Working with the local sponsors of the process, we present information in ways that facilitate its integration into local planning, which may be associated with hazard mitigation planning, comprehensive planning, or adaptation planning. Depending on participant preferences, the process may conclude with discussions about how to prioritize and schedule implementation of management actions. We use participant checking to validate results.

Assessment Methodology

Soon after completion of most VCAPS processes, we have gathered feedback from individual participants. We seek to understand individual participants' experiences, such as whether they found the process valuable for planning and if they learned new information. Many report positive opinions about both topics (e.g., Tuler et al. 2016, Webler et al. 2016, Tuler et al. 2016).

In this assessment we were primarily interested in *community*-scale impacts of VCAPS. The goal of the assessment was to better understand:

- If and how VCAPS was associated with any plans or decisions (i.e., impact policy),
- If knowledge among participants was improved, and
- If the ability of the community to address climate related stressors and impacts was improved.

To gather this information, we sought interviews with 1-3 participants in each case. We targeted the lead contact / organizer in each community and we sought additional interviews with other participants who played a significant role in the process.

The questions we posed were (full interview guide is in Appendix A):

1. What kinds of decisions or plans have been made in the community to address hazards associated with climate stressors and management concerns that were discussed as part of VCAPS process?
2. Did the VCAPS project help inform planning and decisions?
3. Did the VCAPS project help participants learn about climate stressors?

4. Did the VCAPS project help participants learn about management strategies?
5. Did the VCAPS project help participants learn about the physical and social and political and regulatory system (including beliefs and values of the participating parties, as well as institutional structures and processes)?
6. Did the VCAPS project impact how people are working together on climate-related issues?

In addition, we reviewed case-specific reports and post-process interviews and survey responses obtained after completion of some of the processes.

The challenges of this assessment were to:

- find and reach individual participants after multiple years since a VCAPS process was completed. In some cases, individuals moved jobs or retired and we were unable to locate them.
- Overcome loss and muddling of memories after multiple years since a VCAPS process was completed.
- Attributing subsequent actions to the VCAPS process; other planning activities, events, etc. often were part of the overall context for climate adaptation and hazard mitigation planning.

Still, we marched on…To overcome the first challenge we sometimes gathered feedback from facilitators of the VCAPS processes (e.g., Sea Grant staff).

Overall, during November 2017 through May 2018 we were able to complete 11 telephone interviews. We also obtained feedback via email from 9 participants. In only 1 case (Plymouth, MA) were we unable to locate anyone associated with the process. In these 4 additional cases we only obtained feedback from Sea Grant or technical advisors: McClellanville, SC; Beaufort, SC (COCA); Dauphin Island, A; S. Thomaston, ME). In another case, Sea Grant staff provided feedback about multiple processes.

Results

Table 1 provides a detailed summary of the VCAPS processes, including climate stressors considered and number of people providing feedback.

Table 1. Implemented VCAPS processes

Location	Climate stressors discussed in process	Length of process	Process details	# of participants in VCAPS meetings	# participants and organizers contacted for feedback
Beaufort, SC (CCCAI funded)	Sea level rise and extreme rainfall impacts on flooding	2012 - 2014	2 all day VCAPS meetings in one month, create a spatial vulnerability assessment using GIS, and two public workshops to gather feedback about possible adaptation actions	12	1
Beaufort, SC (COCA funded)	Drought and extreme rainfall impacts on blue crab fishery	2013	2 half-day VCAPS meetings (separated by 2 months) and systems dynamics model building	5	3
Boston, MA	Winter storms; flooding from precipitation and storm surges; extreme heat	2012-2014	5 two-hour meetings, incl. breakouts on specific stressors to inform Hazard Mitigation Plan revision	Approx. 90	2

Dauphin Island, AL	Severe coastal storms in combination with sea level rise	2012	1 full day	15	1
McClellanville, SC	Heavy precipitation; sea level rise	2011	Two half day meetings (over two consecutive days)	6	1
New Bedford and Fairhaven, MA	Extreme coastal storms	2012	Two half day meetings (separated by 1 week), to inform Hazard Mitigation Plan revision	13	3
Orange Beach, AL	Heavy rainfall; severe coastal storms	2012-2013	1 full day	13	2
Plymouth, MA	Flooding (as result of sea level rise and increased precipitation); coastal erosion (stronger and more frequent storm events)	2011	Two half day VCAPS meetings (separated by 1 week), to inform Hazard Mitigation Plan revision	6	0
Plymouth, NC	River level rise (due to heavy precipitation upland, tropical storms, and sea level rise)	2010 - 2013	Two 2.5 hour VCAPS meetings (over two consecutive days), in conjunction with creation of flood maps	7	1
South Thomaston,	Precipitation sea level	2013-2016	Two all day meetings in	12	1

ME	rise, ocean temperature		one year, create multiple GIS reports, and systems dynamics model building, with training workshops		
St. Marys, GA	Hurricanes, storm surge, sea level rise	2013-2016	Two VCAPS meetings, followed by public discussions and workshops	20 (plus up to 350 in all community meetings related to the project)	2
Sullivan's Island, SC	Extreme rainfall; sea level rise; higher high tides	2010	Four two-hour meetings (over two months)	9	1
Tybee Island, GA	Sea level rise, coastal flooding	2012-2016	Town Hall meeting in combination with additional public discussions and workshops	30-40 participants in the Town Hall meeting (plus up to 200 in all community meetings related to the project)	2
Wellfleet, MA	SLR, coastal storms, water temperatures	2013 - 2015	2 years, 6 meetings, 2-3 hours each and systems dynamics model building	11	2

A list of reports and other resources produced for each case are listed in Appendix C.

We designed VCAPS with the purpose of supporting community adaptation through:

1. informing discussions and learning by integrating climate and related natural and social sciences and local knowledge
2. summarizing the information, knowledge, and experience that exists within a community.
3. facilitating exploration of (local) complexities and uncertainties
4. stimulating discussions about how to manage consequences by taking upstream or downstream actions
5. aiding in future decision making

The extent to which VCAPS served these purposes for communities can be usefully evaluated over multiple timeframes to gauge near and longer-term effects. After the final meetings in most cases we gathered feedback via a short survey and/or interviews with key participants. By and large, participants reported achieving many of these goals in the VCAPS process. This assessment provides an opportunity for participants to reflect on the achievement of the VCAPS goals after a longer period of time. From these interviews and associated documentation, several consistent themes have emerged relating to how VCAPS supported community goals over the longer term.

