Are Rhode Islanders Ready?

Assessing Individual Climate Change Preparedness

Clara Rubin, Pam Rubinoff, Isaac Ginis, Heather McGee, Kathy Meier, Norbert Mundorf, , Andrea Paiva, James Prochaska, Nicole Rohr, Judith Swift, and Chip Young

Graduate School of Oceanography, Rhode Island Sea Grant, Cancer Prevention Research Center, Coastal Institute, Coastal Resources Center, Communication Studies

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Abstract

As global climatic conditions shift, the resulting ecological and social impacts increasingly point to the need for effective ways to mitigate those impacts and adapt to a shifting climate. One of the big challenges in achieving climate change mitigation and adaptation is figuring out how to bring about changes in the behavior of individuals, communities and societies at large. One method to examine behavior change is through the lens of the Transtheoretical Model (TTM), which has been successfully employed to promote behavior changes that impacted personal health and well-being. This model examines the five stages of change: Precontemplation, Contemplation, Preparation, Action, and Maintenance. The University of Rhode Island Climate Change Collaborative explored the TTM as a tool to examine and change behaviors in response to climate change threats, thus expanding the ways in which communities can adapt to climate change.

A key element to successful use of the TTM is selecting a singular focal behavior, which is a challenging task when dealing with the inherently broad and complex topics of coastal hazards mitigation and adaptation. The URI Collaborative pilot study first identified preparedness as the specific focus and then piloted a computer-tailored intervention with the goal of changing the behavior of individuals through key actions: being informed, getting a kit, and making a plan. The pilot study and associated communication strategies that were developed for targeting behaviors led to encouraging results. The results indicate that the TTM may be used successfully in two ways: to initiate change in individuals' behaviors aimed at reducing impacts from selected coastal hazards and to provide a framework for developing messages for a variety of outreach approaches. However, application of the health sector-based model to the coastal management and climate adaptation field includes numerous challenges, such as identifying definitive actions and behaviors that may be taken to prepare for climate change impacts. Target behaviors must be clearly defined and relevant to the target audience for successful use of the model.

This pilot study provides a starting point for applying TTM to help individuals and populations better prepare for impacts of climate change. In applying a behavior change model to climate change adaptation for individuals and encouraging individuals, groups, and communities to initiate and adopt potential solutions, the URI Climate Change Collaborative is making an interdisciplinary contribution to addressing the problems presented by climate change in Rhode Island.

Introduction

Since 2010, Rhode Island has experienced three major storm events: the March 2010 floods, Tropical Storm Irene in August 2011, and Superstorm Sandy in October 2012. This research project was launched on February 1, 2010, two months prior to the infamous March floods. The subsequent series of storms influenced the researchers' perspectives and

provided an ongoing context for the importance of the project. The storms served as catalyzing events in Rhode Island by exposing the state's vulnerability to long-term climate change impacts such as rising sea levels and increasing frequency of severe storms as well as immediate impacts from flooding, erosion, and high-speed winds. Coastal communities must prepare for and adapt to these changes–both long-term and immediate–in order to minimize risks of damage to property and infrastructure, reduce threats to human life, and improve overall community resilience. Behavior change is the central component necessary for adapting to short-term and long-term coastal hazards impacts and climate change at both a societal and individual level. It is a difficult and complex process, particularly when applied to a long-term and seemingly distant challenge such as climate change. On a positive note, many actions that people can take to prepare for today's natural disasters such as Superstorm Sandy can also help them adapt to long-term climate change. The research presented here focuses on individual behavior change. Clearly, changes in infrastructure, laws and administrative processes must supplement individual choices and behavior changes in order for mitigation and adaptation to occur.

Effective communication about the impacts of climate change, the proposed actions to reduce impacts, and the need for proactive adaptation requires that the communicators deal with numerous challenges. Climate change science is complex and can be difficult for non-scientists to understand. The challenges and likely risks are enormous. Some people deny that climate change is even occurring. And, more generally, people have repeatedly demonstrated an inability or unwillingness to change behaviors that leave them increasingly vulnerable to impacts of climate change even after experiencing severe impacts from recent storm events. The challenge of effectively changing individuals' behaviors pertaining to disaster preparedness and climate change adaptation was the impetus for this research.

To begin addressing the social, economic, and environmental problems of climate change, the University of Rhode Island (URI) Climate Change Collaborative was formed by researchers from a variety of backgrounds. One of the objectives of URI's interdisciplinary Collaborative was to design and implement a behavior change model focusing on changing individuals' behaviors regarding climate change adaptation. In order to develop an innovative behavior change model, the Transtheoretical Model (TTM) of behavior change was applied to climate change adaptation and coastal hazard adaptation. The TTM was originally developed for use in the field of public health as a method of changing risky health behaviors. The goal of this project was to assess participants' "stages of change" pertaining to disaster preparedness and then help them to make further changes, along the spectrum of behavior change, in order to advance the implementation of climate change adaptation strategies in Rhode Island. A computer-tailored intervention was used to

deliver individualized messages targeted to each participant's current stage of behavior change.

The Local Problem: Climate Change in Rhode Island

Climate change poses a significant and immediate challenge to Rhode Island, aptly nicknamed *The Ocean State*, with severely damaging potential impacts. Rhode Island's long and highly developed coastline leaves many communities vulnerable to impacts from rising sea levels, storm surge, inland flooding, and wind damage (RIEMA, 2014; Titus et al., 2009; Field et al., 2007; Frumhoff et al., 2007; Solomon, 2009). Rising sea levels combined with increasing severity of storms causes greater coastal erosion, damaging the state's beaches and coastline (Heffner et al., 2012). Increased storm intensity affects riverine flooding, where existing natural riparian buffers are affected by increased development. Warmer average temperatures contribute to worsening air quality, which poses a risk to human health while providing a more hospitable habitat for disease-carrying insects such as ticks and mosquitoes (Patz et al., 2005). Rhode Island's tourism and recreation industries, which are central to the state's economic well-being, largely depend on the beauty and quality of the state's coastal ecosystems and man-made infrastructure. As sea level rise and severe storms accelerate the erosion of the state's beaches, revenue from tourism may decline (Heffner et al., 2012). Overall, Rhode Islanders should expect a variety of impacts related to climate change, and thus the state has a significant incentive to take proactive steps toward implementing adaptation actions and increasing resiliency.

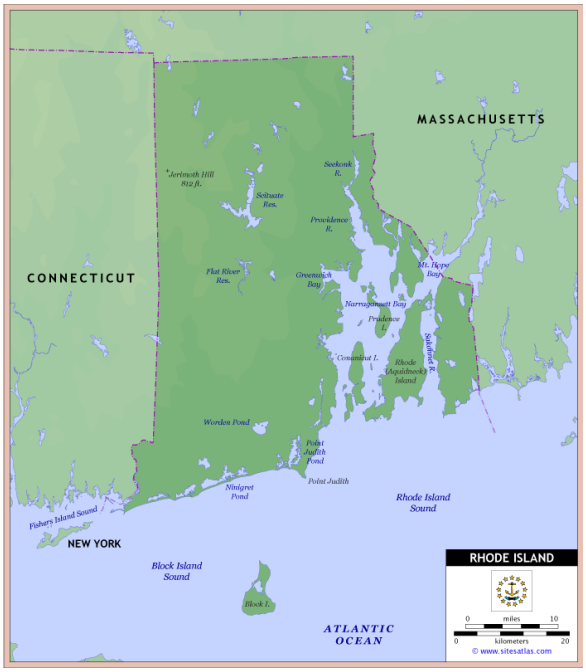

Figure 1: Rhode Island is the smallest state in the U.S., only 1,214 square miles, but it has more than 400 miles of coastline (www.siteatlas.com).

The State of Rhode Island has taken several progressive steps toward climate change adaptation, including conducting a statewide vulnerability assessment and creating an Executive Climate Change Coordinating Council established by the Legislature. While some property owners and municipalities, such as North Kingstown, have taken action to increase their resilience and decrease their vulnerability to climate change impacts, there has not yet been a concerted large-scale effort to change individual adaptation behaviors (RISG, 2014). As extreme weather events increase in frequency and intensity, new methods must be developed to create more adaptive and resilient communities and increase relevant actions at individual, community, and statewide levels.

Further complicating preparedness planning, there are serious concerns that individuals are not adequately engaged in climate change adaptation. Important segments of populations perceive climate change as outside of their control; they may be in the precontemplation stage because they feel powerless to help solve the problem. Others believe that there is no scientific consensus about the cause of and adaptation to climate change and may, therefore, be in the contemplation stage, where the attitude is often "when in doubt, don't act." Still others believe that the only effective solutions will come from mitigation in the form of innovative technologies or policies.

The Local Solution: The Climate Change Collaborative

The Climate Change Collaborative (hereafter referred to as "the Collaborative") was formed at the University of Rhode Island (URI) in 2010 as an interdisciplinary group with the goal of addressing the challenges of adapting to climate change in Rhode Island. The Collaborative brings together sound climate science knowledge, effective human behavior change methods, applied techniques in communication, and recognized approaches to community extension education in coastal management. The Collaborative is composed of a variety of contributors, including faculty, researchers, outreach practitioners, and undergraduate and graduate students.