VCAPS has proven to be flexible and responsive to community preferences for process design

An important reason for the positive views of the VCAPS processes has been the flexibility in the way VCAPS is implemented, including number, frequency, and duration of meetings. By being flexible local needs can be considered, which has the effect of increasing participation. In all cases meetings were held at times convenient for participants e.g., day or evening, day of week) and in all cases experts presented information about climate stressors of interest. In addition, case specific considerations also included:

- Boston, MA: We conducted multiple workshops with large numbers of participants during work hours to facilitate gathering of input from multiple city and state agency staff and NGOs. Breakout groups were designed to promote small group discussions and attention to multiple climate stressors (e.g., winter storms, sea level rise).
- Wellfleet, MA: Seasonal workloads required not having meetings during the peak summer tourism season or peak aquaculture seasons. Meetings were also timed to avoid conflicts with low tides, when work on aquaculture grants is done. In addition, the focus of the process was shifted in response to a nearby vibrio outbreak.

- S. Thomaston, ME: Seasonal workloads required not having meetings during the peak summer tourism season or peak lobster seasons. Meetings were also timed to avoid conflicts with prime fishing times.
- Beaufort, SC (COCA): Meeting times were organized to avoid conflicts with fishing and other work (e.g., time of year and time of day).
- McClellanville, SC: meeting times were organized around schedules of volunteer members of the Kitchen Study Group.
- Sullivan's Island, SC: meetings were organized not to conflict with the peak tourism season and scheduled during working hours because participants were town staff and officials.
- Tybee Island, GA: participation of city council members required open public meetings. In addition, the VCAPS scenario diagrams were developed by project staff after gathering input in an open town hall meeting.

However, there were limitations resulting from different designs. For example, in Boston learning among participants was limited because of the large groups and limited duration of meetings. The focus of the Boston effort was to provide public input into the hazard mitigation plan revision process (per FEMA requirements) and to initiate discussions about climate-related hazards. This process was more effective for planners to gather input from diverse stakeholders rather than promote learning among the participants. Similarly, in Dauphin Island, Orange Beach, Plymouth, NC opportunities for learning were restricted due to the short duration and limited number of meetings.

On the other hand, in S. Thomaston, Wellfleet, Beaufort, SC (COCA), and Beaufort, SC (CCCAI), where processes occurred over longer time periods, participants reported learning more and experts were invited to present information at meetings on topics in addition to climate stressors. In Wellfleet, presentation topics included shellfish diseases and dynamics of sand transport in the harbor. In Beaufort, SC crabbers heard presentations from a researcher on blue crab population dynamics and threats.

VCAPS has informed local plans and decisions

People providing feedback in multiple cases identified clear links between VCAPS and specific local planning outcomes. Across the 14 cases, these instances were reported:

- Orange Beach, AL: revised its beach emergency operations plan and created a template for business and condo emergency preparedness planning and City information gathering. According to City staff, "the update and templates came directly out of VCAPS meetings. The actions were identified during VCAPS."

- Beaufort, SC (CCCAI): incorporated findings from the VCAPS process into the most recent Local Comprehensive Plan. Specifically, the VCAPS process identified 23 adaptation actions grouped into nine categories that addressed diverse topics such as increasing intergovernmental cooperation; strengthening development and building standards; protecting low-lying areas from development; monitoring the impacts on natural resources; and protecting vulnerable infrastructure and developing standards for the location and design of future public facilities.
- New Bedford/Fairhaven, MA: The staff of the Buzzards Bay National Estuary Program did not participate in the New Bedford/Fairhaven VCAPS process, but they did learn from and use the outcomes of the process to inform decisions to add certain tasks in the Buzzards Bay NEP work plans in three consecutive years.
- Tybee Island, GA: A sea level rise adaptation plan was prepared, and then adopted by the City Council. Actions included beach renourishment, creation of a living shoreline, modification of wells, installing tide gates on outfall pipes, and improved the CRS rating.
- St. Mary's, GA: information generated, and recommendations presented in the project report served as the basis for City action in a number of ways, including installing outfall pipe gates, purchasing property to improve flood protection, and informed local ordinances.

In some cases, participants contacted in this assessment noted that local plans and decisions were *not* directly impacted by the VCAPS processes. Reasons included:

- McClellanville, SC: VCAPS process was conducted with a volunteer group that later disbanded and which had no direct influence on local planning.
- Wellfleet, MA: VCAPS process was conducted with a volunteer group that later disbanded and which had no direct influence on local planning. Subsequently, some effort is being made to integrate the outcomes of the VCAPS process into an updated local comprehensive plan; the LCP process is on-going, so the extent of this integration is currently not known.
- S. Thomaston, ME: VCAPS process was conducted with a volunteer group that later disbanded and which had no direct influence on local planning, although there are reports that individuals' decisions were impacted (see more detail below).
- Beaufort, SC (COCA): the VCAPS process was not connected to any ongoing regulatory or planning activities at the local or state level.
- Dauphin Island, AL: the VCAPS process was not connected to any ongoing regulatory or planning activities at the local or state level.

Finally, in several cases participants were not able to identify clear causal links between VCAPS and impacts on local plans and decisions, as other activities were on-going to

address climate-related issues. These communities included Orange beach, AL, Boston, MA, Sullivan's Island, SC, Plymouth, NC, Plymouth, MA, New Bedford/Fairhaven, MA, and Beaufort, SC (COCA). However, interviewees suggested that VCAPS helped "in a general way," that "in a broad sense I feel that you broke a lot ground locally that helped pave the way for interest and participation in our effort," (and "The VCAPS project perhaps helped contribute to the discussion of this topic and the need for more info on this topic." These comments reflect fairly common circumstances in which VCAPS was not usually the only activity related to climate adaptation planning or hazard mitigation planning, and identifying causality was not possible. For example, one participant explained, "VCAPS didn't cause things to happen, but it was a component to help city do what already striving to do." In other cases, VCAPS was a very early effort to promote discussions about climate adaptation: "VCAPS was one of the initial efforts in Boston. The ground was not as fertile then to discuss climate change as it is now. People needed a lot more background. VCAPS helped to elevate the issue."

VCAPS has informed individual plans and decisions

In some cases, the plans, actions, or decisions of individuals were influenced by their participation in a VCAPS process.

- S. Thomaston, ME: The VCAPS effort, which included the development of a systems dynamics model, helped lobstermen think about options for fishing – when it made more or less financial sense. Individuals and the Sea Grant staff person reported that participating lobstermen took home the message that they needed to think more about how the plan their fishing efforts, and that "fishing no matter what" is not the best option (see Webler et al. 2016 for more detailed discussion).
- New Bedford/Fairhaven, MA: A regional planner commented that "helped informed my own decision to add certain tasks in the Buzzards Bay NEP work plans in three consecutive years: expansion of the floodplain with sea level rise (using a simple bath tub model), salt marsh expansion at selected sites in Buzzards Bay, and a proposal I developed and submitted to EPA to do a vulnerability assessment for New Bedford Harbor."
- New Bedford/Fairhaven, MA: A participant in the process stated that "VCAPS workshop helped me to focus on flood prone areas and water quality issues which I often deal with" as part of her city job.
- Orange Beach, AL: Via participation in the VCAPS process elected officials and staff from different municipalities began working together on regional issues; "After that [VCAPS process] I had a lot more communication with Perdido Beach on resilience planning and have a continued good relationship with them."

- Wellfleet, MA: commercial shellfish growers reported considering different strategies for managing vibrio risks.

VCAPS has helped generate broader support for subsequent actions

A common observation from participants was that VCAPS helped generate support within a community for action to address climate stressors and other hazards. In 7 out of the 14 VCAPS cases, the process provided a forum for municipal staff to discuss challenges and options with elected officials, business owners, etc. in ways that did not happen otherwise.

Instances include:

- Sullivan's Island, SC: "VCAPS gave traction to what we (the staff) believe needed to be done." According to the town manager, VCAPS sparked an informed discussion about resiliency with staff, the planning commission, and town council members. While they were aware of SLR etc., the VCAPS process gave legitimacy, authenticated that there are real problems.
- Orange Beach, AL: VCAPS informed diverse participants, including elected officials, about hazards and consequences of climate stressors. In particular, they learned how the consequences could impact city finances, which got the attention of the elected officials and community members that participated in VCAPS, which helped generate support within the community for actions. The City of Orange Beach now has $30 million in reserves.
- Plymouth, NC: Lots of interaction with employees, with local leaders, cross section of community. A continuation of public awareness especially about public infrastructure. Created positive public appreciation for value of infrastructure and need to maintain it need to be smart about where to put things for future.
- Beaufort, SC (CCCAI): Study provided rationale and support – could broach subject with council. Introduce topic to public.
- St. Marys, GA: According to the Town Manager the process involved close coupling of the VCAPS process with communications with city officials, including planners, development director, town manager, council, etc." so everyone involved and all the work was oriented to integration and action." The "Diagramming was useful for developers and council members to understand the importance of new ordnances and why need to build on piles or raise structures by at least 2 feet."
- Boston, MA: According to a Regional Planner, it is hard to point to specific tangible outcomes from the VCAPS process – there is "not a straight line from cause to effect." However, he noted that this VCAPS process occurred in the earliest stages of the City grappling with climate *adaptation*; most previous work had been on

mitigation. It helped in early days of officials starting to think about adaptation and resilience. The Regional Planner feels that "It helped in early days of officials starting to think about adaptation and resilience…. VCAPS helped to elevate the issue."

- New Bedford/Fairhaven, MA: "VCAPS program provided seed ideas to individuals to develop hazard mitigation planning."

VCAPS impact is limited when process does not include or not linked to governance (including people and specific processes)

Multiple processes show the importance of linking VCAPS with on-going planning activities to ensure that information is used to inform action, including those processes in Tybee Island, GA, St. Marys, GA, and Beaufort, SC (CCCAI). This kind of integration was not always possible or achieved, however.

The case of McClellanville, SC supported participant learning, but the processes had limited influence policies and actions because they not closely linked to existing planning or decision processes. In the case of McClellanville, the VCAPS process was proposed and conducted in partnership with the *Climate Change Kitchen Table Group,* a group of residents. Since the VCAPS process, the group disbanded. While some residents were clearly concerned about climate-related hazards and how to better manage possible impacts, according to Sea Grant staff the Town has not really incorporated climate change into their decision-making processes/policies as a result of or since the VCAPs exercise.

This limited potential of VCAPS when the process is not linked to ongoing planning of decision making processes is also illustrated by other cases that were not well-integrated with important municipal Departments or staff or governance processes:

- Wellfleet, MA: The VCAPS process was completed with an *ad hoc* Shellfish and Climate Change Working Group, whose members were also members on various town boards and committees (e.g., Shellfish Advisory Board, Board of Health). Thus, the impact of VCAPS was limited via "trickling" through to managers and decision makers: "In general, no major changes as a result of our project, but some "infiltration" of our work into other management and planning documents."
- New Bedford/ Fairhaven, MA: While the "VCAPS program provided seed ideas to individuals to develop hazard mitigation planning but these people, with the exception of myself and Ed are no longer with us. In addition, our Department of Public Infrastructure (DPI) did not participate in VCAPS and they are a very

important department in terms of available funding to address critical infrastructure vulnerabilities in the City."

- Dauphin Island, AL: The VCAPS process was initiated by regional planners and extension agents, rather than local officials or staff, and it was not linked to a particular planning process. In addition, a social conflict among participants about how to manage flooding hazards on different parts of the island was not clearly addressed or made clear to facilitators prior to the workshops. Both of these issues made the goal of the VCAPS process ambiguous to many participants. "In Dauphin Island it was 'Which side of the Island do we save first?' Part [of the difficulty] was people in the room and part was that hearing there are multiple problems for multiple reasons and it became hard to digest at once. The community had to think about it some before they could move forward, it was hard to hear from other people even when you know it's true."

The impacts of VCAPS were also limited when participants did not feel that there was an urgent problem. This is exemplified by the VCAPS process with blue crab fishermen in Beaufort, SC. While a state resource manager and sea grant staff person felt that the project provided information factors affecting the blue crab populations and health and how those can interact with fishery production and profits, "With the return of normal rain for several years now, I don't think climate is on the mind of the crabbers so much now. I suspect that will change when flow rates change and crabs move up the rivers above the legal harvesting lines. The managers would like to have much more leeway to deal directly with the effects of climate, but this is a relatively low priority with the legislature and some of the influential people of the crabbing industry would fight any tightening of regulations. Unfortunately, our history is 'get to a crisis level' before we can get anything moving."

VCAPS has contributed to local resources and efforts to seek funding

Multiple communities used the results of the VCAPS processes explicitly to initiate or support efforts to obtain funds for adaptation actions. In some cases, the VCAPS effort provided extra support for proposed actions, while in others funding was sought to extend outreach efforts or initiate new activities. Directly attributable efforts to obtain funding occurred in 7 cases, although additional funding was not always obtained:

- New Bedford/Fairhaven, MA**:** VCAPS results informed the requirements of a Request for Proposals for a sea level rise vulnerability assessment that was supported by the Buzzards Bay NEP (the VCAPS study was explicitly referenced). In 2016, New Bedford received a $255,000 grant to address a specific recommendation in that. The City also applied for and received two additional grants relating to

protecting a seawall and infrastructure. Currently, New Bedford is participating in the state-sponsored Massachusetts Municipal Vulnerability Preparedness (MVP) Program.