Members of the Collaborative recognize that adapting to climate change entails more than research and application of applied science, policy development, communication, and outreach in isolation. Experts in these areas must combine their knowledge and experience to tackle the complex interdisciplinary challenges presented by climate change. To do this, subgroups of the Collaborative worked together on several projects, including hosting a science symposium, developing and launching a climate change website (http://riclimatechange.org), designing a behavior change model based on the TTM, and implementing that model in a statewide survey to assess levels of individual willingness to change in order to prepare for the current and projected impacts of climate change. The diverse skills and experience each Collaborative member brought to the project was

essential to adapting the TTM to climate change applications. The Collaborative's inclusive and interdisciplinary approach to this project helped create and foster relationships among disciplines, departments and individual group members and, from this foundation, advanced discussions beyond the Collaborative on translating science for policymakers and adapting models of behavior change for other populations to address climate change challenges. Through this project, the Collaborative increased URI's capacity to more effectively respond to the needs of communities and to support the choices that individuals and communities need to make to adapt to climate change.

The Approach: The Transtheoretical Model and Computer Tailored Intervention

The Transtheoretical Model (TTM) of behavior change identifies change as a process consisting of multiple steps over a period of time as opposed to a single one-time event. The individual progresses through five stages of change, from Precontemplation to Contemplation to Preparation to Action, and lastly to Maintenance (Figure 2). "Behavior change" is defined as moving from one stage to the next. Progress is made even if the change occurs in the "non-action" stages (Precontemplation, Contemplation, and preparation). For example, a move from Precontemplation to Contemplation is considered an important change. Hence, the absence of "action" (Action or Maintenance on the TTM spectrum) with respect to a particular behavior does not mean that no change has occurred.

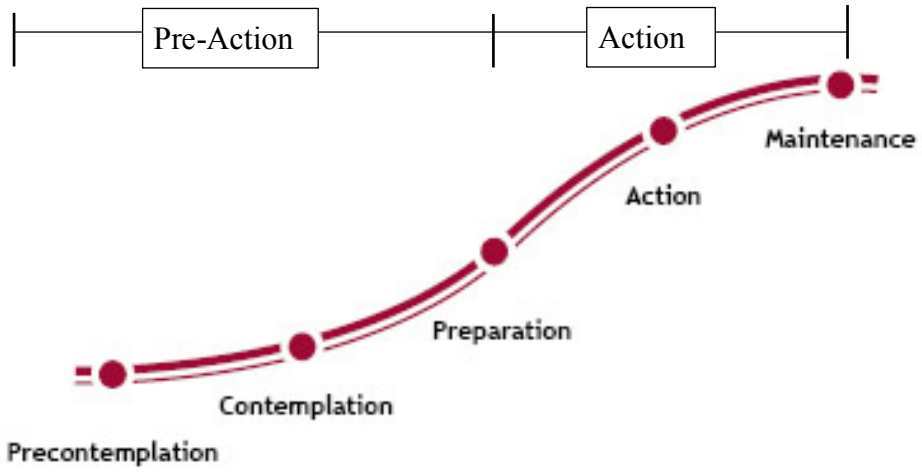

Figure 2: The five stages of change in the Transtheoretical Model (adapted from www.prochange.com).

This stage-based intervention approach, developed to assist with changing health behaviors, produced a far greater impact, measured at 10 to 15 times greater, than traditional approaches when applied to smoking cessation and changes to diet, exercise,

and medication compliance (Prochaska, 2008). Due to the high success rate of TTM when applied to health-related behaviors, it is seen as a promising approach to changing environmental and climate change response-related behaviors as well (Semenza et al., 2008, Gertner, 2009, Doppelt, 2008; Pike et al., 2010). The goal of the Collaborative's project was to test the utility of the TTM in the climate change adaptation field and provide a model for future applications in environmental and coastal hazard projects.

The TTM uses several components to understand and assess the movement of individuals through the five stages of change (Figure 3). "Decisional Balance" refers to the balance of pros and cons of changing from the individual's perspective. If the cons outweigh the pros, the individual is unlikely to change his or her behavior and may exhibit resistance to change. "Self-Efficacy" refers to an individual's confidence in his/her ability to change given the factors of time, money, and the bother of changing personal behavior. "Processes of Change" are the strategies that help individuals change, such as knowledge about the issue, commitment to a belief or value, reminders about changing behavior, and social norms and peer influences.

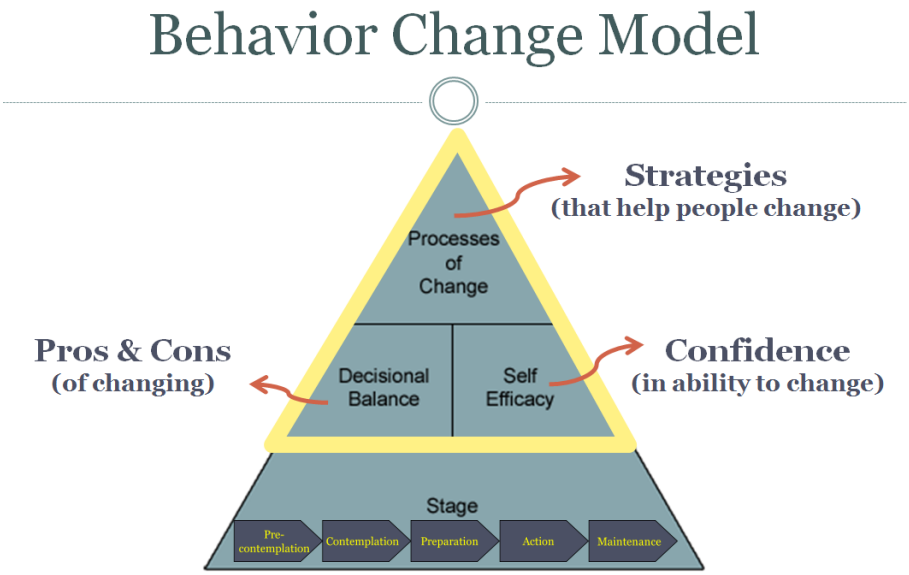

Figure 3: The Behavior Change Model uses three components, Decisional Balance, Self-Efficacy, and Processes of Change, to move individuals through the five stages of change (McGee et. al, 2012).

Each of these components is included in the development of a computer-tailored intervention (CTI), a survey tool commonly used in assessing behavior change relating to personal health, that utilizes participant feedback and tailors the survey questions to respondents' current stages of behavior change as they progress through the survey. One of the benefits of implementing a CTI is that it renders the survey broadly accessible to many

people; the only requirements for use of the CTI are literacy and Internet access. Thus, participants from a wide variety of educational and socio-economic backgrounds may benefit from engagement with the CTI.

Study 1: The Application of the Transtheoretical Model to Climate Change Adaptation

One of the key elements of the TTM and its implementation through the CTI is the identification of specific behaviors to be changed or achieved. Since climate change adaptation is a relatively new area of inquiry and the issues are so broad (from basement flooding to dune erosion), it is difficult to prescribe population-based adaptation behaviors and actions. The innovative nature of this project and the application of the TTM in a non-health behavior field necessitated some modifications, such as narrowing the initial focus of inquiry to a specific, clearly definable behavior. Few clear adaptation behaviors have been identified in published research and some that have been identified have not yet been quantified. The action criteria for applying the TTM to a new field have not been identified formally, thus the first challenge was to determine what constitutes an "adaptation action" and how such an action could be quantified for the purposes of the TTM and CTI. Currently, there is a lack of scientific consensus on specific adaptation actions for individuals to adopt in the climate change field, so a measurement development process was conducted in order to select a focal behavior for change. Behavior change may be applied on multiple levels (individual, community, state, and policy), but in order to make the project as broadly applicable as possible the Collaborative decided to focus on the individual and population-based levels with a focus on the general public of Rhode Island and New England.

There is a common misunderstanding that the greatest influences on smoking cessation were public health policies such as increased cigarette tax and smoke-free environments. Actually, such policies followed changes at individual and population levels, with more than 50% of those who ever smoked having quit before major policy initiatives emerged. For policies to have adequate impact there need to be adequate numbers of people who will support and abide by them. By producing and implementing surveys like the CTI, focused at the individual level for climate change adaptation, more people can be prepared not only to make individual-level changes, but also to support policy changes at state and national levels.

Measurement Development Survey

The first phase of this project consisted of creating and conducting a measurement development survey, a tool designed to assess which change behaviors would be best suited for use in the CTI pilot study and to develop reliable and valid measures of decisional balance (pros and cons) and confidence for the target

behavior(s). Focus groups and key informant interviews were conducted and results were used to develop and subsequently prioritize the initial list of behaviors and actions, resulting in the identification of ten primary behaviors. The results of this first phase were then used in the development of the second phase of the pilot project, the CTI behavior change program.

The results of the measurement development survey indicated that "being prepared" or "preparedness" was a key target behavior for the CTI application. The behavioral disposition of "being prepared" had the best staging distribution, meaning that there were numerous individuals in each of the five stages of change. Thus "preparedness" was selected as the primary behavior to focus on through the CTI; "preparedness" is widely used and already defined by the Red Cross and the Federal Emergency Management Agency as consisting of three key actions–be informed, get a kit, make a plan. There is a strong link between preparedness, disaster resilience, and climate change adaptation (IPCC, 2007; Keim, 2008).

Actions such as "trimming trees" and "getting a sump-pump" and "re-grading property" were selected as secondary behaviors which would help minimize damage to an individual's property from high winds and floods. The secondary behaviors were selected during the measurement development process using the same methods that were employed in selecting the primary focus behavior.