- Orange Beach, AL: Grants were obtained to complete two actions identified during the VCAPS process: update Orange Beach emergency operations plan and prepare business and condo template to provide emergency preparedness information to the city.
- S. Thomaston, ME: Multiple grant proposals were submitted to continue working with lobstermen statewide. The grants were submitted in collaboration with the ME Sea Grant Program, associations of lobstermen, and University of Maine. To date none of these efforts have been successful in obtaining funding.
- Wellfleet, MA: The Town of Wellfleet worked with the Social and Environmental Research Institute to extend planning for climate change adaptation into a revision of the local comprehensive plan; the planning process is to be completed during spring 2018. The funds were obtained from the MIT Sea Grant Program to build on the initial VCAPS process.
- Plymouth, MA: sought funding for additional work, not funded. to protect and restore coastal and estuarine resources in Plymouth, MA by supporting development of a shoreline management plan. This project will facilitate actions at multiple scales of governance to promote restoration and stewardship of coastal resources and provide scientific basis for decision making, by providing technical support to local decision makers. The technical support will be aimed at building capacity of local planners about best practices and alternative management strategies for restoring coastal and estuarine resources in Plymouth. The outcome of the project will be a set of prioritized strategies for long-term restoration of coastal and estuarine resources in the Town of Plymouth, MA. These strategies can become part of a shoreline management plan for the Town.
- St. Marys, GA: The community applied for a Section 319H grant based on information produced from the study to support a downtown project to mitigate storm water risks.
- Tybee Island, GA: The city obtained a FEMA pre-disaster mitigation grant using information about sea level rise impacts developed as part of the project.

In an interesting twist, one community *rejected* federal funding because it was for a project that was viewed as unnecessary if predictions for sea level rise materialize as predicted:

- Sullivans Island, SC: The wastewater treatment plant is a vulnerable critical facility. While FEMA recommends building to a 500-year event, this would cost $19-20 million. According to an interviewee, the town says it does not need to build to this level of protection, and that protecting up to a 100-year event is

sufficient. The town feels that a 500-year event will cause many other problems – so that damage to the wastewater system will not be the biggest problem in the town. Consequently, the town is walking away from FEMA money to help offset costs.

In all cases reports summarizing the process and outcomes of VCAPS were provided to communities (these are listed in Appendix C). In addition, several municipalities also generated new resources via VCAPS:

- Wellfleet, MA: obtained maps illustrating the impacts of sea level rise on access to aquaculture grants and a website, linked to the Town webpage, about impacts of climate change on shellfish.
- Beaufort, SC (CCCAI): obtained maps and a report detailing 23 actions to mitigate and adapt to flood hazards, which were incorporated into the most recent Local Comprehensive Plan
- Boston, MA: included the VCAPS diagrams as an appendix to the revised Hazard Mitigation Plan
- Plymouth, NC: obtained maps illustrating flood risks.
- S. Thomaston, ME: obtained a report prepared by Clark University on water temperature changes associated with climate change.
- St. Marys, GA: sea level rise data were generated, and influential is furthering action.

VCAPS has promoted serval types of learning among participants

A goal of VCAPS has been to stimulate learning, thinking, and conversation about how to manage climate stressor impacts. Thus, learning, by and among participants, about climate stressors, possible management strategies, information gaps and needs, and the physical and social and political and regulatory system is a core aspect of VCAPS. In most cases where we successfully obtained feedback, participants could point to specific examples of learning about these topics. On occasion they also highlighted learning of skills related to communication and decision making (see Tuler et al 2016 for more discussion about learning).

For example, post-process interviews and from interviews associated with this assessment revealed participants' observations about learning in eight cases:

- Dauphin Island, AL: The process helped participants understand risks and how they were viewed from others' perspectives. "They know they have flooding issues and SLR will exacerbate it but going through and realizing the long-term effects of their actions in a group setting. [They talked about] is it smart to bring water off West

End to sewer plant, etc.? All people had a specific amount of knowledge but then everyone knew maybe there were more consequences than they'd thought or hadn't thought of things others brought up."

- Orange Beach, AL: VCAPS revealed and "opened up participants' eyes about hazards and consequences," including potential impacts on City finances.
- Plymouth, NC: VCAPS contributed to building public awareness especially about the value of infrastructure and the need to maintain it.
- Beaufort, SC (CCCAI): Even though city officials initially downplayed the role of learning, they acknowledged that participants did learn from each other: "Not sure anyone came to meeting to learn much. People who came to public meetings were interested already. This was the 1st time we had public meetings in the county about SLR. VCAPS revealed and opened up people's eyes about hazards and consequences." A separate study of this process reveals that learning was a primary outcome of the process (Bath 2015).
- S. Thomaston, ME: The Sea Grant staff observed that participants got "the take home message" that they all needed to think more about their own business models, that maybe just "fishing no matter what" is not the best option.
- Beaufort, SC (COCA): state officials felt that crabbers who participated in the process "probably left with a new appreciation of potential effects of climate change on their fishery. I think those that participated left with an understanding of how climate can affect the resource" as well as more insight about management options and associated strategies. However, the SC Sea Grant staff that supported this process were more skeptical about learning among the participating crabbers.
- Wellfleet, MA: A participant observed that "we all learned something new from the project."
- New Bedford/Fairhaven, MA: "It brought some barriers to the forefront. I don't know that it had to do with understanding them. We kind of know what the barriers are but it did help to give me a little insight instead of looking at always from a regulatory standpoint, to look at it from the other side, and what is important to the actual homeowner or property owner as far as mitigation is concerned. And sometimes their interest in mitigation and the interest from the regulatory standpoint are totally different."

An important reason that participants felt learning occurred was the presence of people with different perspectives and roles. There was important value in getting people together with diverse responsibilities and jurisdictions to discuss and learn from each other. For example, from post-process interviews in Boston we heard that:

- "It also opened the door to the possibility that we could have found some places where infrastructure improvements that might not otherwise have been identified

were identified because of the human services people there and their particular perspective. Or maybe changed how that mitigation action might have been advanced. Another example was having the historic preservation people there who wouldn't normally show up. Again another very different perspective."

- "When you have different departments there in the room, what seems like a good idea when you have just the infrastructure-based people in the room becomes less of a good idea when you have social service providers who are actually talking about different people with different disabilities or health conditions, and so on and so forth, then interact with that process."

This view was echoed by a city official from Orange Beach, AL: "The community throws things out from a different perspective that are really important that perhaps from a staff perspective we may have missed."

Discussion

The assessment of 14 VCAPS cases provides a relatively rare view of the use of a particular decision support and planning tool in multiple contexts. There are very few such assessments in the context of climate adaptation planning, although there is strong emphasis on the development and use of planning tools by federal and state agencies, university researchers, etc.

Our assessment leads to observations about VCAPS that a) point to improvements and next steps for the practice of VCAPS and b) provide broader insights into the role of dialogue and scenario-based planning tools in adaptation.

Diagramming is effective as a process facilitating the conversation and for recording and generating knowledge, but the diagrams themselves were not always liked by participants

The diagramming of scenarios based on group discussion is a core feature of VCAPS. We have learned previously that participants appreciate the "real time" representation of knowledge and ideas expressed by participants. Yet, we often heard feedback, both as part of this assessment and in previous efforts to gather feedback, that participants did not always find the diagrams useful. They observed that diagrams are overly complicated, like a "bowl of spaghetti." It may be that there is an important distinction between diagramming as an action and diagrams as an output. As an activity, diagramming enabled diverse participants to coalesce around the topic. They had a collective task to focus on, which played a role in breaking up patterns of thought and required more active listen and synthesizing/constructing understanding of place and process. For example, a participant from Dauphin Island stated that

> "When you go through and do diagrams, and think of different pieces, you get down to economic losses even and funding chances – then you have to backtrack and think about implementation actions. Required more complex thought because you think of who is affected and how to be proactive and prevent consequences."

VCAPS is applied within broader long-term contexts of climate and hazard planning, such that outcomes may be significant but not readily apparent in the short term.

In many of the cases, VCAPS was one of multiple activities conducted in a municipality to plan for climate change. As we have noted VCAPS was at times closely integrated into an existing planning effort; for example, hazard mitigation planning in Boston, master planning in Beaufort, SC (CCCAI), resilience planning in St. Marys and Tybee Island, GA. At other times, VCAPS was not well-integrated into ongoing planning activities (e.g., McClellanville, Beaufort, SC (COCA)).

What is apparent in all cases, however, is that VCAPS is occurring within a broader and longer term series of activities to address climate change risks within a municipality. This has three, related, implications for our effort to assess VCAPS.

First, there can be many forces and complicated dynamics that lead communities to take adaptation actions. Planning is not a rational, linear process. Politics, competing agendas, new events (natural and human-caused) can intervene, new information can be forthcoming, etc. Some can be internal to a community; such as new officials being elected or staff retiring. In other cases, the forces may be external – such as an economic downturn.

Second, adaptation is an ongoing "forever" process. Planning and implementation can occur iteratively. VCAPS has helped agencies and organizations advance learning and develop new questions and leverage resources to pursue them. Examples can be found in Plymouth, NC, Tybee Island, GA, St. Marys, GA, and Wellfleet, MA which continue to integrate adaptation strategies into their on-going planning activities. Communities can also learn by doing, and then further adapt what they are doing. A case in point is Orange Beach, AL. This community developed a template for gathering information from condominium and homeowner associations to inform emergency preparedness. The first version was, according to City staff, too long and cumbersome. They did not get many responses and that they need to come up with a shorter and easier form.

Third, and consequently, given the complexity of adaptation planning processes, it can be very hard to pinpoint causality. What exactly caused a particular decision to be made or action to be taken? Often it is a confluence of multiple streams of action and thought. Thus,

clear, measureable outcomes may not emerge in the short term. Instead, VCAPS can be like planting seeds in the words of one participant: "The VCAPS program provided seed ideas to individuals to develop hazard mitigation planning." This underscores how the goal of learning among participants is crucial. Participants can learn from a VCAPS process and apply that knowledge in the future. For example, according to ME Sea Grant staff a lobster marketing council was created and some of the ideas from S. Thomaston VCAPS infused its process via individual participants. Similarly, and in the words of a participant from Wellfleet, MA:

> "It has taken a while for the work of our group to trickle down to others in the Town. We now have an ad hoc group that is mobilizing about climate change issues in general so this group is raising awareness about climate change in a general way and promoting local action (use of renewable energy, carpooling, etc.). This group is aware of the work of our project. In addition, Wellfleet is drafting a Local Comprehensive Plan and for the first time, there is a chapter about Shellfish (Chapter 11). Some of us have been participating in focus groups and discussions about what to include in this chapter. There will be a section on climate change which will hopefully refer to the website that resulted from our working group. Finally, our Town Administrator has asked the Wellfleet Shellfish Advisory Board to update the 2007 Shellfish Management Plan. Although I am no longer a member of the Shellfish Advisory Board, the new shellfish warden asked me to draft a section on climate change to include in the updated plan. Much of the section I wrote resulted from the work of our group and suggestions about management around climate change issues."

VCAPS can inform adaptation planning at multiple points as municipalities grapple with the long-term process of confronting climate stressors

A way in which our work with VCAPS has varied has to do with *when* the VCAPS process was implemented within a broader context of planning. In many cases, VCAPS played multiple roles because: a) a municipality could be characterized as being at a different stage for different climate stressors or management concerns and b) different participants had more/less knowledge (e.g., resident vs. town staff). In general, however, we can characterize communities as being predominately oriented toward one of the three stages:

1. Building awareness within the community about climate stressors and the need to act (McClellanville, SC; Beaufort, SC (COCA), Wellfleet, MA; Boston, MA; New Bedford / Fairhaven, MA)
2. Identifying sets of strategies to manage the impacts of particular climate stressors (S. Thomaston, ME; Beaufort, SC (CCCAI); Plymouth, MA; Plymouth, NC; Sullivans Island, SC), St. Marys, GA, Tybee Island, GA

3. Building support for specific actions (Orange Beach, AL), St. Marys, GA, Tybee Island, GA

This has implications for the implementation of VCAPS in particular, and planning tools more generally. It is flexible and can play multiple roles. VCAPS can be understood as a "micro intervention" in a long-term process, which helps agencies and organizations advance learning and develop new questions and leverage resources to pursue them. It begins with a collective description of what is happening now, and then overlays an uncertain future on top of that, which in turn can inform future planning (e.g., vulnerability assessments, hazard mitigation plans, local comprehensive plans).

Consideration needs to be given to the stage of planning when designing a process, including

- Who should participate?
- How results of the process should be shared?
- How long and for how often a group should meet?
- What is the appropriate set and scope of topics to be discussed?
- What should be the topic of expert presentations and what experts can best contribute to discussions?

To illustrate these issues, we highlight a few cases. The Dauphin Island process illustrated how a relatively rapid design (1 day) in the context of a complex socio-political environment was ineffective. The process was too short to adequately explore the complexities and ensure that all voices were heard. Furthermore, the facilitators were unaware of different agendas and controversies within the community. On the other hand, a rapid approach worked well in Orange Beach, AL, where staff had already laid the foundation for the discussions and people were motivated to work together. The Boston VCAPS occurred at the early stages of the city and its officials considering adaptation (as opposed to mitigation). A process with many participants that enabled discussion in small groups about multiple climate stressors helped participants appreciate the importance of adaptation and its complexities.