Participants in the measurement development survey were recruited through emails sent out to University of Rhode Island and other email lists, Facebook postings, and personal contacts. A total of 277 homeowners took the survey, 214 (77.3%) from Rhode Island, 45 (16.2%) from Massachusetts, and 18 (6.5%) from Connecticut.

Measures

Stage of Change, Decisional Balance, Self-Efficacy

Stage of Change

Knowing an individual's stage of change is necessary in order to understand his or her progress through the stages and associated processes. Participants' stages of change were assessed across three primary behaviors and seven secondary behaviors. Primary and secondary behaviors and corresponding assessment questions are listed in Figure 4. Participants were asked to choose one statement that best reflected their current situation from a list of five staging statements. For example, for disaster preparation, the staging question was "Have you prepared for a potential disaster by making an action plan and preparing disaster supplies such as food, water, and other essentials that allow you to be self-sufficient for at least five days?" The five response options were: (1) "No, and I do not

intend to prepare in the next year" (Precontemplation); (2) "No, but I intend to prepare in the next year" (Contemplation); (3) "No, but I intend to prepare in the next 6 months" (Preparation); (4) "Yes, I have been prepared for the last year" (Action); or (5) "Yes, I have been prepared for more than a year" (Maintenance).

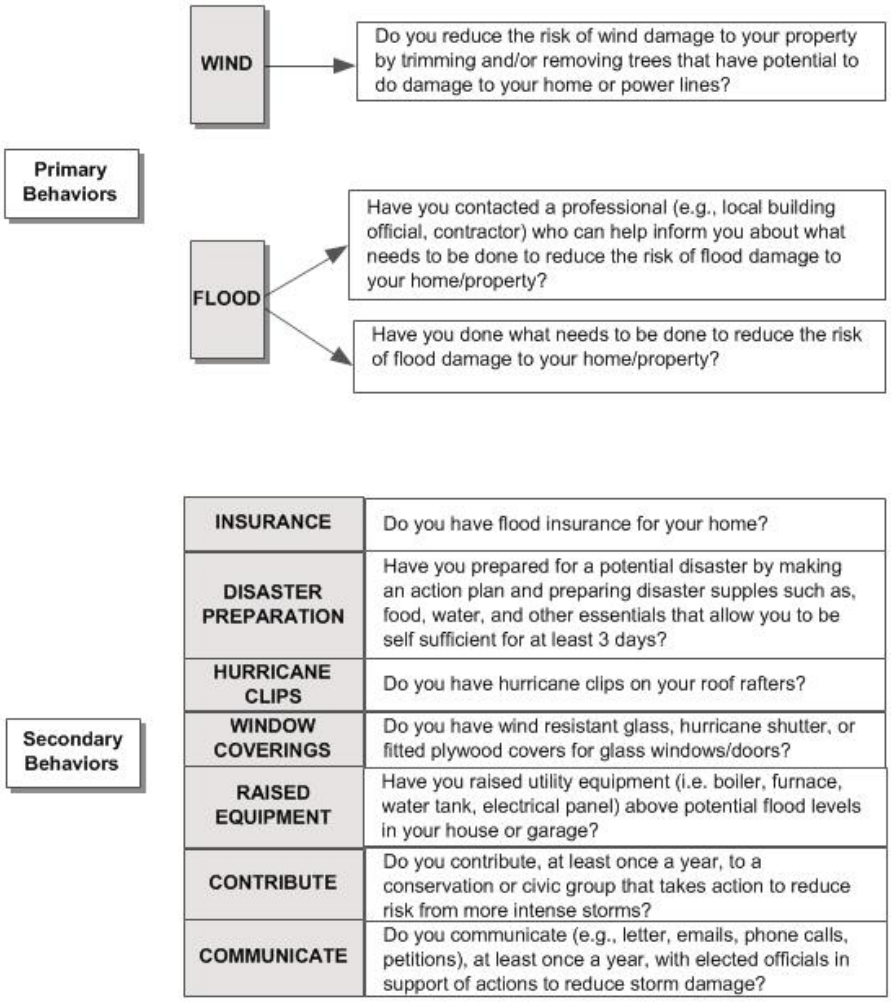

Figure 4: Primary and secondary behaviors and their corresponding assessment questions.

The results from the stages of change survey across the three primary behaviors and seven secondary behaviors over the distribution of participants are displayed in Appendix 1. The distribution of stages differed noticeably across the ten primary behaviors. The staging distribution for the disaster preparation behavior showed the broadest distribution, with a significant number of individuals in each of the five stages (see Figure 5). A broad distribution of participants across all five stages is necessary in order to show potential movement of participants through the stages of change during and after the behavior change intervention. Of the 277 participants, 14.8% were in Precontemplation, 15.2% in Contemplation, 10.8% in Preparation, 22% in Action, and 37.2% in Maintenance. The stage distributions are similar to what is found for some major health risk behaviors, such as

smoking. This supports the use of TTM and CTI for non-health behaviors such as climate change adaptation.

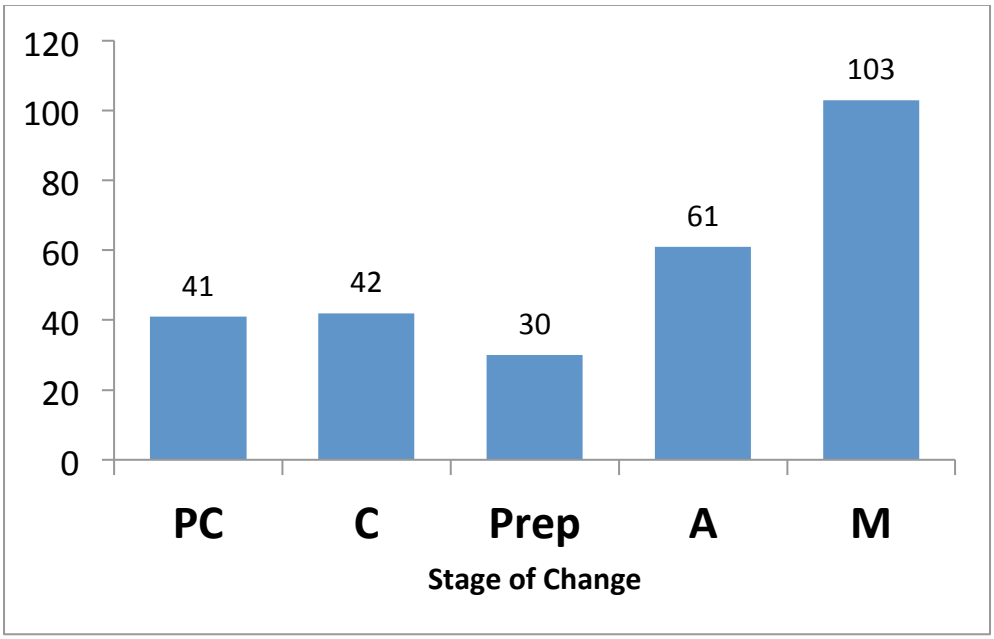

Figure 5: Frequencies of participants for Disaster Preparation secondary behavior.

Decisional Balance

Decisional balance, the component of the TTM in which the individual evaluates the pros and cons of behavior change, helps move the individual through the stages of change. For the decisional balance measure, twenty items were included in the initial survey, with ten pros and ten cons of taking adaptive actions. Respondents were asked: "How important to you are the following statements in your decisions concerning risk reduction strategies?" Respondents then ranked the importance of each statement to their decision making regarding specified adaptive actions on a five-point Likert scale with one corresponding to "not important" and five corresponding to "extremely important."

Confirmatory factor analysis, used by social science researchers to find the relevance in survey responses compared to the research hypothesis, was performed on the twenty original decisional balance measurement items to test the TTM. In the analysis, Collaborative researchers imposed the model on the measurement items to see how well the model fit with the data. The initial twenty items were reduced to eight items: four pros and four cons. The final eight items are presented in Figure 6.