In addition, the stage of the process can help with choices about how to integrate VCAPS's focus on qualitative scenario-building with other types of tools, such as mapping, systems dynamics modeling, engineering analyses, research involving data gathering, etc., as well as *how* such supplemental activities are conducted; for example, via citizen science efforts or by domain experts/consultants.

Conclusion

This assessment of 14 prior VCAPS processes was conducted with two purposes in mind. First, we sought to understand the impact of VCAPS processes on municipal adaptation planning. Second, we sought to understand the ways that dialogue-based scenario tools, exemplified by VCAPS, inform adaptation planning that is both long-term and episodic. Third, we sought to identify opportunities for improving the design and implementation of VCAPS for future applications.

We identified ten insights about the potential and limitations of the VCAPS process:

- VCAPS has proven to be flexible and responsive to community preferences for process design
- VCAPS has informed local plans and decisions
- VCAPS has informed individual plans and decisions
- VCAPS has helped generate broader support for subsequent actions
- VCAPS impact is limited when process does not include or not linked to governance (including people and specific processes)
- VCAPS has contributed to local resources and efforts to seek funding
- VCAPS has promoted learning among participants
- Diagramming is effective as a process facilitating the conversation and for recording and generating knowledge, but the diagrams themselves were not always liked by participants
- When VCAPS is applied within broader long-term contexts of climate and hazard planning, outcomes may be significant, but not readily apparent in the short term
- VCAPS can inform adaptation planning at multiple points as municipalities grapple with the long-term process of confronting climate stressors

This assessment highlights potential future directions for increasing the ease of use and range of applicability for VCAPS, including improvements or next steps for practice. As elaborated in the discussion, these include:

Providing more guidance about how to use VCAPS at different "stages" of planning.

VCAPS has proven to be a flexible process, which can be modified to accommodate community-specific preferences for focus and interactions. Another way to capitalize on this flexibility is to design specific implementations for different stages in adaptation planning. We have worked with communities that are, for example, just at the beginning of discussing the possible implications of emerging climate stressors. We have also worked with communities that have already completed quite a bit of thinking and planning for climate stressors. Three stages of adaptation planning can be defined as: 1) building awareness within the community about climate stressors and the need to act, 2) identifying sets of strategies to manage the impacts of particular climate stressors, and 3) building support for specific actions. Further development of VCAPS can consider:

- How to explicitly guide and focus dialogue among participants at different stages of adaptation planning.
- Developing additional methods of scenario visualization and integration of information to support learning at different stages of adaptation planning.

Providing guidance about how to integrate VCAPS with other tools (e.g., systems dynamics modeling, mapping).

To date implementations of VCAPS have presented, organized, and analyzed information using multiple methods, such as GIS mapping and systems dynamics modeling. Photos to promote visualization have also been utilized. Further development of VCAPS can consider a broad array of other tools that have been developed to support climate adaptation planning. These include dynamic visualization tools and additional on-line visualization tools. Other tools have been developed to support dialogue, including the use of real-time feedback devices (e.g., clickers). Guidance for future use of such tools can also consider the role of various tools in the context of different stages of adaptation planning and for different kinds of participants with different levels of knowledge and authority (e.g., residents, municipal staff and officials)

Developing a process for assessing context and purpose of VCAPS to improve design and to better connect VCAPS with ongoing and future activities.

To best provide guidance about best-use of VCAPS for different stages of adaptation planning and integration with different tools, another type of process design tool is

required: a method for assessing community-specific contexts and needs. Experience with VCAPS highlights the importance of integrating VCAPS with on-going or planned processes. Experience with VCAPS also highlights the importance of understanding local political, economic, social, institutional, regulatory, and cultural contexts. This includes how authorities for adaptation actions may be split across political jurisdictions (e.g., city, county, and state). Further development of guidance to support the design of VCAPS will be useful and help to ensure maximal impact.

This assessment of 14 cases also represents a unique opportunity for long-term and multi case comparisons. Typically, evaluations in the domain of adaptation planning are based on single cases or at most a few cases. A set of 14 cases enables a deeper consideration of the various factors that come into play in adaptation planning. Specifically, this assessment raises questions about the when and how to work with communities in the long-term process of adaptation. A key insight of the assessment is that adaptation planning is both long-term and emergent. In other words, adaptation planning is something that communities do over long periods of time, because they are responding to emerging and uncertain threats that present a combination of both known/routine consequences and a broad range of novel and uncertain consequences. Adaptation planning takes a long time, intersects with other types and scales of planning, and has complex linkages with other events and processes as well as with evolving knowledge. VCAPS provided greater benefits to communities when the effort was tied to governance activities, (e.g., as a springboard or leveraged to support other adaptation processes) rather than as a standalone activity.

Scenario and stakeholder dialogue-based tools like VCAPS offer a particularly useful approach for planning situations that involve multiple forms of knowledge, potential differences in goals, and significant dependence on community support for implementation. They offer an opportunity for people to explore what they know, identify gaps in knowledge, and develop understandings of others' points of views. Individual and group learning over time is central to planning in such contexts. Developing and exploring scenarios may also offer a "safe place" for discussions about high stakes or highly divisive challenges in communities. Further application of VCAPS should develop and test combinations of methods for supporting planning in such contexts.

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Appendix A: Conference and workshop presentations about VCAPS

Mississippi-Alabama Sea Grant Consortium webinar, Helping Coastal Communities Strategize Adaptations to Climate Change: How to Implement a Structured Dialogue Using an Interactive Diagramming Program. March 1st, 2012.

Brinn, D., and J. Whitehead. "Assisting Hyde County, NC with comprehensive community flood resilience planning." Carolinas Climate Resilience Conference, Charlotte, NC, 15 September 2016.

Dow, K. 2017. "Vulnerability, Consequences, Adaptation Planning Scenarios (VCAPS). NOAA Social Science Webinar. September 20.

Dow, K., S. Tuler, T. Webler, J. Whitehead, and N. Kettle. "Developing Vulnerability and Consequence Planning Scenarios for Adaptation." 2012 Adaptation Futures Conference. Tucson, Arizona, 29-31 May, 2012.

Tuler, S. 2012. Invited presentation at the Climate Adaptation Training for Local Governments in Southeastern Massachusetts Workshop, Waquoit National Estuary Reserve, Waquoit, MA, 24-26, April, 2012 (see www.waquoitbayreserve.org/eventshow.aspx?eventid=337 for more information)

Tuler, S. 2013 (November). *Supporting Local climate change adaptation planning: Integrating Local and Scientific Expertise*, Invited Presentation, Department of Environment and Natural Resources, Mahidol University, Bangkok, Thailand.

Tuler, S. 2015. *A community-based approach to planning for the effects of climate change on shellfishing in Wellfleet Harbor*. 3RD Annual Cape Coastal Conference, Hyannis, MA, December 10, 2015.

Tuler, S. 2015. *A community-based approach to planning for the effects of climate change on shellfishing in Wellfleet Harbor*, State of Wellfleet Harbor Conference, Wellfleet, MA, November 7, 2015.

Tuler, S. 2016. *A community-based approach to planning for the effects of climate change on shellfishing in Wellfleet Harbor*. Howard Hughes Medical Institute (HHMI) Seminar Series on Climate Science, Boston University, 8 Nov., 2016.

Tuler, S. and Stancioff, E. 2016. *Promoting climate awareness and adaptive planning in three Atlantic fisheries communities using the VCAPS process and system dynamics model*. Increasing resilience of fishing communities in a changing climate workshop, National Marine Fisheries Service, Silver Spring, MD, 3-5 May, 2016.

Tuler, S. and Webler, T. 2013 (November). *Integrating climate change adaptation planning and hazard mitigation planning in coastal Massachusetts,* Invited workshop, Northeast Regional Sea Grant Biennial Meeting, New Bedford, MA, 22 November, 2013.

Tuler, S. and Whitehead, J. 2012. Invited presentation at the session on Considering Climate in Decision Support for Resilient Coastal Communities at the *Southeast and Caribbean Climate Outreach Community of Practice meeting*, June 12-14, 2012, in Jacksonville, FL.

Tuler, S. and Whitehead, J. 2013 (December). *Helping Coastal Communities Strategize Adaptations to Climate Change: How to Implement a Structured Dialogue Using an Interactive Diagramming Program*, Invited Workshop leader, supported by North Carolina Sea Grant. NOAA Beaufort Lab, Pivers Island, Beaufort, NC, December 10-11, 2013.

Tuler, S. *Workshop/training for Great Lakes Sea Grant on the Vulnerability, Consequences, and Adaptation Planning Scenarios (VCAPS) Process*, Great Lakes Sea Grant Network Conference, Cleveland, OH, 7-8 June, 2017.

Tuler, S., Webler, T., and Whitehead, J. 2012. *Climate-Ready States and Cites Initiative (CRSCI) webinar* on public health, climate change, and the VCAPS tool, October 18th, 2012.

Tuler. S. 2012. *Improving Understandings of Consequences, Vulnerabilities, and Adaptation Strategies to Climate Change Related Hazards,* Invited presentation to grantees workshop, MIT Sea Grant. (see http://seagrant.mit.edu/press_releases.php?ID=292).

Tuler. S. 2013. *Integrating climate change adaptation planning and hazard mitigation planning in coastal Massachusetts,* Invited presentation to grantees workshop, Adapting to Change in Marine Ecosystems - A Stakeholder Science Forum, MIT Sea Grant. (see http://seagrant.mit.edu/press_releases.php?ID=416).

Webler, T. and Tuler, S. 2013 (November). *Project Overview: A Working Group on Climate Change and Shellfish in Wellfleet Harbor: Anticipating impacts, reducing threats, and increasing resilience*. Invited Poster Presentation, Wellfleet State of the Harbor, Wellfleet, MA.

Whitehead, J. "Discussing, Engaging, Adapting: Improving Resilience in Nags Head, North Carolina." Changing Climate: Preparing for North Carolina's Uncertain Future. Durham, NC. 17 May 2018.

Whitehead, J. "Approaches to Improving Resilience in coastal North Carolina: A Focus on Using the Vulnerability, Consequences, and Adaptation Planning Scenario (VCAPS) Process." NOAA Coastal Adaptation Training. Beaufort, NC. 18 April 2018.

Whitehead, J., H. White, and L. Schiavinato. "Discussing, Engaging, Adapting: Improving Resilience in coastal North Carolina Using the Vulnerability, Consequences, and Adaptation Planning Scenario (VCAPS) Process." North Carolina Association of

Floodplain Managers Annual Conference. Wilmington, NC. 17 April 2018.

Whitehead, J., L. Schiavinato, H. White, and C. Kamrath. "Adaptation Planning in Nags Head, NC: From Communication, to Co-Production, to Funded Actions." 98th Annual Meeting of the American Meteorological Society, Austin, TX, 12 January 2018.

Whitehead, J., and H. White. "Adaptation planning in the Town of Nags Head." Hampton Roads Adaptation Forum, Norfolk, VA, 2 February 2017.

Whitehead, J. "Discussing, Engaging, Adapting: Improving Resilience in coastal North Carolina Using the Vulnerability, Consequences, and Adaptation Planning Scenario (VCAPS) Process." 3rd European Climate Change Adaptation Conference, Glasgow, Scotland (presented remotely). 7 June 2017.

Whitehead, J., and H. White. "Adaptation planning in North Carolina: Overcoming barriers using facilitated dialogue." Oregon Symposium on Coastal Resiliency in the Face of Climate Change, Eugene, OR, 7 April 2017.

Whitehead, J., and R. Register. "Using the Vulnerability, Consequences, and Adaptation Planning Scenario (VCAPS) process to facilitate community resilience discussions." Training delivered at 2016 Sea Grant Week, Newport, RI, 11 October 2016.

Whitehead, J., K. Dow, L. Fly, S. Tuler, and T. Webler. "Facilitating hazard discussions using the Vulnerability, Consequences, and Adaptation Planning Scenario (VCAPS) process." Mid-Atlantic Sea Grant Meeting, Red Bank, NJ, 28 April 2016.

Whitehead, J., and J. Evans. "Hurricanes and Hyde County, NC: A Catalyst for flood resilience planning." Southeast and Caribbean Climate Outreach Community of Practice Meeting, Tybee Island, GA, 14 April 2016.

Whitehead, J., K. Dow, S. Tuler, and T. Webler. "Make dialogue happen! Using the Vulnerability, Consequences, and Adaptation Planning Scenario (VCAPS) process for flood vulnerability." Local Solutions: Eastern Regional Climate Preparedness Conference, Baltimore, MD, 4 April 2016.

Whitehead, J., and L. Schiavinato. "What do we do about the Outer Banks? Overcoming barriers to resilience in a multiple decision-maker environment." Social Coast Forum, Charleston, SC, 9 February 2016.

Whitehead, J. and Evans, J. "Assisting Hyde County, NC, with Comprehensive Community Flood Resilience Planning." 96th Annual Meeting of the American Meteorological Society, New Orleans, LA, 12 January 2016.

Whitehead, J., and J. Evans. "Implementing comprehensive community flood resilience planning in Hyde County," NC. 70th International Soil and Water Conservation Service Conference, Greensboro, NC, 29 July 2015.