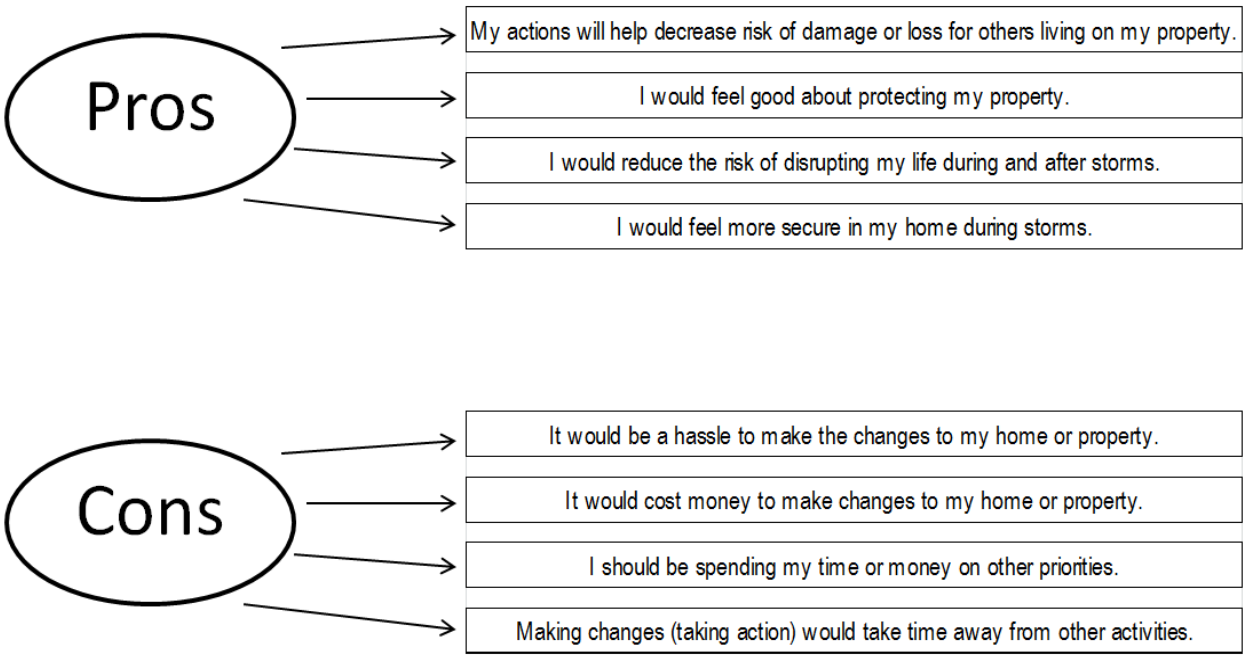

Figure 6: Final eight Decisional Balance items.

Pros and Cons scores were then calculated for each participant by summing up the responses of the final four Pros items and final four Cons items. In order to examine the relationship of pros and cons across the different stages of change, the pros and cons scores were converted to T-scores, where the mean equals 50 and the standard deviation equals 10, and plotted by stage (see Figure 7). Converting raw scores to T-scores facilitates comparison across subscales (pros and cons) and across other studies that use the TTM scales.

There was a large increase observed in pros from the Precontemplation and Contemplation stages to the Preparation and Action/Maintenance stages (Figure 7), notably, an approximately one standard deviation increase in pros from Contemplation to Preparation. A decrease in cons was also observed across stages. Incidentally, the pattern observed in Figure 7 is consistent with those found in many health-related behaviors (Prochaska, 1994).

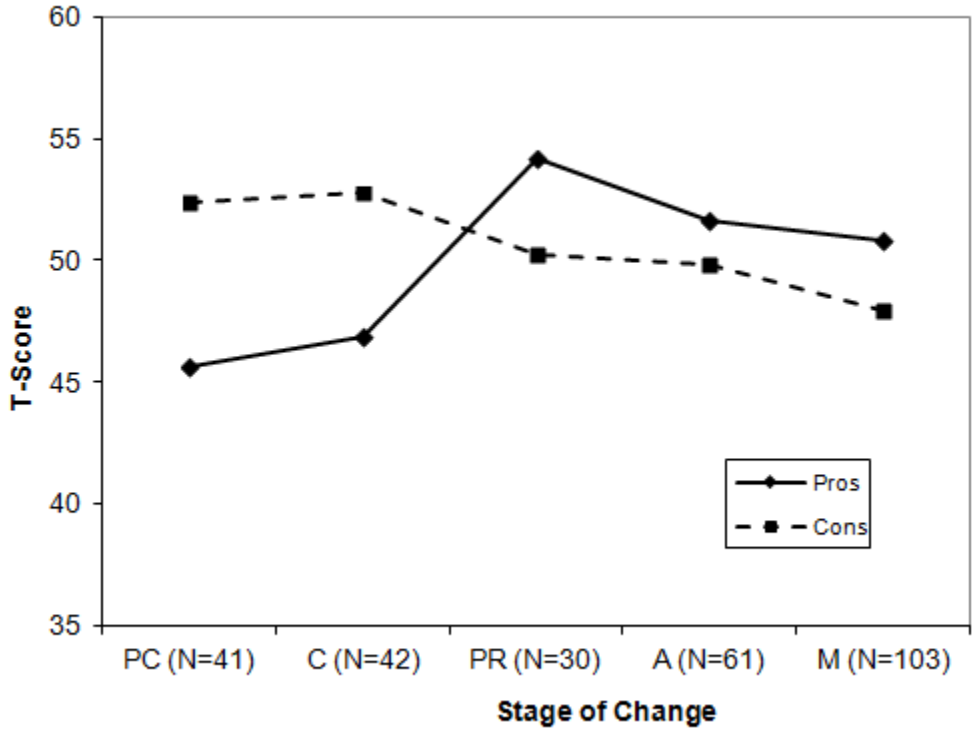

Figure 7: Disaster Preparation stage of change by Decisional Balance.

Self-Efficacy

In addition to decisional balance, self-efficacy (also called "confidence") contributes to moving individuals through the processes of change. The self-efficacy metric measures individual's levels of confidence in his or her ability to take and maintain behavior change actions. For the confidence scale, thirteen items were included in the initial survey and each respondent rated his or her degree of confidence on a five-point Likert scale (1 = not at all confident to 5 = completely confident). Confirmatory factor analysis was performed on the thirteen original confidence items, reducing the list to the most significant six items (Figure 8).

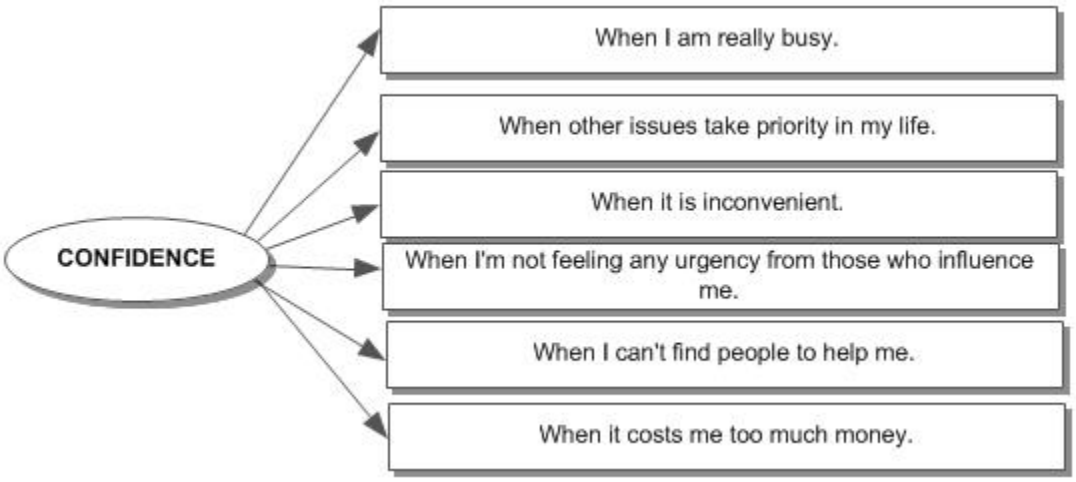

Figure 8: Final six Confidence items.

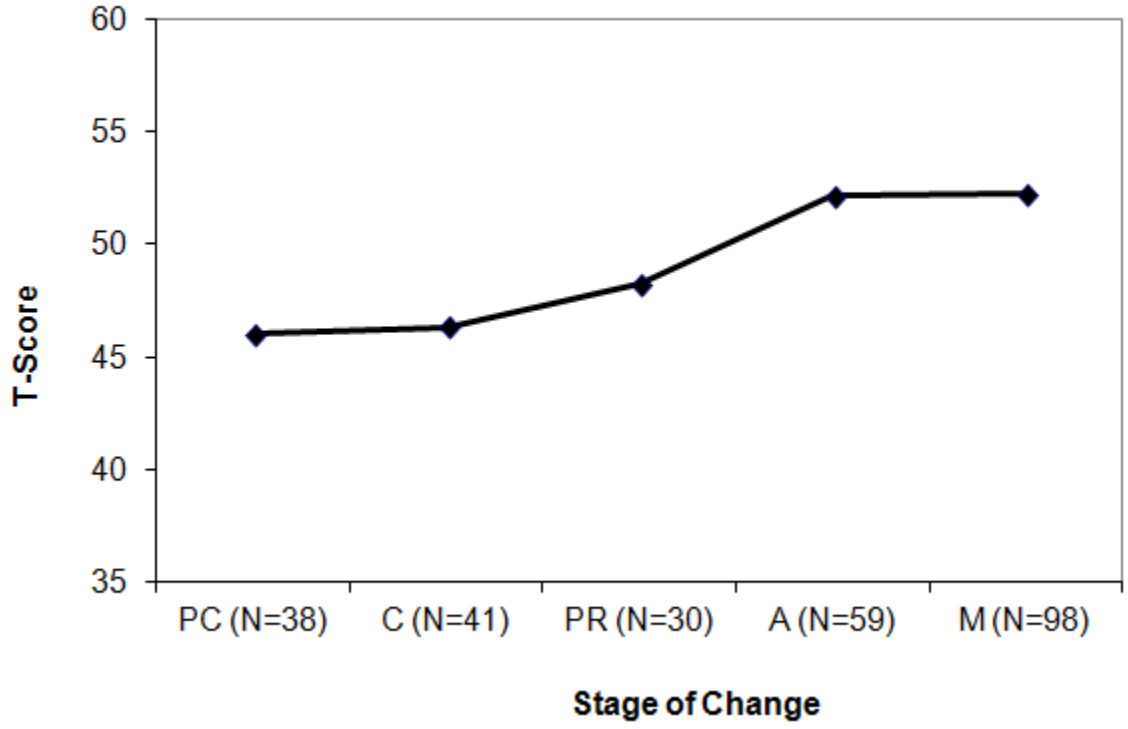

Figure 9: Disaster Preparation stage of change by Confidence.

Confidence scores were then calculated for each participant by summing the responses of the final six items. As with the decisional balance measures, confidence scores were converted to T-scores and plotted by stage (Figure 9). Findings showed that confidence increases across stages, with the largest increase observed from Preparation to Action.

Discussion: TTM Measures

The Processes of Change build on the measures of Self Efficacy and Decisional Balance resulting in an overall stage of behavior change. The pyramid structure of Figure 3 (see page 6) illustrates how Decisional Balance and Self Efficacy are based on stage, and the Processes of Change or strategies that help people change behavior are based on the rest of the pyramid. The results of the measurement development survey provide valuable insights into the motivations individuals need to take various adaptive actions when faced with climate change. The initial survey also supports the application of the TTM to climate change adaptation behaviors and demonstrates potential future applications of these methods to other fields such as disaster mitigation and coastal hazards management. As Appendix 1 shows, the participants' distribution across the stages of change indicated that the behavior of disaster preparedness was best suited for use in developing a computer-tailored intervention (CTI). The measurement development survey provided the research team with a clear path for applying the CTI. Among the 277 participants surveyed during the measurement development phase, each of the five stages of change were represented, which indicates that there was adequate distribution to display movement between stages through the application of a CTI. Additionally, selection of disaster preparedness as the target behavior for the CTI resulted in a population-based pilot study that was applicable to a broad audience, including coastal and non-coastal communities and individuals across a range of socio-economic statuses.

Study 2: Computer Tailored Intervention

Program Description

The Disaster Preparedness computer-tailored intervention was a pilot designed to promote increased preparedness for natural disasters such as tropical storms and hurricanes, inland and coastal flooding, and blizzards through a web-based interactive survey. Participants were recruited through email announcements, listservs, postcards, and personal contacts. The pilot Disaster Preparedness CTI consisted of one session lasting approximately 20 minutes that began with an overview of the pilot study, informed consent, and questions to determine eligibility followed by a series of interactive questions (Figure 10). This study examined three behaviors: increasing disaster preparedness, reducing the risks of wind damage, and reducing the risks of flood damage. The primary focus of the CTI was increasing individuals' preparedness for disasters that will become more frequent with climate change. Being prepared was defined as a three-part process including the actions of "getting a kit, making an evacuation plan, and being informed."

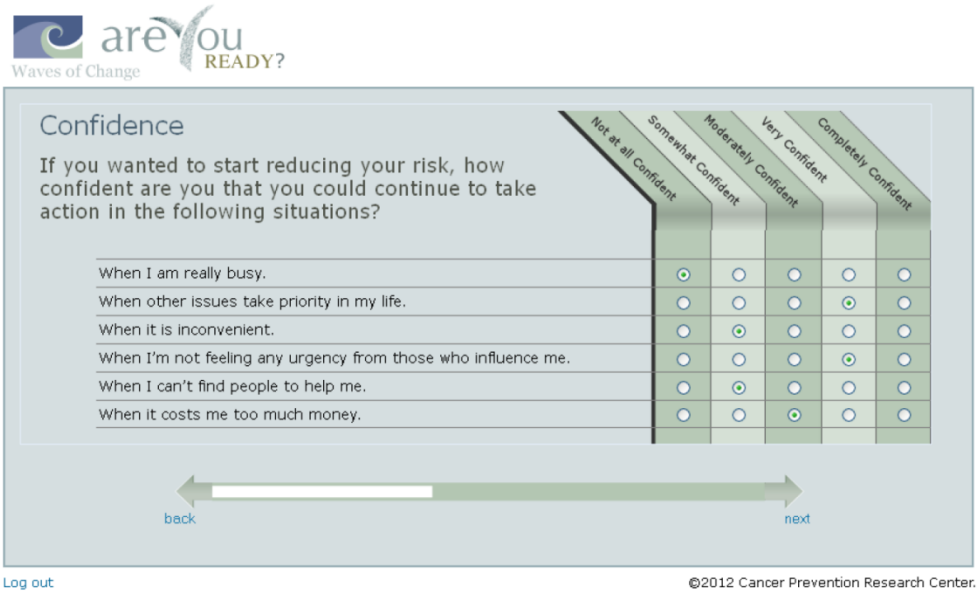

Figure 10: Example from the Computer-Tailored Intervention.

Measures

Demographics

Several questions were used to gain basic information related to participants' race, gender, age, level of education, and homeowner status. Participants in this CTI (N=100) included individuals with a variety of educational levels, both homeowners and renters, and from a broad age range. Appendix 2 displays the demographic characteristics of this study population. The majority of the participants were white (95%), female (60%), ranged in age from 22-77 (medium of 51.59 years), and were highly educated (64% had graduate degrees). The disproportionately high number of white and highly educated respondents indicates that this is a non-representational sample of the overall population in the target region.

Stage of Change

Participants' stages of change were determined for the disaster preparedness behavior through a computer algorithm which classified individuals into one of the five stages of change based on their responses to questions about their behavior and intentions. Precontemplation is characterized by not currently engaging in the behavior and not intending to start within the next year. Contemplation is characterized by considering engaging in the behavior within the next year. Preparation is characterized by planning to engage in the behavior in the next six months. Action is characterized by engaging in the behavior during the last year. Maintenance is characterized as having been engaged in the behavior for the last year or more. Knowing participants' stages of change is very

important because the CTI provides different responses and feedback information for individuals in different stages. For example, the feedback given to a participant in Precontemplation is worded quite differently from the feedback given to someone in the Action stage.

The CTI used in this study focused on improving individual's disaster preparedness, thus the information provided centered on getting a disaster kit, making an evacuation plan, and being informed about disasters and risks in the individual's area. Individuals who stated they were not thinking about taking these actions to improve their disaster preparedness, and thus were in Precontemplation, were provided with information about the benefits of preparedness, such as: "I will know how to keep my family safe and recover faster in a disaster. I will know how to stay in contact with my family when a disaster happens. I will feel good knowing that I am helping to protect my family and pets." Individuals who stated they were thinking about getting prepared but had not yet taken action (in Contemplation) were encouraged to "think about the basic supplies you, your family and your pets will need in advance of a disaster, how you will communicate, and what supplies you need to keep in your home. The more you know about what to do, the more confident and secure you will feel in your ability to stay safe and recover faster from a disaster." Individuals in the Preparation stage were provided with specific information regarding what supplies should be in their disaster kits, what information they should include in their evacuation plans, and sources of additional information such as www.redcross.org and www.Ready.gov. Individuals in the Action stage were congratulated on taking action to protect their home and family during disasters and reminded of the supplies needed for a complete disaster kit and what information to include in their evacuation plan. Similarly, individuals in Maintenance were applauded on their continued action and encouraged to keep their disaster kits and evacuation plans updated and review them on a regular basis.

The pre-intervention test results revealed that 12% of the participants were in Precontemplation, 17% in Contemplation, 19% in Preparation, 18% in Action, and 34% were in Maintenance. Thus, a total of 48% of respondents were in the pre-action stages of change (Precontemplation, Contemplation, and Preparation) and 52% were in the Action/Maintenance stages. The post-intervention test showed some movement between stages with 9% of participants in Precontemplation, 19% in Contemplation, 19% Preparation, 18% in Action, and 35% in Maintenance. However, this small amount of movement is to be expected since it was only approximately a 20-minute interval between the pre- and post-intervention surveys. The final division of participants showed 47% in pre-action stages and 53% in Action/Maintenance. Because pre-test, CTI, and post-test were completed within one session, participants could not be expected to move to the Action stage during the session.

Decisional Balance

The two decisional balance subscales, pros and cons of behavior change, were adapted to the behavior of disaster preparedness. Individuals measured their pros and cons on a five-point Likert scale from "not at all important" to "extremely important." The pros and cons questions were asked once at the beginning of the CTI program and the pros questions were repeated once at the end following evaluation feedback. Each subscale contained four questions regarding the pros and four regarding the cons of disaster preparedness. The scale reliability for the decisional balance measures is reported in Table 1.

Table 1: Scale Reliability for Decisional Balance and Confidence Measures

Time	*Scale*	*No. Items*	*Cronbach's α*
Pre-test	Pros	4	.732
	Cons	4	.694
	Confidence	6	.890
Post-test	Pros	4	.866
	Confidence	6	.917

Note: Cons were not included in the post-test

Self-Efficacy

Self-efficacy was measured as a six-item scale regarding participants' confidence in behavior change. Questions were measured on a five-point Likert scale ranging from "not at all confident" to "completely confident." The scale reliability for the confidence measure is also reported in Table 1.

Evaluation Questions

Sixteen items on the CTI survey asked respondents for feedback regarding the CTI program itself, including 14 questions using a four-point Likert scale from "strongly agree" to "strongly disagree" and two open-ended questions asking participants what aspects of the program they liked the most and liked the least.