Whitehead, J, K. Dow, E. Fly, S. Tuler, and T. Webler. "Discussing, engaging, adapting: Resilience and the Vulnerability, Consequences, and Adaptation Planning Scenario (VCAPS) Process." Invited webinar, U.S. EPA's Sustainable and Healthy Communities (SHC) Seminar Series. Durham, NC, 7 July 2015.

Whitehead, J, J. Davis, K. Dow, E. Fly, N. Kettle, E. Stancioff, S. Tuler, and T. Webler. "Facilitating hazard resilience discussions using the Vulnerability, Consequences, and Adaptation Planning Scenario Process." Invited presentation, NOAA Science Days 2014. Silver Spring, MD 23 September 2014.

Whitehead, J, S. Tuler, T. Webler, and K. Dow. "Using participatory engagement to initiate climate and infrastructure discussions in the Coastal Carolinas." Invited presentation, Los Alamos National Laboratory Conference on Eastern Coastal Infrastructure and Climate Change. Washington, DC, 26 February 2014.

Whitehead, J. "Bridging the gap between information and implementation for small and medium sized coastal communities in the Carolinas: Facilitating the creation of useful information." 9th Symposium on Policy and Socio-Economic Research, 94th American Meteorological Society Annual Meeting. Atlanta, GA, 5 February 2014.

Whitehead, J. "When 'wicked challenges' abound: Participatory processes to explore climate change impacts on NC's coast." Invited presentation, NC Environmental Health Collaborative Conference. Raleigh, NC, 29 October 2013.

Appendix B: VCAPS assessment Interview Guide

1. Since [date of VCAPS process] what kinds of decisions or plans have been made in the community to address hazards associated with _____ [climate stressors / management concerns that were part of VCAPS process]?

   If no action has taken place, why not?

2. Did the VCAPS project help inform planning and decisions about _____ [climate stressors / management concerns that were part of VCAPS process]?
   - Explain / elaborate….
   - What plan or decision?
   - How?
   - Did the effort lead to new questions or interests that were explored in subsequent studies or efforts?
   - Has a final report from the project been a useful resource?
   - Have the diagrams from the project been a useful resource?
   - What sort of additional information did you need?

3. Did the VCAPS project help participants learn about climate stressors?
   - Including who might be impacted and how?
   - Explain / elaborate….
   - What type of information was most compelling or actionable?

4. Did the VCAPS project help participants learn about management strategies?
   - Including what role they could plan in management?
   - Did the effort assist with priority setting?
   - Promoting broader opportunities for public involvement?
   - Explain / elaborate….
   - [have a list of management actions proposed / diagramed to ask about, to jog memories…]

5. Did the VCAPS project help participants learn about the physical and social and political and regulatory system (including beliefs and values of the participating parties, as well as institutional structures and processes)?
   - Including understanding others' concerns or views?
   - Explain / elaborate….

6. Did the VCAPS project impact how people are working together on climate-related issues?
   - Explain / elaborate….

Appendix C: VCAPS reports and other resources produced for each case

A website with information and resources about VCAPS is:

http://www.vcapsforplanning.org/places.html

Beaufort, SC (CCCAI)

Final Report and Executive Summary, which include 23 adaptation actions for the County to consider in planning and implementation.
http://www.vcapsforplanning.org/docs/Beaufort_Co_SLRA_Digital_Final31815.pdf
http://www.vcapsforplanning.org/docs/Beaufort_Co_SLRA_Exec_Summary_Digital.pdf

Beaufort, SC (COCA)

No report available.

Boston, MA

Information from the VCAPS report for Boston was integrated into the draft Hazard Mitigation Plan for Boston completed in December 2012.
https://docs.google.com/file/d/0By5enT3tgjj4a1BOWUFfd29oVzQ/edit?pli=1
https://www.cityofboston.gov/images_documents/Boston%20Revised%20Draft%20Hazard%20Mitigation%20Plan%202014%20Update%20%2003-31-15_tcm3-51167.pdf

Dauphin Island, AL

A report of the Dauphin Island experience is available. The results of the VCAPS workshop helped to inform a climate resilience study for Dauphin Island.
http://www.vcapsforplanning.org/docs/Dauphin%20Island%20Report.pdf
http://masgc.org/news/article/report-analyzes-planning-actions-that-could-make-Dauphin-Island-more-climat

McClellanville, SC

A diagram of their process and the report on storm water management are available.
http://www.vcapsforplanning.org/docs/McClellanville%20Diagram.pdf
http://www.vcapsforplanning.org/docs/McClellanville%20Report.pdf

New Bedford and Fairhaven, MA

A report describing the VCAPS process with Fairhaven and New Bedford is available
http://www.vcapsforplanning.org/docs/New%20Bedford%20Fairhaven%20report.pdf

Orange Beach, AL

A report describing the VCAPS process in Orange Beach is available.
https://docs.google.com/file/d/0By5enT3tgjj4azVJQ1F3eVIxWlk/edit?pli=1

Plymouth, MA
A report describing the VCAPS process in Plymouth, Massachusetts, is available.
https://docs.google.com/file/d/0By5enT3tgjj4MWRsQ2JPTWtVbFE/edit?pli=1

Plymouth, NC
A report is available from North Carolina Sea Grant.
http://digital.ncdcr.gov/cdm/singleitem/collection/p249901coll22/id/509055

South Thomaston, ME
Reports developed as part of the project include an overview of the project, a poster presentation, and a report describing (1) the geographical context of South Thomaston and Spruce Head at multiple scales; (2) the different ways in which fishermen and scientists monitor and model processes of environmental change; and (3) scenarios and opportunities associated with climate change that were discussed during VCAPS meetings.

St. Marys, GA
A report describing the project using VCAPS in St. Marys, GA project is available.
https://www.researchgate.net/publication/317008117_St_Marys_Flood_Resiliency_Project

Sullivan's Island, SC
A report summarizing the major points identified in these meetings is available. A journal article describing the process and outcomes was published in 2014.
http://www.vcapsforplanning.org/docs/Sullivans%20Island%20report.pdf
https://www.sciencedirect.com/science/article/pii/S2212096314000254

Tybee Island, GA
A report describing the project using VCAPS in Tybee Island, GA project is available.
https://www.researchgate.net/publication/289999590_Tybee_Island_Sea-Level_Rise_Adaptation_Plan

Wellfleet, MA
A brief overview of this project is available. Reports summarizing the impacts of climate change on shellfish and shell fishing, sea level rise on aquaculture, and strategies to manage to increasing risks of Vibrio infections from rising air and water temperatures were produced as part of this project and can be found on the website Planning for Climate Change Impacts on Shellfish in Wellfleet Harbor.

http://www.vcapsforplanning.org/docs/Wellfleet%20overview.pdf

http://wellfleet.seri-us.org