CTI Evaluation Statement	% of participants who responded "Agree" or "Strongly Agree"
The program gave sound advice.	≥90%
The program was easy to use.	
The personal feed back was easy to understand.	
The program was easy to navigate.	
The program was useful.	80% to 89%
I liked the way the program looked.	
I would feel comfortable recommending this program to others.	
The program could help me be more prepared.	
The program could help me make changes.	
I enjoyed using the program.	
The questions were easy to understand.	70% to 79%
The program gave me something new to think about.	
The program was designed for people like me.	
I learned new information by using this program.	60% to 70%

Program Strengths

Aspects to Improve

Figure 11: Results of CTI pilot evaluation.

Discussion: Computer-Tailored Intervention

This study demonstrates that the health-behavior based method of the TTM and its CTI implementation can be adapted and applied to individual behavior change related to climate change adaptation. Given the one time, 20-minute intervention pilot, the slight movement between the pre-action stages (Precontemplation, Contemplation, and Preparation) that participants showed over the course of the CTI indicates that it may be successfully applied on a broader scale. Additionally, the decrease in the number of individuals in Precontemplation from 12% to 9% suggests that the CTI was effective in encouraging individuals who had not previously considered preparing for disasters to at least think about getting prepared. This result indicates that this method could be an effective tool to reach populations and change preparedness and other behaviors associated with climate change adaptation. Moreover, the participants' evaluation of the interactive program was positive. This positive evaluation of the CTI program supports future efforts to reach key population segments and encourage individual climate change adaptation behaviors through the use of the TTM and CTI methods. The lessons from this work could also be used to address decision makers and administrators who may be reluctant to embrace the necessary steps to promote preparedness in their communities.

Limitations of These Two Studies

These studies were limited by several factors, which may be addressed in future work. Individuals who were recruited to participate in the measurement development survey and

the subsequent CTI were drawn from a convenience sample, not a random sample. Since solicitation emails were sent out to personal contacts and listservs, participants were limited to individuals who received the emails, postcards, or were contacted personally. Many of the personal contacts are already engaged with environmental and resource-based initiatives; consequently, there may have been a response-bias in this sample. In future applications of the TTM and CTI, the researchers would prefer to use a random sample of respondents and include a larger study population. It is important to note that the participants are non-representative demographically with the vast majority of respondents (64%) holding a graduate degree. Additionally, it is not possible to draw conclusive evidence from this pilot project because it is hard to see change over the course of a 20-minute survey. In order to obtain more conclusive results, additional research should include longitudinal studies over a longer period of time, reassessing participants after a six-month or one-year period to determine how behaviors change, indicated by movement through the five stages.

Future Research and Applications

General

Finding solutions to the complex, multi-faceted challenges posed by climate change requires the expertise of interdisciplinary teams capable of understanding and synthesizing information and data from a variety of sources. A broad spectrum of experts from different fields, including psychology, biology, oceanography, political science, economics, planning, management, and communication is needed. The combination of several fields of study, methods, and outcomes created a unique opportunity for the team of faculty, staff, and students to learn from each other and from the project process itself, providing a rich and complex set of skills uniquely suited to addressing climate change problems. It is important to address differences in terminology, work style, and project goals early in the collaboration process in order to facilitate a comfortable and efficient work environment. While dividing the tasks into branches or subgroups was essential to the project's progress, it was especially important to actively resist moving back into the separate "silos" of discrete disciplines. Regular check-ins throughout the project including all members of the team are critical to improving integration and cooperation between different fields of expertise.

The application of the TTM to climate change adaptation is a good example of the challenges and rewards of applied research. Not surprisingly, one of the central lessons that members of the Collaborative learned through this project was that applied interdisciplinary research is complicated and adds complexity to the application of models such as the TTM. The model, in turn, provided many opportunities to experiment, learn, and reformulate hypotheses. The TTM was initially developed to change health behaviors

such as smoking cessation, increasing exercise frequency, and improving diet. While the challenges of climate change adaptation and health-related behaviors differ there are also some important similarities. In each case, the behavior targeted for change must be clearly defined and achievable to make it applicable to TTM. Additionally, each stage of behavior change must be identifiable and individuals must be able to assess their progress through the stages. Defining "climate change adaptation" as a targeted behavior is complex and identifying specific adaptation actions and behaviors is difficult, but both are essential to the successful application of the TTM. However, by applying the TTM and CTI to the topic of climate change adaptation, the Collaborative learned that the model could be successfully applied in fields other than health behavior change, and a new way of approaching individual adaptation actions and behaviors was developed. Communicating to the broader public was an additional objective of this work. Once the theory was fully understood, it was incorporated into messaging for policy and outreach materials as well as in the development of the Climate Challenge Collaborative's *Waves of Change* website, all the while helping to target messages toward strategic actions.

Behavior Change

One of the most important lessons that emerged from this project was that behavior change in the face of climate change impacts is a long process involving many small steps to move people from Precontemplation to Maintenance. Members of the Collaborative with previous knowledge in the psychology of behavior change were familiar with the slow deliberate processes involved. Those with backgrounds in oceanography and coastal management learned that changes in behavior often cannot be measured immediately, and that movement demonstrated by an individual from one stage of change to the next is still meaningful and important change, even if the individual has not yet reached the Action stage. For example, movement between Precontemplation and Contemplation dramatically increases the likelihood that the person will eventually reach Action and Maintenance. Each stage is a step on the way to lasting behavior change.

The Collaborative also concluded that if individuals do not understand what actions they need to take to change their behavior it is much harder to promote and support behavior change. Likewise, if practitioners do not clarify what change they want to enact, they cannot effectively communicate and take action to achieve the behavior change.

Further, the assessment tool and related communications must clearly define the behavior targeted for change and include specific achievable actions. Other desired changes that are meaningful but difficult to operationalize within the TTM should be omitted. The initial target behaviors for this project focused on reducing an individual's risk of damage from flooding and high winds, which are the two primary threats associated with increased

flooding and more frequent severe storms in Rhode Island. However, the measurement development survey found bi-modal distribution of individuals across stages for flood and wind behaviors. Individuals with a high risk of flood damage already had flood insurance (and were in the Maintenance stage) and those with a low risk of damage were not planning on getting flood insurance (and thus were in the Precontemplation stage). Similarly, many homeowners in areas with high wind risk already had hurricane clips on their homes; however, the majority of other homeowners were not planning on getting them. Since most of the respondents were either in the Precontemplation or Maintenance stages for these two behaviors, application of a CTI focused on these behaviors was unlikely to successfully promote any changes in behavior. Therefore, the Collaborative decided to focus on disaster preparedness since this behavior is incremental in nature and showed better distribution across the five stages of change.

Interventions and Communications

Engaging with the public about climate change science and adaptation is often difficult due to the complexity of the subject and the perceived uncertainty of timing and severity of threats. This project identified several strategies that may facilitate better communication by coastal managers and climate change scientists working with the public. Communication effectiveness may be improved by targeting messages to the audience's current stage of behavior change, either individually or as a group.

The problems and challenges posed by climate change vary across the country and the world; thus, multiple stakeholders and stakeholder groups must be involved in adaptation behavior change. If an audience is completely unaware of sea level rise and its impacts and has no understanding of climate change, the message should be tailored to an audience in the Precontemplation stage of change. However, an audience with knowledge about sea level rise impacts may be in the Preparation or even Action stage of change, and the messages they receive should be different from those presented to individuals in Precontemplation. Examples of messages and language used in communicating information to individuals in different stages may be seen in the feedback responses provided by the CTI in Appendix 3.

One of the major challenges of outreach, communication, and engagement is that in dealing with any given audience, all five stages of behavior change may be represented. Thus if messaging relies on a single document, it must deliberately use a broad range of communication strategies. For example, the *Waves of Change* website is designed to provide appropriate information to individuals in each and any of the five stages of behavior change. For an audience in the early stages of Precontemplation or Contemplation, the website contains a broad general overview of climate change impacts and preparedness actions. An audience in the Preparation or Action stage can also find

more in-depth information, additional readings and resources, and detailed actions they can take at home and in their community.

Another language and design consideration was the website visitor's confidence in his or her ability to change. As the pros and cons of changing behaviors vary across the different stages, targeted communication needs to emphasize different pros and cons when addressing audiences in the Precontemplation stage versus Preparation and Action stages. To maximize appeal to different segments, an array of media is employed throughout the website to assist individuals who are more visual (video, animation) or aural (narrated short videos and songs) in decoding messages. Using a variety of media can also increase time spent with the message.

Designers also decided that the *Waves of Change* website should, in general, be easily navigated from one section to the next, enabling the user to easily find the appropriate section. The language throughout the site is conversational in tone with an abundance of opportunities for visitors to explore topics in-depth.

When developing outreach and communication materials for the general public, it is important to recognize that an overly academic focus on the science of climate change is not likely to capture and hold the attention of a broad audience or lead to engagement in behavior change. While scientific facts need to be evident, it is information about the actions people can take that is likely to empower and engage an audience. Highlighting what an audience can do sets up an inclusive and encouraging dialogue focused on behavior change and, ultimately, adaptation.

In developing communication vehicles and messages, the inclusion of numerous stakeholder groups' perspectives is difficult but vitally important. While stakeholder groups should be discrete audiences for behavior change messaging and communication, the groups' perspectives should also be included in behavior change communications intended for a general public audience. Both individual and societal behavior change is necessary in order to adapt and prepare for climate change. Cooperation between and among different stakeholder groups also provides opportunities for information sharing and collaborative learning. General audiences benefit from this process because it informs messaging about adaptation.

Outreach and Communication

The insights, strategies, and lessons learned from this climate adaptation behavior project may be used to inform future coastal management, climate change science, communication, and outreach efforts. This pilot project's application of the TTM and CTI methods to non-health related behaviors may serve as a model for future applications of this behavior

change model to other environmental fields, such as natural hazard and greenhouse gas mitigation, and conservation efforts.

The URI Climate Change Collaborative engaged in other activities to complement the TTM and CTI pilot project. Insights, skills, and ideas gained from the TTM and CTI process informed concurrent public education and community engagement projects, materials and events including a science symposium, the *Waves of Change* website (http://riclimatechange.org), new climate change fact sheets and brochures, and stakeholder and sectoral meetings and presentations.

This pilot project reframed the Collaborative members' perspectives regarding what constituted "action" and behavior change. The members learned to expect that individuals in different stages of change are likely to be present within any given audience. With that realization in mind, the language and communication style of the *Waves of Change* website was designed to effectively address an audience composed of individuals in all five stages of change. In addition, new fact sheets and educational materials highlight the actions individuals can take with sections addressing "what you can do," as well as presenting the science that supports the actions.

The three-step model of disaster preparedness used in the CTI consisted of "get a kit, make a plan, and be informed." This simple model may also be applied in future outreach projects and materials–such as the Shoreline Change Special Area Management Plan (SAMP)–the *Waves of Change* website, and educational resources. The components of each of these three actions may change when applied in different ways, but this three-step model provides a framework that addresses knowledge needs, planning needs, and tool or strategy needs to create a useful "kit" or "toolbox" of skills and information.

This project has the potential to bring about important synergies between the social sciences, the natural sciences and the coastal outreach community. A number of steps can be taken to continue growing the momentum from the work described here:

- Identify opportunities to take the pilot project to a larger scale and include longitudinal study to measure change over time
- Apply TTM/CTI in other hazard mitigation scenarios or for specific adaptation actions
- Identify specific action criteria for other areas of climate change adaptation
- Develop policy-level and community-level change strategies which create a supportive environment for individual change
- Promote awareness of the need for interdisciplinary synergies among researchers and practitioners
- Accentuate the need to improve communication and behavior change strategies as essential ingredients of addressing the future impacts of climate change

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Appendix 1: Measurement Development Survey Stages of Change

Figure 1-1 displays the distribution of individuals across the five stages of change for each of the 10 Measurement Development behaviors. These graphs clearly illustrate that Disaster Preparation has the best distribution of individuals across each of the five stages.

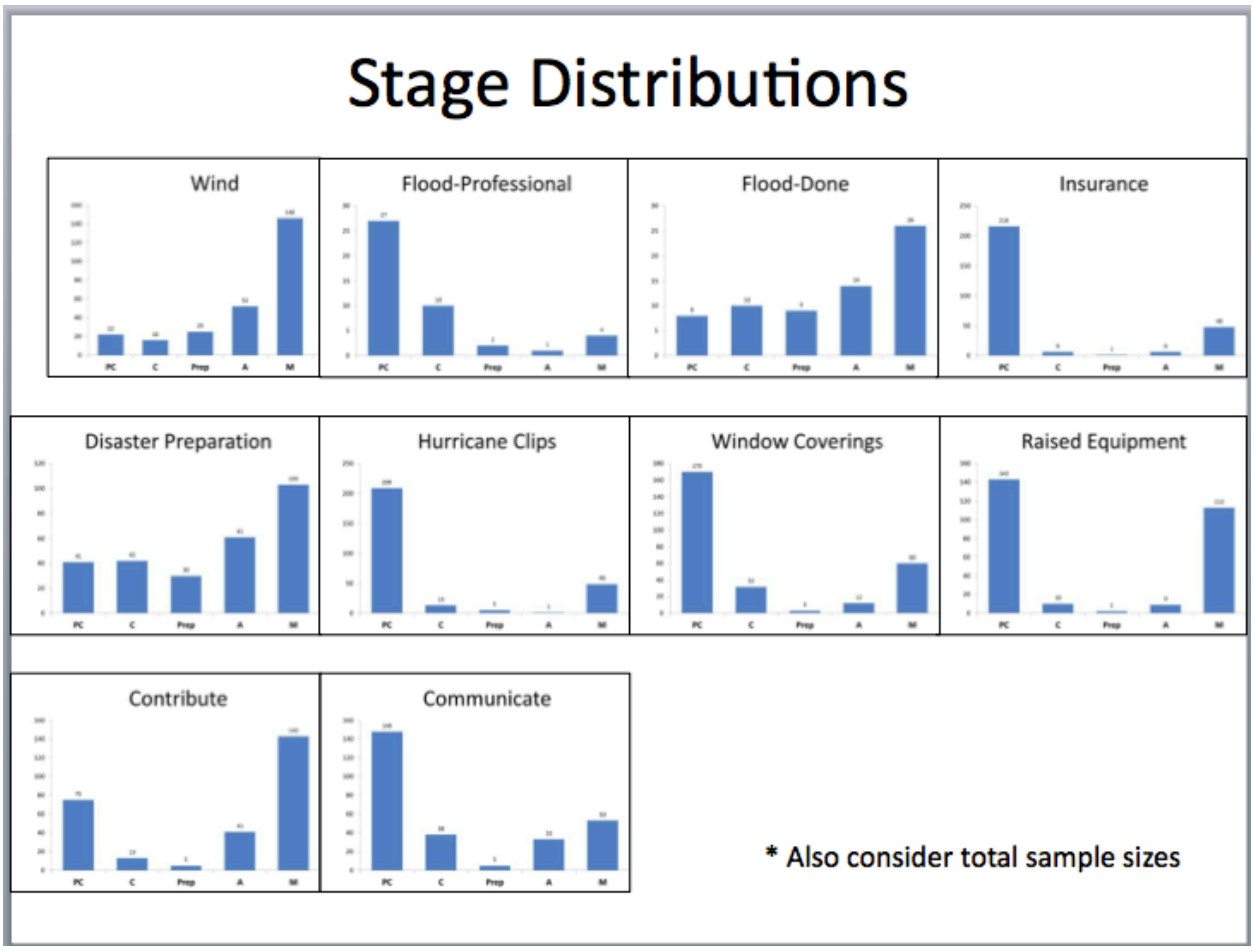

Figure 1-1: Stage Distributions from Measurement Development Survey.

Appendix 2: Demographics of CTI Study Participants

Figure 2-1 contains the demographics of the individuals who participated in the Computer Tailored Intervention Study.

Demographics	***n***	***Percent***
Race		
White	95	95%
Asian	2	2%
American Indian or Alaska Native	3	3%
Ethnicity		
Hispanic or Latino	2	2%
Not Hispanic or Latino	98	98%
Gender		
Female	60	60%
Male	40	40%
Highest Level of Education		
High School Graduate	2	2%
Some College	4	4%
Bachelor's Degree	30	30%
Graduate Degree	64	64%
Homeowner		
Yes	90	90%
No	10	10%
Age	Range: 22-77; M =51.59, SD =13.44	

N = 100

Figure 2-1: Demographics of participants in Computer Tailored Intervention Study.

Appendix 3: Examples of Feedback and Information Provided by the CTI Survey

Figures 3-1 to 3-4 include examples of feedback and information provided to individuals through the Computer Tailored Intervention Study. All feedback and information provided is tailored to the individual's specific stage of change and thus feedback and information given to different individuals includes variations in language and content.

Figure 3-1 provides feedback for an individual in the Contemplation stage of change, focusing on encouraging the individual to think about what they need to do to become more prepared and the pros of taking preparedness actions (they will feel more confident and secure in their ability to stay safe during a disaster).

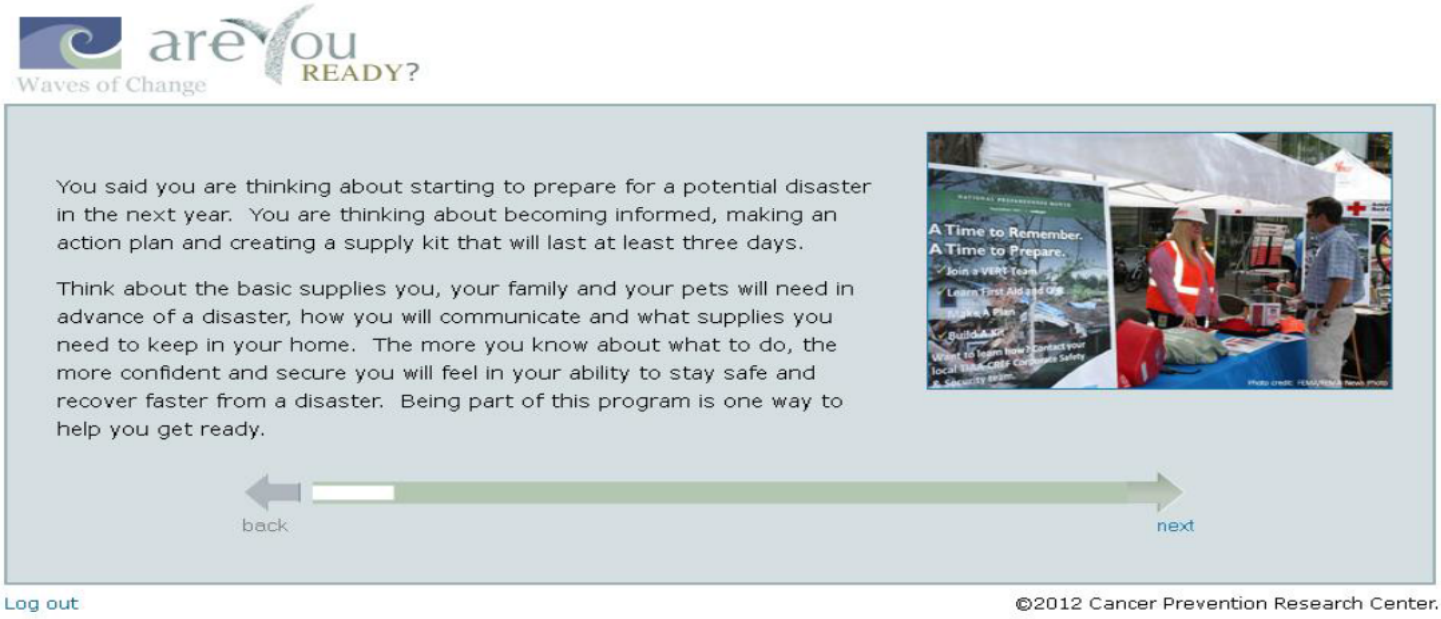

Figure 3-1: Feedback for individual in Contemplation stage of change.

Figure 3-2 is tailored for an individual in the Preparation stage of change. In contrast to the first paragraph shown above, the second example congratulates the individual on starting preparing to take action and encourages them to continue their behavior change and take more steps to become prepared.

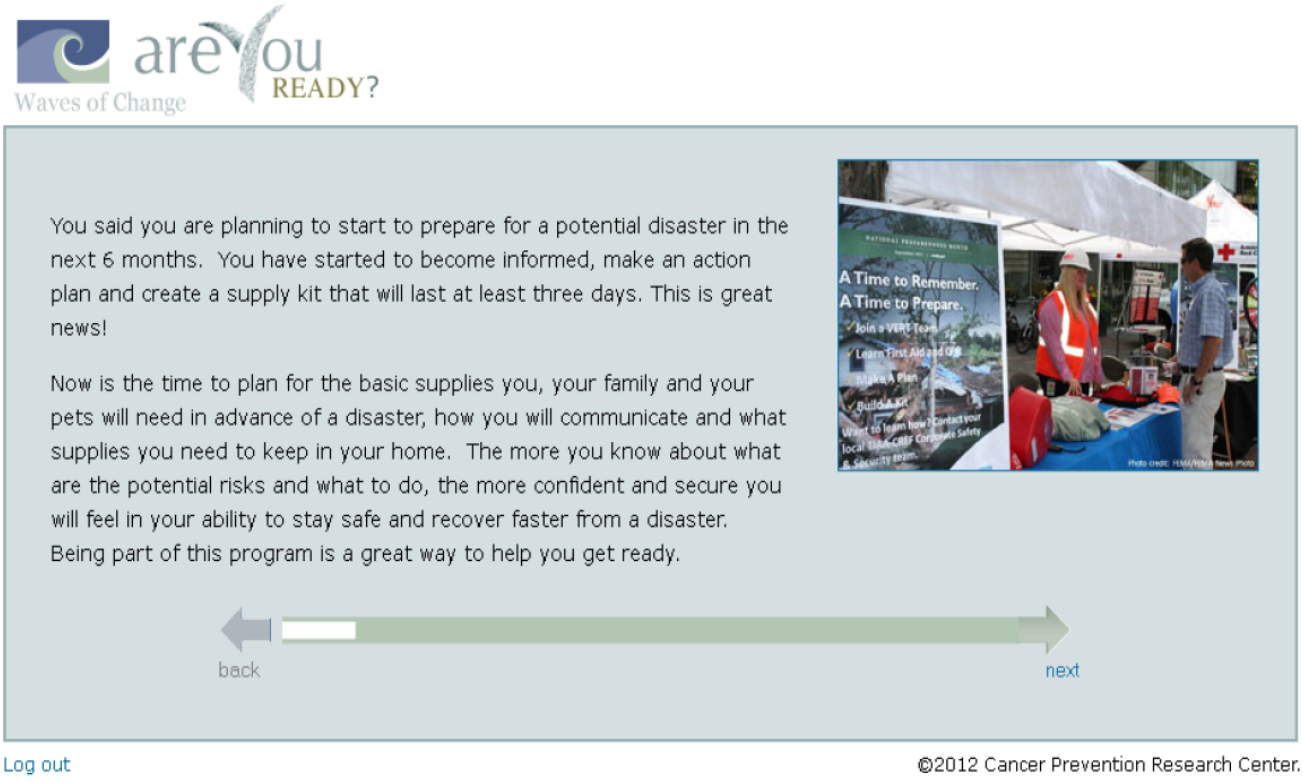

Figure 3-2: Feedback for individual in Preparation stage of change.

Figure 3-3 provides information on specific actions individuals may take to become more prepared. This feedback may be helpful for individuals in several stages of change, particularly Contemplation and Preparation, but individuals in all stages may learn from it.

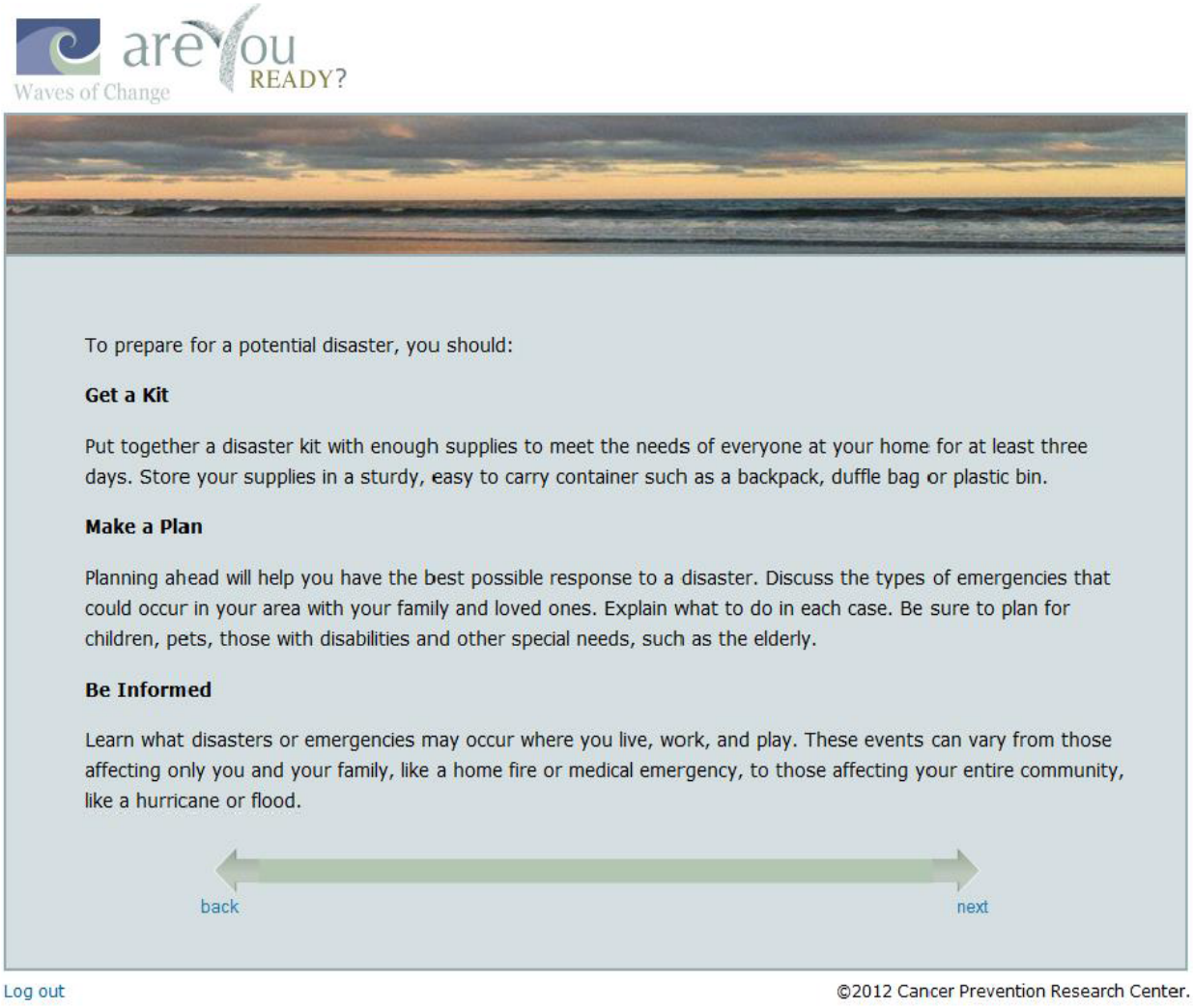

Figure 3-3: Information on actions individuals may take to become more prepared.

Examples of the pros and cons of becoming more prepared are outlined in Figure 3-4. Similar to the previous example, this feedback is appropriate for individuals in more than one stage of change and can encourage them to start taking steps towards changing their behaviors or continue behavior changes they have already started.

Figure 3-4: Examples of the pros and cons of becoming more prepared.